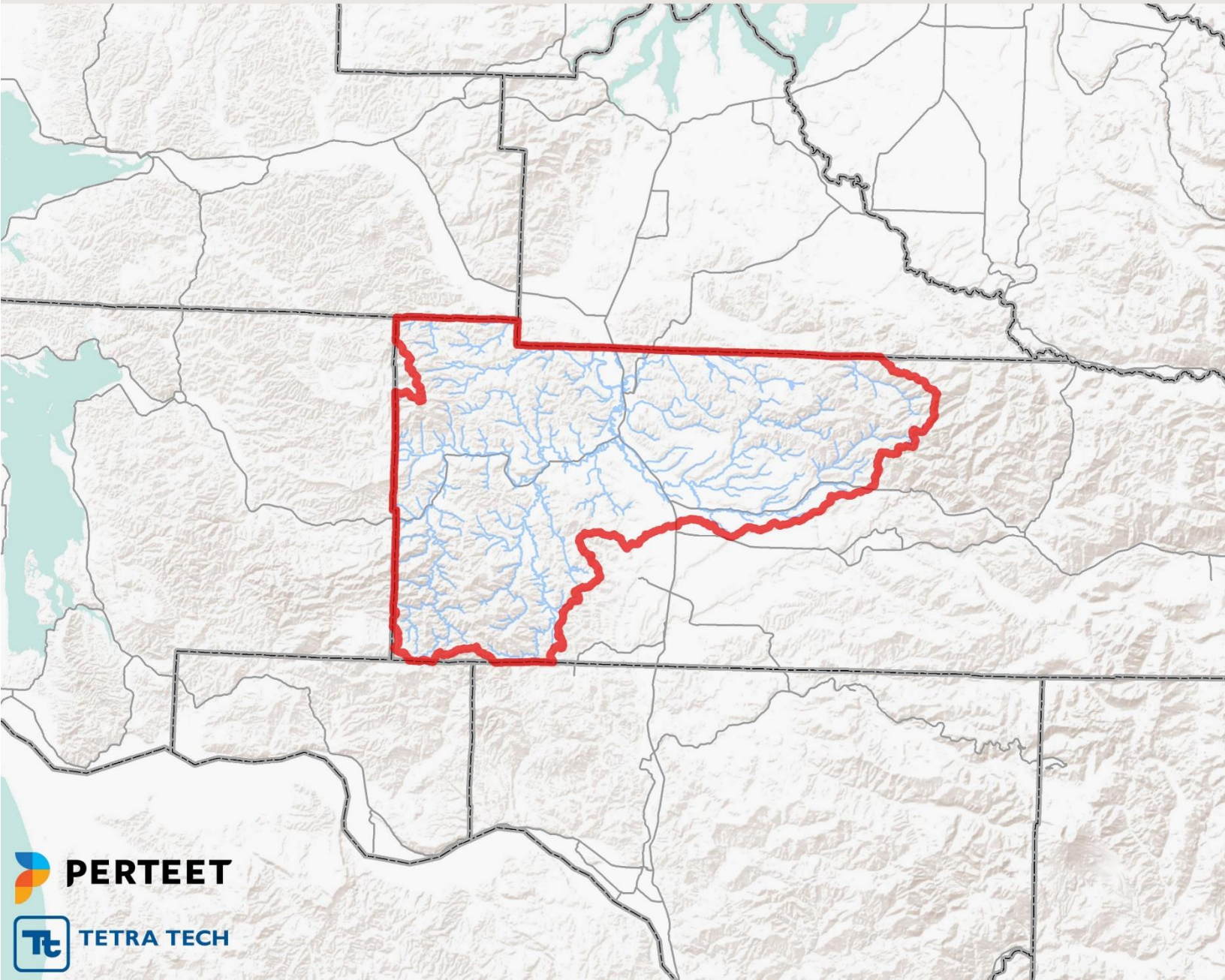
Chehalis River Basin Flood Control Zone District

Comprehensive Flood Hazard Management Plan

Public Review Draft
August 23, 2021



PERTEET

TETRA TECH

AKNOWLEDGMENTS

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Chehalis River Basin Flood Control Zone District

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Special Acknowledgments

The development of this plan would not have been possible without the dedication and commitment to the process by the Stakeholder Committee. The dedication of the Stakeholder Committee volunteers who graciously allocated their time to this process is greatly appreciated. In addition to the Stakeholders Committee's effort, the Flood Control Zone District and the Comprehensive Flood Hazard Management Plan would not be possible without the citizens of Lewis County.

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EXECUTIVE SUMMARY

Flooding is a major concern in the Chehalis River Basin within Lewis County. Flood events have caused millions of dollars in damage, lost commerce, and disrupted lives. Recent events and the formation of the Chehalis River Basin Flood Control Zone District (FCZD) have prompted the FCZD to update this Flood Plan. The FCZD needs a comprehensive plan to guide its operations. This Flood Plan will serve as a guidance document for the FCZD by providing regional policies, programs, and projects to reduce the risk to people and property from river and stream flooding within the Chehalis River Basin. It presents a long-term vision for managing all flood hazards in Lewis County's Chehalis River Basin and recommends near-term actions to achieve that vision. The Flood Plan recommends actions the FCZD, Lewis County and the Cities of Centralia, Chehalis, Napavine, and the Town of Pe Ell. may take to reduce flood risks and to protect, restore, or enhance riparian and aquatic ecosystems.

What is Flood Hazard Mitigation?

Mitigation is defined as "sustained action taken to reduce or eliminate long-term risk to life and property." It involves strategies such as planning, policy changes, programs, projects, and other activities to address risk from hazards in a planning area. The responsibility for hazard mitigation lies with many, including private property owners, business, industry, and local, state, and federal government. Recognizing that there is no one solution for mitigating flood hazards, planning provides a mechanism to identify the best alternatives within the capabilities of a jurisdiction. A flood hazard management plan achieves the following in order to set the course for reducing the risk associated with flooding:

- Ensuring that all possible activities are reviewed and implemented so that local problems are addressed by the most appropriate and efficient solutions.
- Ensuring that activities are coordinated with each other and with other community goals and activities, preventing conflicts and reducing the cost of implementing each individual activity.
- Coordinating local activities with federal, state, and regional programs.
- Educating residents on the hazards, loss reduction measures, and natural and beneficial functions of their floodplains.
- Building public and political support for mitigation projects.
- Fulfilling planning requirements for obtaining state or federal assistance.
- Facilitating the implementation of floodplain management and mitigation activities through an action plan that has specific tasks, staff assignments and deadlines.

The Chehalis River Basin Comprehensive Flood Hazard Management Plan identifies policies and actions chosen through a facilitated process that focused on meeting these objectives.

Plan Development Methodology

Development of the Chehalis River Basin Comprehensive Flood Hazard Management Plan included five phases:

- Phase 1, Organize and review – An 11-member Stakeholder Committee of local representatives was assembled to oversee the development of the plan, consisting of County staff, citizens, and other stakeholders in the planning area. A planning team consisting of key County staff as well

as a technical consultant was assembled to provide technical support to the Stakeholder Committee. Full coordination with other county, state, and federal agencies involved in flood hazard mitigation occurred from the outset of this plan's development through its completion. A multimedia public involvement strategy centered on a hazard preparedness questionnaire was implemented. A comprehensive review was performed of existing plans and programs that can support flood hazard mitigation. A key function of the Stakeholder Committee was to identify guiding principles, goals, and objectives for the Flood Plan.

- Phase 2, Flood Hazard Risk Assessment – Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards. This process assesses the vulnerability of people, buildings, and infrastructure to natural hazards. It focuses on the following parameters:
    - Hazard profiling
    - The impact of hazards on physical, social, and economic assets
    - Vulnerability identification
    - Estimates of the cost of damage or cost that can be avoided through mitigation.
- The flood hazard risk assessment for this Flood Plan meets the requirements outlined in Chapter 44 of the Code of Federal Regulations as well as the requirements for flood hazard assessment included in the Federal Emergency Management Agency's (FEMA's) Community Rating System (CRS).
- Phase 3, Engage the public – The Stakeholder Committee developed a public involvement strategy to maximize the capabilities of the County. This strategy was implemented by the planning team and included two public meetings early in the planning process, a public meeting to review the draft plan, a hazard mitigation survey, a County-sponsored website dedicated to the plan, and multiple media releases. This strategy was a key element in the success of the planning effort.
- Phase 4, Assemble the updated plan – The Planning Team and Stakeholder Committee assembled key information from Phases 1 and 2 into a document to meet CRS requirements. Under the CRS, a flood hazard management plan must include the following:
    - A description of the planning process
    - A risk assessment
    - A mitigation strategy including goals, a review of alternatives, and a prioritized action plan
    - A plan maintenance section
    - Documentation of adoption
- Phase 5, Plan adoption – Upon completion of Phase 4, a pre-adoption review draft of the Flood Plan will be sent to the Insurance Services Office (ISO), FEMA's Community Rating System (CRS) contractor, for review and comment. Once pre-adoption approval has been granted by ISO, the final adoption phase will begin. The Flood Plan includes a plan implementation and maintenance section that details the formal process for ensuring that the plan remains an active and relevant document. The plan maintenance process includes a schedule for monitoring and evaluating the plan's progress annually and producing a plan revision every five years. This phase includes strategies for continued public involvement and incorporation of the Flood Plan recommendations into other County planning mechanisms, such as the comprehensive plan, capital improvement plan, and the Lewis County Hazard Mitigation Plan.

This plan is an update to the 2008 Lewis County Comprehensive Flood Hazard Management Plan. The 2008 plan was a comprehensive update of the 2001 and 1994 plans. Relevant components of the 2008 plan have been carried over to this plan, which applies only to the Chehalis River Basin within Lewis County. In addition, information relevant to Lewis County was gathered from several of the studies and other documents that have been prepared for activities related to the Chehalis Basin Flood Authority and recently formed Office of the Chehalis Basin.

Goals and Objectives

Through a facilitated process, the Stakeholder Committee identified goals and objectives. These planning components all directly support one another. Goals were selected that meet County and city priorities, and objectives were identified that fulfill multiple goals.

Goals:

1. Reduce and minimize flood related hazards to the public and emergency responders.
2. Reduce and minimize flood damage and financial impacts to the community.
3. Avoid impacts that cause flooding of downstream neighbors.
4. Avoid, minimize, or mitigate environmental impacts of flood hazard reduction activities.
5. Increase public awareness and understanding of flooding.

Objectives:

1. Utilizing the best available data and science, continually improve and annually review plans for mitigating and minimizing flood damage impacts.
2. Identify and support flood damage mitigation projects that provide the highest cost benefit and greatest protection, and avoid, minimize, or mitigate impacts on the environment.
3. Communicate flood damage risk to the public, including increased risk due to climate change, and encourage that future development recognize and minimize this risk.
4. Consider floodplain management policies that promote resiliency and sustainable operations of identified critical facilities.
5. Support the current Chehalis Basin Strategy and the Lewis County Shoreline Master Program to enhance aquatic species and restore habitat in the floodplain.
6. Promote and maintain partnerships among all levels of government, including tribal governments, and the business community to coordinate mutually beneficial mitigation strategies.
7. Continue to improve systems that provide warning and emergency communications.
8. Enhance all facets of partnership emergency response capabilities, including flood damage mitigation of vulnerable critical facilities and infrastructure.

Mitigation Actions

The flood hazard mitigation action plan is a key element of this plan. It is through the implementation of the action plan that Lewis County can strive to become flood disaster-resilient through sustainable hazard mitigation. The action plan includes an assessment of the capabilities of the FCZD, County, and

Cities to implement hazard mitigation actions, a review of alternatives, a prioritization schedule, and a mitigation strategy matrix that identifies the following:

- Description of the action
- Objectives addressed
- Lead implementation agency (or agencies)
- Estimated benefits
- Estimated costs
- Timeline for implementation
- Funding sources
- Prioritization

For the purposes of this document, mitigation actions are defined as activities designed to reduce or eliminate losses resulting from the impacts of flooding. Mitigation actions may be implemented by one or more of the agencies that participated in this planning effort. Not all mitigation actions apply to all agencies.

Although one of the driving influences for preparing this plan was the CRS program and receiving more CRS credit to improve the rating of participating communities, this plan does not focus solely on CRS credits. It was important to the FCZD and the Stakeholder Committee to examine actions that would work through all phases of emergency management and flood risk reduction. Some of the actions outlined in this plan fall outside CRS credit criteria, and CRS creditability was not the focus of their selection. Rather, the focus was on the actions' effectiveness in achieving the goals of the Flood Plan and whether they are within the FCZD's, County's, and Cities' capabilities. Table ES-1 presents a summary of the identified hazard mitigation actions.

Table ES-1. Summary of Hazard Mitigation Actions.

Action #	Description	Priority
1	Continue participation and implementation of the flood damage reduction projects that are part of the Chehalis Basin Strategy sponsored by the Office of the Chehalis Basin.	High
2	Develop a technical assistance program to support landowners with bank stabilization and/or post-disaster debris removal.	High
3	Develop a Newaukum Unit Drainage Basin Plan for Dillenbaugh, Dilly, and Berwick Creeks. Develop a comprehensive drainage basin plan to identify cost effective and feasible structural and non-structural actions that will minimize future peak flow increases. The study should include the area between Armstrong Road and Jackson Highway adjacent to Logan Hill Road.	Medium
4	Identify sources of local funding for the FCZD to fund FCZD administration and leverage alternative funding sources.	High
5	Identify alternative sources of funding to leverage FCZD funding to perform new flood studies in identified areas of need based on risk.	Low
6	As FCZD projects are constructed, monitor projects using identified performance measures and adaptive management to track the effectiveness of completed projects to inform the design and implementation of future projects.	Medium
7	When requested, FCZD may act as the applicant agent for mitigation grant opportunities for private property requesting to participate in grant programs.	Medium

Action #	Description	Priority
8	Maximize federal, state, and local funding opportunities through grant application submittals in support of capital improvement projects, technical studies, and other flood hazard management activities.	Low
9	Mitigate flood related risk to publicly owned County and City bridges.	Low
10	Maintain database of flood control needs within the planning area as needs become identified for incorporation into future updates and progress reporting to this plan.	High
11	Inform future mapping, grant applications, studies, and other activities by maintaining a database on known flood risk that tracks historical flood conditions to include, but not be limited to: high water marks, recorded damages, photos, observed flood conditions, etc.	High
12	Utilizing the best available data, science, and technology, maintain and enhance, as data becomes available, the Level 2, user-defined Hazus-MH model that was constructed to support this planning effort.	High
13	Offer the Chehalis River Basin Comprehensive Flood Hazard Management Plan as information available for integration into other appropriate plans and programs that can support or enhance the participating jurisdictions efforts to reduce flood risk as these plans and programs are updated. Examples of such plans/programs would include but are not limited to: Lewis County Hazard Mitigation Plan, Lewis County Comprehensive Plan, and Lewis County Shoreline Master Program	High
14	Lewis County and the Cities of Centralia and Chehalis will continue participating in the Community Rating System (CRS) process.	High
15	Deploy public information and outreach program targeting at risk properties within the planning area.	High
16	Coordinate with FEMA Region X on deploying flood insurance workshops for agents, lenders, and citizens within the performance period for this plan.	High
17	Participate and coordinate with the Office of the Chehalis Basin, the Chehalis River Basin Flood Authority, and other pertinent Chehalis Basin organizations to ensure projects and programs are consistent with larger basin-wide objectives.	High
18	Participate in updates to the County's Flood Insurance Rate Maps to ensure the maps accurately reflect local conditions.	Medium
19	Include CMZs, dam and levee breach inundation areas, and other critical areas as informational layers in the County's online public web map.	Medium
20	Encourage FEMA and NFIP training for County and City staff that administer floodplain regulations and FEMA grant programs.	High
21	Provide outreach and educational materials for the public on flood hazards, risks of development in floodplains, NFIP regulations, and flood mitigation programs, including annual mailings to flood prone properties and placing flood information at local libraries.	High
22	Maintain the flood information website on the FCZD web page to provide Chehalis River Basin information and links to the flood warning system and all other related websites and information.	High
23	Maintain an inventory of properties located in the floodplain.	High
24	Continue to support projects that evaluate the feasibility of regional stormwater detention facilities to address increased stormwater runoff for development in the basins that occurred prior to implementation of site-specific stormwater management measures	High
25	Maintain a database of properties that experience repetitive flooding, to include properties identified as Repetitive Loss (RL) properties. The County will establish a procedure for updating the list annually or following a flood event as necessary. The	High

Action #	Description	Priority
	database will be used to establish a prioritized list of properties that would benefit from mitigation or acquisition, and to provide the owners of the properties information about available funding.	
26	Participate in developing flood control projects with other entities such as the Chehalis River Basin Flood Authority, Office of the Chehalis Basin, USACE, and the Washington State Department of Transportation (WSDOT).	Low
27	Perform a field examination of all flood control structures and create a database of the information, including ownership and maintenance responsibilities. Determine the maintenance responsibility of each structure.	Medium
28	Support projects that would mitigate or relocate utilities and critical facilities which are subject to flooding.	Low
29	Encourage NIMS/ICS training for County staff that may work within or interact with the Emergency Operations Center (EOC).	High
30	Develop a flood response plan that includes response and recovery roles, responsibilities, and priorities, flood early warning system procedures, pre-identified detour routes, criteria to assist emergency response personnel in determining what actions are appropriate when providing assistance to private property during the response and recovery phases, and a list of not-for-profit essential service providers that provide community support during and after a flood event.	Medium
31	Develop and/or review adequacy of mutual aid agreements and procure on-call service contracts to assist with demand for human resources following a disaster.	Medium
32	Maintain a database of all known past problem areas. This database should be linked to GIS for easy visual examination. The County should update the database after each flood event to ensure that the information is captured for future mitigation grant opportunities.	High
33	Assign a staff member to become familiar with the FEMA Stafford Act Section 406 mitigation assistance program and identify potential new mitigation funding opportunities.	Medium
34	Coordinate with WA EMD to ensure County staff attends annual preliminary damage assessment and Public Assistance Grant Program training.	Medium
35	Prevent adverse impacts to the floodplain by requiring all new commercial, industrial, multi-family, and subdivisions to demonstrate no adverse impact.	High
36	Continue to maintain good standing under the National Flood Insurance Program by implementing programs that meet or exceed the minimum NFIP requirements. Such programs include enforcing an adopted flood damage prevention ordinance, participating in floodplain mapping updates, and providing public assistance and information on flood hazard requirements and impacts.	Medium
37	Develop a communication protocol plan and provide training to all County and city responders on new protocol and system upgrades as funding becomes available.	Medium
38	Map detour routes and share routes with WSDOT to assist in efficient detour planning.	High
39	Support updates to the flood warning system to ensure it utilizes the best available data, science, and technology.	High
40	Utilize the best available data, science, and technology in District led projects, programs, and outreach.	Low

Implementation

Full implementation of the recommendations of this plan will require time and resources. This plan reflects an adaptive management approach in that specific recommendations and plan review protocols are provided to evaluate changes in vulnerability and action plan prioritization after the Flood Plan is adopted. The true measure of the plan's success will be its ability to adapt to the ever-changing climate of hazard mitigation.

Funding resources are always evolving, as are programs based on state or federal mandates. Lewis County has a long-standing tradition of progressive, proactive response to issues that may impact its citizens. This tradition is reflected in the development of this plan. The Chehalis River Basin Flood Control Zone District Board of Supervisors will assume responsibility for adopting the recommendations of this plan and committing resources toward implementation of actions that are the responsibility of the FCZD and supporting the implementation of actions that are the responsibility of other agencies. The framework established by this plan will help to identify strategies to maximize the potential for implementation based on available and potential resources. It encourages the responsible agencies to pursue mitigation projects when the project benefits exceed the project costs. The FCZD developed this plan with extensive public input. These techniques will set the stage for successful implementation of the recommendations in this plan.

PART 1 – PLANNING PROCESS AND PROJECT BACKGROUND

1.0 INTRODUCTION

1.1 Why Prepare this Plan

Flood hazard mitigation is a way to reduce or alleviate the loss of life, personal injury, and property damage that can result from flooding through long- and short-term strategies. It involves strategies such as planning, policy changes, programs, projects, and other activities that can mitigate the impacts of floods. The responsibility for flood hazard mitigation lies with many, including private property owners, business, industry, and local, state, and federal government.

Numerous state and federal programs and regulations promote comprehensive flood hazard management planning. Notable among these is the Federal Emergency Management Agency's (FEMA) Community Rating System (CRS) program. This program that is part of the National Flood Insurance program (NFIP), provides benefits in the form of reduced flood insurance costs for communities that meet minimum requirements for flood hazard management.

The Chehalis River Basin Comprehensive Flood Hazard Management Plan (the Flood Plan) recommends regional policies, programs, and projects to reduce the risk to people and property from river flooding and channel migration in Lewis County. This plan presents a long-term vision for managing all flood hazards within the portion of the Chehalis River Basin that is within Lewis County and recommends specific near-term actions to achieve that vision. The Flood Plan recommends actions the FCZD, Lewis County, and cities in the County may take to reduce flood risks and to protect, restore or enhance riparian and aquatic ecosystems.

Lewis County and the Cities of Centralia, Chehalis, and Napavine, and Town of Pe Ell participate in the NFIP. Flooding has been an ongoing hazard in the County. Historical records indicate that minor flooding occurs every two to five years, and major flooding every ten years. Yes, major floods occurred in 2007 and again in 2009. The 2007 flood caused an estimated $500 million in public and private property damage in the County. Data suggests that flood frequency and intensity are increasing. Current estimates range from an 18 percent to 90 percent increase in peak flows. (WA Ecology, 2016). In light of this, the County formed a Flood Control Zone District (FCZD) in 2011 to support flood hazard management, and the State formed the Chehalis Basin Work Group. The Chehalis Basin Work Group led to the formation of the Chehalis River Basin Flood Authority and the Office of the Chehalis Basin and millions of dollars of state funding to perform flood reduction projects throughout the watershed.

Recent efforts led by the Office of the Chehalis Basin involving the FCZD have demonstrated the need to update this Flood Plan. The Flood Plan complies with state and federal requirements for flood hazard management and meets the specific near-term planning needs of Lewis County for flood control. It identifies resources, information, and strategies for reducing risk from flood hazards, and will help guide and coordinate mitigation activities. The Flood Plan was developed to meet the following objectives:

- Meet the needs of the FCZD, Lewis County, and state and federal requirements.
- Coordinate existing plans and programs so that high-priority actions and projects to mitigate possible flood impacts are funded and implemented.

- Create a linkage between the Flood Plan and other established City, County, and state plans so that they can work together for successful mitigation.

All citizens and businesses of Lewis County are the ultimate beneficiaries of this plan. The plan's goals and recommendations lay the groundwork for development and implementation of local mitigation activities and partnerships.

1.2 Lewis County's Planning Authority

The Revised Code of Washington (RCW, Section 86.12.210) authorizes county legislative bodies in Washington to adopt comprehensive flood control management plans for any drainage basin wholly or partially within the county. The Flood Plan must meet NFIP participation requirements (44 CFR Part 60.3) and Washington Department of Ecology flood hazard management requirements (Chapter 86.26 RCW, Chapter 86.16 RCW, and Washington Administrative Code (WAC) Chapter 173-145). The Lewis County Chehalis Basin Comprehensive Flood Hazard Management Plan will be adopted by reference in the Lewis County Comprehensive Plan for protection of frequently flooded areas, as required by Washington's Growth Management Act. The comprehensive flood hazard management plan also functions as the updated flood hazard portion of the Lewis County Multi-Jurisdictional Hazard Mitigation Plan, which was adopted for compliance with the federal Disaster Mitigation Act.

1.3 Guidelines for Flood Planning

The priority for this plan is to benefit the citizens of Lewis County by providing the greatest possible protection against the hazard posed by flooding in the Chehalis River Basin. In addition, the Flood Plan has been developed to follow as closely as feasible the guidelines for flood planning for the Community Rating System (CRS) and by Washington State for the Flood Control Assistance Account Program (FCAAP).

1.3.1 CRS Steps for Comprehensive Flood Hazard Management Plan

Developing a comprehensive flood hazard management plan is among the activities that earn CRS credits toward reduced flood insurance rates. To earn CRS credit for a flood hazard management plan, the community's process for developing the Flood Plan must include at least one item from each of 10 steps (see Appendix A for details):

- Planning process steps:
  - Step 1, Organize
  - Step 2, Involve the public
  - Step 3, Coordinate
- Risk assessment steps:
  - Step 4, Assess the hazard
  - Step 5, Assess the problem
- Mitigation strategy steps:
  - Step 6, Set goals
  - Step 7, Review possible activities

    - Step 8, Draft an action plan
- Plan maintenance steps:
    - Step 9, Adopt the plan
    - Step 10, Implement, evaluate, and revise

1.3.2 Flood Control Assistance Account Program (FCAAP) Requirements for Comprehensive Flood Control Management Plan

Eligibility for Washington's FCAAP funding for flood projects requires that the requesting jurisdiction complete a comprehensive flood control management plan. The Flood Plan must include six components, as summarized below and described in detail in Appendix A:

- Determination of the need for flood control work.
- Description of alternative flood control work, including potential in-stream measures and alternatives to in-stream measures.
- Identification and consideration of potential impacts of in-stream flood control work on the in-stream uses and resources.
- Area of coverage shall include, at a minimum, the area of the 100-year floodplain within a reach of the watershed of sufficient length to ensure that a comprehensive evaluation can be made of the flood problems for a specific reach of the watershed, as well as flood hazard areas not subject to riverine flooding (e.g., coastal flooding, flash flooding, or flooding from inadequate drainage)
- Conclusion and proposed solutions.
- Certification from the Department of Commerce that the local emergency management organization is administering an acceptable comprehensive emergency operations plan.

1.4 How to Use this Plan

This Comprehensive Flood Hazard Management Plan is organized into the following primary parts, which follow the organization of the CRS steps for flood hazard management planning:

- Part 1 – Planning Process and Project Background
- Part 2 – Risk Assessment
- Part 3 – Mitigation Strategy
- Part 4 – Plan Maintenance

Each part includes elements identified in the CRS's 10 steps. These steps are often cited at the beginning of a subsection to illustrate compliance with the requirement.

The following appendices provided at the end of the Flood Plan include information or explanations to support the main content of the plan:

- Appendix A – Relevant Programs and Regulations
- Appendix B – Description of CRS and FCAAP planning guidelines
- Appendix C – Public outreach information, including the survey and summary and documentation of public meetings

- Appendix D – Mitigation Actions Alternative Catalog
- Appendix E – A template for progress reports to be completed as this plan is implemented

2.0 PLAN DEVELOPMENT METHODOLOGY

This chapter describes key parameters, participants and agreements for the following steps followed in developing the Chehalis River Basin Comprehensive Flood Hazard Management Plan:

- Form a planning team
- Define the planning area
- Establish a Stakeholder Committee
- Coordinate with other agencies
- Review existing programs
- Engage the public

2.1 Formation of the Planning Team

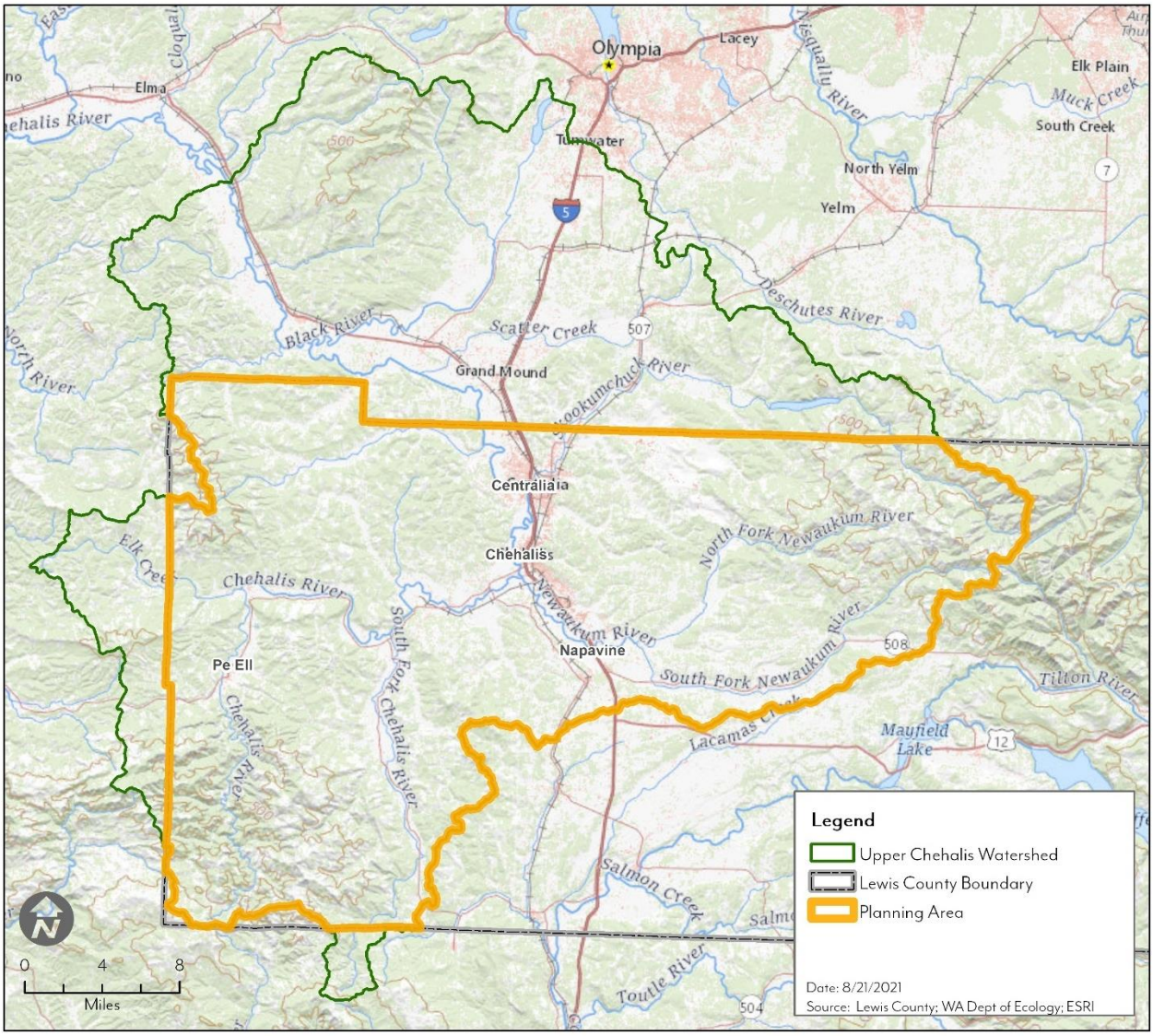
This planning project was initiated and overseen by the FCZD. The County hired Perteet Inc. and Tetra Tech, Inc. to assist with plan development and implementation. A planning team was formed to lead the planning effort, made up of the following members:

- Erik Martin, PE, County Manager, FCZD Administrator
- Betsy Dillin, PE, Lewis County Department of Public Works – County Project Manager, FCZD Project Manager
- Lara McRea, Assistant to the County Manager, FCZD Clerk
- Christina Wollman, Perteet – Project Manager/Lead Project Planner
- Kirk Holmes, Perteet – Subject Matter Expert
- Rob Flaner, Tetra Tech – CFHMP Expert
- Carol Baumann, Tetra Tech – Risk Assessment Lead

2.2 Defining the Planning Area

The planning area for this Flood Plan is defined as the portion of Lewis County within the Chehalis River Basin, including cities. The Flood Plan assesses the flood risk for all municipalities in the planning area. However, not all municipalities participated in the planning process or identified actions. The planning area is shown in Figure 2-1.

Figure 2-1. Planning Area.



2.3 The Stakeholder Committee

A Stakeholder Committee was formed to oversee all phases of the planning effort. The members of this committee included key Lewis County staff, citizens, and other stakeholders from within the planning area. The planning team assembled a list of candidates representing interests within the planning area that could have recommendations for the Flood Plan or be impacted by its recommendations. The team confirmed a committee of 11 members and 10 alternates, listed in Table 2-1. The planning team ensured that the committee make up met the requirement for CRS credit. The committee included 10 members representing the County and Cities of Centralia and Chehalis, and 11 members representing the public.

Leadership roles and ground rules were established during the Stakeholder Committee's initial meeting on March 24, 2020. Due to COVID-19 quarantine rules, the first few stakeholder meetings were held online. This presented a challenge to the project team and slowed the project. Even though the

Stakeholder Committee agreed to meet monthly as needed throughout the course of the plan's development, there were some months without stakeholder meetings. The planning team found it was difficult for the committee members to hold the robust discussions necessary for plan development over a virtual meeting, so some meetings were postponed hoping for the ability to meet in-person. Meetings were held in-person as soon as quarantine rules were relaxed, although about half of the stakeholders continued to attend virtually.

The planning team facilitated each Stakeholder Committee meeting, which addressed a set of objectives based on an established work plan. The Stakeholder Committee met 7 times from February 2020 through June 2021. Meeting agendas and meeting notes are available for review upon request. The attendance record is listed in Table 2.2. All Stakeholder Committee meetings were open to the public and advertised as such on the FCZD website (see Section 2.6.1). The agendas and meeting notes were posted to the website.

Table 2-1. Stakeholder Committee.

Name	Title	Jurisdiction/Agency
Tim Fife	County Engineer	Lewis County
Betsy Dillin (A)		Lewis County
Lee Napier	Director, Community Development	Lewis County
Preston Pinkston (A)	Planner	Lewis County
Andy Caldwell	Deputy Director, Emergency Management	Lewis County
Fionna Velazquez (A)	Emergency Management Coordinator	Lewis County
Emil Pierson	Director, Community Development	City of Centralia
Hillary Hoke (A)	Planner	City of Centralia
Celeste Wilder	Planner	City of Chehalis
Tammy Baraconi (A)	Director, Community Development	City of Chehalis
John Henricksen	FCZD Advisory Committee Member	Chehalis River Basin FCZD
Bill Brumsickle	FCZD Advisory Committee Member	Chehalis River Basin FCZD
Bonnie Canaday Coumbs	FCZD Advisory Committee Member	Chehalis River Basin FCZD
Charles Coddington	FCZD Advisory Committee Member	Chehalis River Basin FCZD
Dan Maughan(A)	FCZD Advisory Committee Member	Chehalis River Basin FCZD
Steve Grega (A)	FCZD Advisory Committee Member	Chehalis River Basin FCZD
Dave Muller (A)	FCZD Advisory Committee Member	Chehalis River Basin FCZD
A. Jason Humphrey (A)	FCZD Advisory Committee Member	Chehalis River Basin FCZD
Alex Rosen	Floodplain Management Specialist	WA Department of Ecology
Chrissy Bailey (A)		Office of the Chehalis Basin
J. Vander Stoep	Citizen	

Table 2-2. Stakeholder Experience.

Stakeholder	Preventative Measures	Property Protection	Natural Resource Protection	Emergency Services	Structural Flood Control Projects	Public Info
Lewis County	X	X	X	X	X	X
Tim Fife	X	X	X	X	X	
Betsy Dillin	X	X	X	X	X	X
Andy Caldwell		X		X		X
Fionna Velazquez		X		X		X
Lee Napier	X	X	X	X	X	X
Preston Pinkston	X	X	X	X	X	X
City of Centralia	X	X	X	X	X	X
Emil Pierson	X	X	X	X	X	X
Hillary Hoke	X	X	X	X	X	X
City of Chehalis	X	X	X	X	X	X
Celeste Wilder	X	X	X	X	X	X
Tammy Baraconi	X	X	X	X	X	X

Table 2-3. Stakeholder Meeting Attendance Records.

Stakeholder	#1	#2	#3	#4	#5	#6	#7
Lewis County	X	X	X	X	X	X	X
Tim Fife			X	X	X		X
Betsy Dillin (A)	X	X	X	X	X	X	X
Andy Caldwell		X	X	X	X		X
Fionna Velazquez (A)			X	X	X	X	X
Lee Napier						X	X
Preston Pinkston (A)			X				
City of Centralia							
Emil Pierson							
Hillary Hoke (A)							
City of Chehalis	X	X	X	X	X	X	X
Celeste Wilder	X	X	X	X	X	X	X
Tammy Baraconi (A)				X	X	X	
Members of the Public							
Bill Brumsickle				X	X		
Bonnie Canaday Coumbs				X			
Charles Coddington	X	X					X
John Henricksen	X	X	X		X	X	X
Steve Grega (A)				X			
Dave Muller (A)							
A. Jason Humprey (A)							
Dan Maughan (A)							
Alex Rosen	X		X	X	X	X	X

Chrissy Bailey (A)	X	X	X			
J. Vander Stoep	X	X		X	X	X

2.4 Coordination with Other Agencies

Opportunities for involvement in the planning process were provided to neighboring communities, local and regional agencies involved in flood hazard mitigation, agencies with authority to regulate development, businesses, academia, and other private and nonprofit interests (CRS Step 3). This task was accomplished by the planning team as follows:

- Stakeholder Committee Involvement – Agency representatives were invited to participate on the Stakeholder Committee.
    - Washington State Department of Ecology
    - Office of the Chehalis Basin
    - Chehalis River Basin Flood Control Zone District
    - City of Centralia
    - City of Chehalis
- Agency Notification – The following agencies were invited to participate in the Flood Plan development from the beginning and were kept apprised of plan development milestones:
    - Chehalis River Basin Flood Authority
    - City of Napavine
    - Town of Pe El
- Pre-Adoption Review – All the agencies listed above were provided an opportunity to review and comment on this Plan, primarily through the Flood Plan website. Each agency was sent an e-mail message informing them that draft portions of the Flood Plan were available for review. In addition, the complete draft Plan was sent to the Insurance Services Office, FEMA's CRS contractor, for a pre- adoption review to ensure CRS program compliance.
    - UPDATE AFTER REVIEW IS COMPLETE

2.5 Review of Existing Programs

The planning effort included review and incorporation, if appropriate, of existing plans, studies, reports, and technical information. Chapter 4 of this plan provides a review of laws and ordinances in effect within the planning area that can affect mitigation actions, including an assessment of all Lewis County regulatory, technical, and financial capabilities to implement flood hazard mitigation actions. In addition, the following programs can affect mitigation within the planning area:

- Lewis County Comprehensive Plan
- City of Centralia Comprehensive Plan
- City of Chehalis Comprehensive Plan
- Lewis County Multi-Jurisdictional Hazard Mitigation Plan (2016)
- Chehalis Basin Comprehensive Flood Hazard Management Plan (2009)
- Chehalis Basin Strategy
- Lewis County Emergency Response Plan

- Stormwater Management Manual for Western Washington
- Lewis County Critical Areas Ordinance
- Lewis County Shoreline Master Program

2.6 Public Outreach Strategy

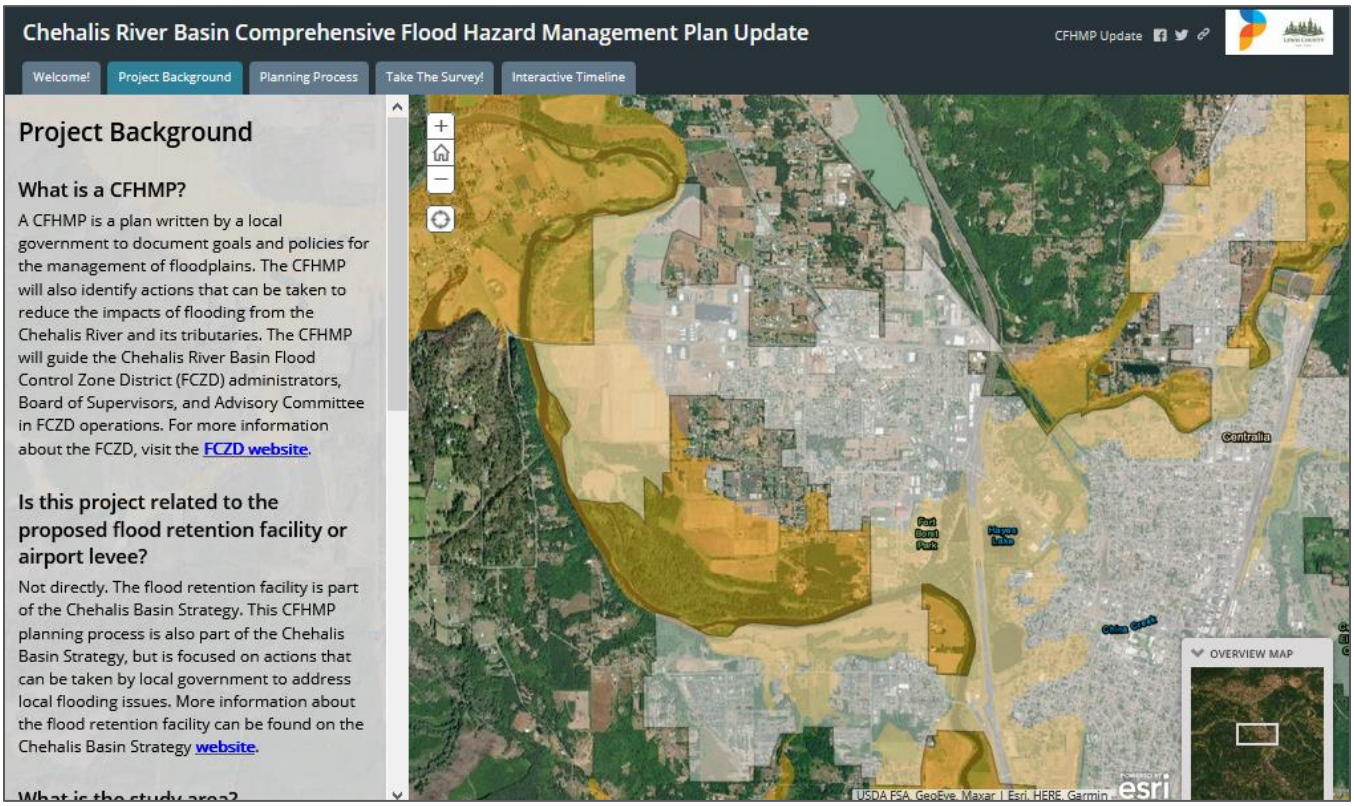
The public outreach strategy originally planned for a combination of in-person and online outreach to ensure the most people possible were able to connect with the project. However, the first public outreach event was planned for mid-April 2020. Due to COVID-19 restrictions, an in-person meeting was not possible, but the online open house was released as scheduled. The second public outreach event occurred during August and September 2021 and included a hybrid in-person and virtual open house and an online open house.

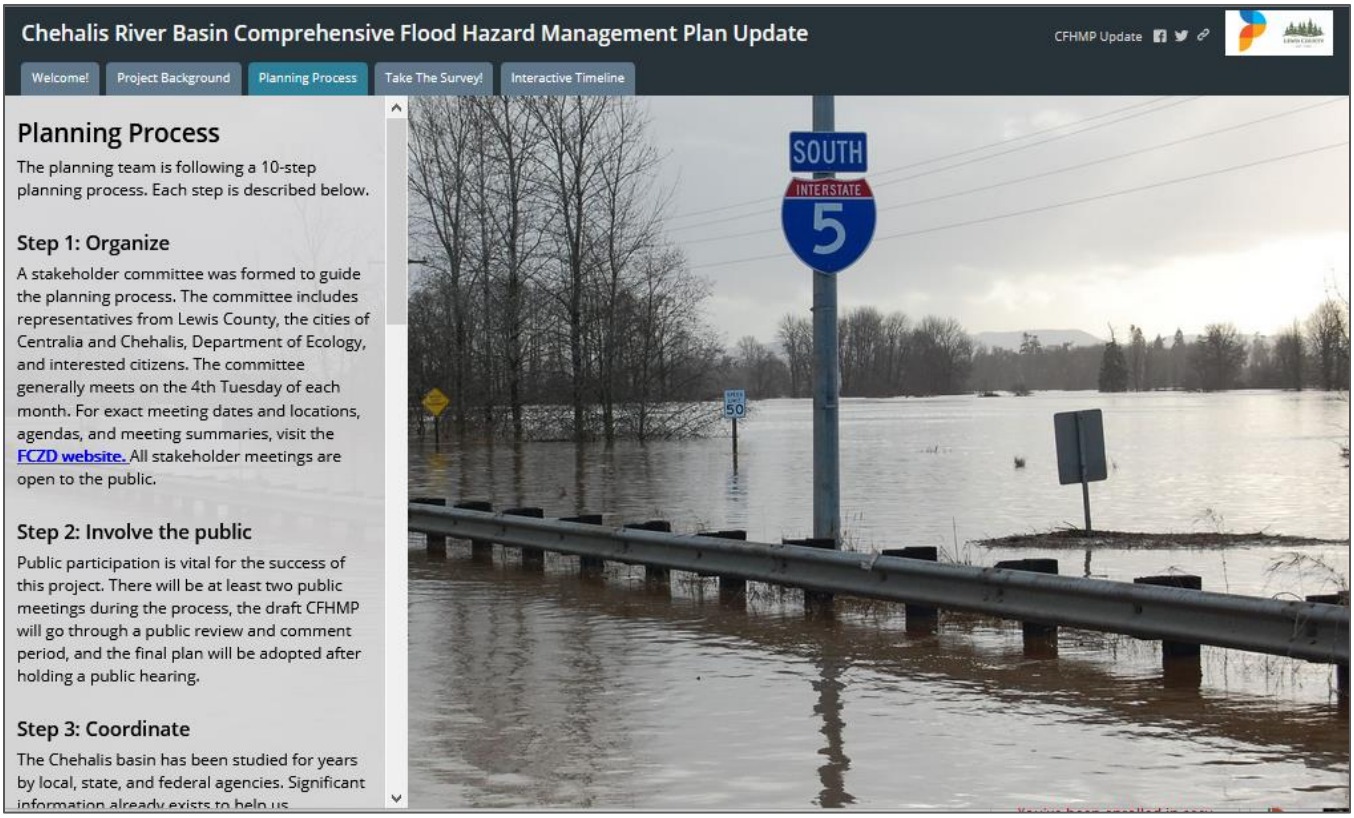
2.6.1 Public Outreach Opportunity #1

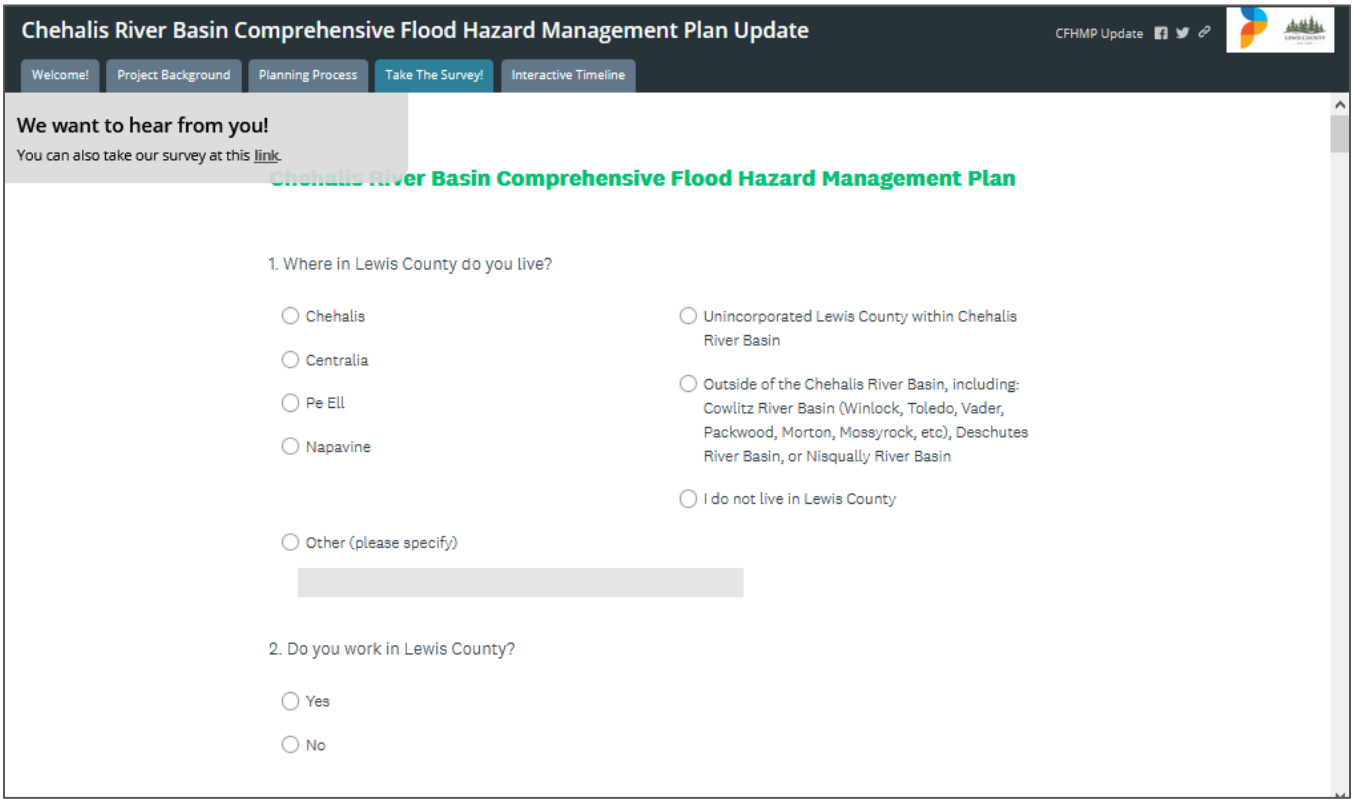
The first public outreach opportunity was planned at the beginning of the project. Initially, the planning team planned to hold an open house style meeting on April 10, 2020, that was supported by an online story map to reach a larger audience. However, on March 25, 2020, the State of Washington's "Stay home, stay safe" order went into effect. To not delay the project, the planning team decided to release the story map as an online open house and cancel the public meeting.

The project team developed the story map to provide information to the public about the project. The story map included information about the project, a timeline of flooding history in the river basin, survey, and a link to an interactive map meant to gather comments from the public. Ultimately, the interactive map was not a successful outreach method, but the survey received 35 responses and the story map was viewed over 1,200 times. The FCZD advertised the website using a county email list of over 800 people and an email list of 183 people from the Chehalis River Basin Flood Authority. It was also posted on the district's website. The story map and survey were left active and regularly received views over the year, providing public outreach during the pandemic quarantine periods and over the extended planning timeline. Figure 2-2 shows page views of the story map, and Figure 2-3 shows the email release. The full story map pages and the survey results are provided in Appendix C.

Figure 2-2. Public Outreach #1 – Story Map Pages.




Chehalis River Basin Comprehensive Flood Hazard Management Plan Update
CFHMP Update
Welcome!
Project Background
Planning Process
Take The Survey!
Interactive Timeline
Planning Process
The planning team is following a 10-step planning process. Each step is described below.
Step 1: Organize
A stakeholder committee was formed to guide the planning process. The committee includes representatives from Lewis County, the cities of Centralia and Chehalis, Department of Ecology, and interested citizens. The committee generally meets on the 4th Tuesday of each month. For exact meeting dates and locations, agendas, and meeting summaries, visit the FCZD website. All stakeholder meetings are open to the public.
Step 2: Involve the public
Public participation is vital for the success of this project. There will be at least two public meetings during the process, the draft CFHMP will go through a public review and comment period, and the final plan will be adopted after holding a public hearing.
Step 3: Coordinate
The Chehalis basin has been studied for years by local, state, and federal agencies. Significant
SOUTH
INTERSTATE
5
50


Chehalis River Basin Comprehensive Flood Hazard Management Plan Update
CFHMP Update
Welcome!
Project Background
Planning Process
Take The Survey!
Interactive Timeline
We want to hear from you!
You can also take our survey at this link.
Chehalis River Basin Comprehensive Flood Hazard Management Plan
1. Where in Lewis County do you live?
Chehalis
Centralia
Pe Ell
Napavine
Unincorporated Lewis County within Chehalis River Basin
Outside of the Chehalis River Basin, including: Cowlitz River Basin (Winlock, Toledo, Vader, Packwood, Morton, Mossyrock, etc), Deschutes River Basin, or Nisqually River Basin
I do not live in Lewis County
Other (please specify)
2. Do you work in Lewis County?
Yes
No


Chehalis River Basin Comprehensive Flood Hazard Management Plan Update
CFHMP Update
Welcome!
Project Background
Planning Process
Take The Survey!
Interactive Timeline
To view the timeline in a separate window, visit this link.
HISTORICAL FLOODING IN LEWIS COUNTY FROM 1887-PRESENT DAY
Flooding is a major concern in Lewis County. Flood events have caused millions of dollars in damage, lost commerce, and disrupted lives. Recent events and the formation of the Chehalis River Basin Flood Control Zone District (FCZD) have prompted the county to update the Comprehensive Flood Hazard Mitigation Plan.
As part of this process, it is important to recognize the historical context of flooding in the region. This timeline includes historical flood information and hisorical river crests as of February 21, 2020. The # indicates that flood's historical rank. The Chehalis River and Skookumchuck River crests are from the gages in Centralia. The Cowlitz River crests are from the gage in Packwood.
Information from the Daily Chronicle article From Native American Legends to 2007: A History of Flooding in the Chehalis River Basin and National Weather Service Northwest River Forecast Center.
Daily Chronicle
Chehalis, 1935
1950
1960
1970
1980

Figure 2-3. Public Outreach #1 – Email Release.

Christina Wollman

From: Lara McRea <Lara.McRea@lewiscountywa.gov>
Sent: Friday, April 10, 2020 10:21 AM
Subject: Comprehensive Flood Hazard Management Plan Update

THE CHEHALIS RIVER BASIN
FLOOD CONTROL ZONE DISTRICT
IS UPDATING THEIR
COMPREHENSIVE FLOOD PLAN

The Chehalis River Basin Flood Control Zone District (FCZD) is currently updating the Lewis County Comprehensive Flood Hazard Management Plan (CFHMP). The update is being led by Betsy Dillin from Lewis County Public Works and guided by a group of Stakeholders comprised of representatives from Lewis County, the cities of Chehalis and Centralia, Department of Ecology, FCZD Advisory Committee, and the public.

A CFHMP provides an overall strategy of programs, projects, and measures aimed at reducing the adverse impacts of flood hazards on the community. The plan will coordinate and support the activities occurring within the Chehalis River Basin and provide guidance for FCZD projects and activities within Lewis County.

The project is funded by a grant from the Chehalis River Basin Flood Authority and will be completed by June 30, 2021.

A Story Map has been developed here to keep you informed throughout the process and provide you an opportunity to participate online in lieu of a public meeting during the "Stay Home, Stay Healthy" order.

The tabs across the top of the webpage provide you information and opportunity to comment and provide feedback. Please take our survey and show us areas of concern on our interactive map.

During the planning process you will be invited to attend public meetings and review the draft plan. Meeting dates will be advertised and posted when they are determined.

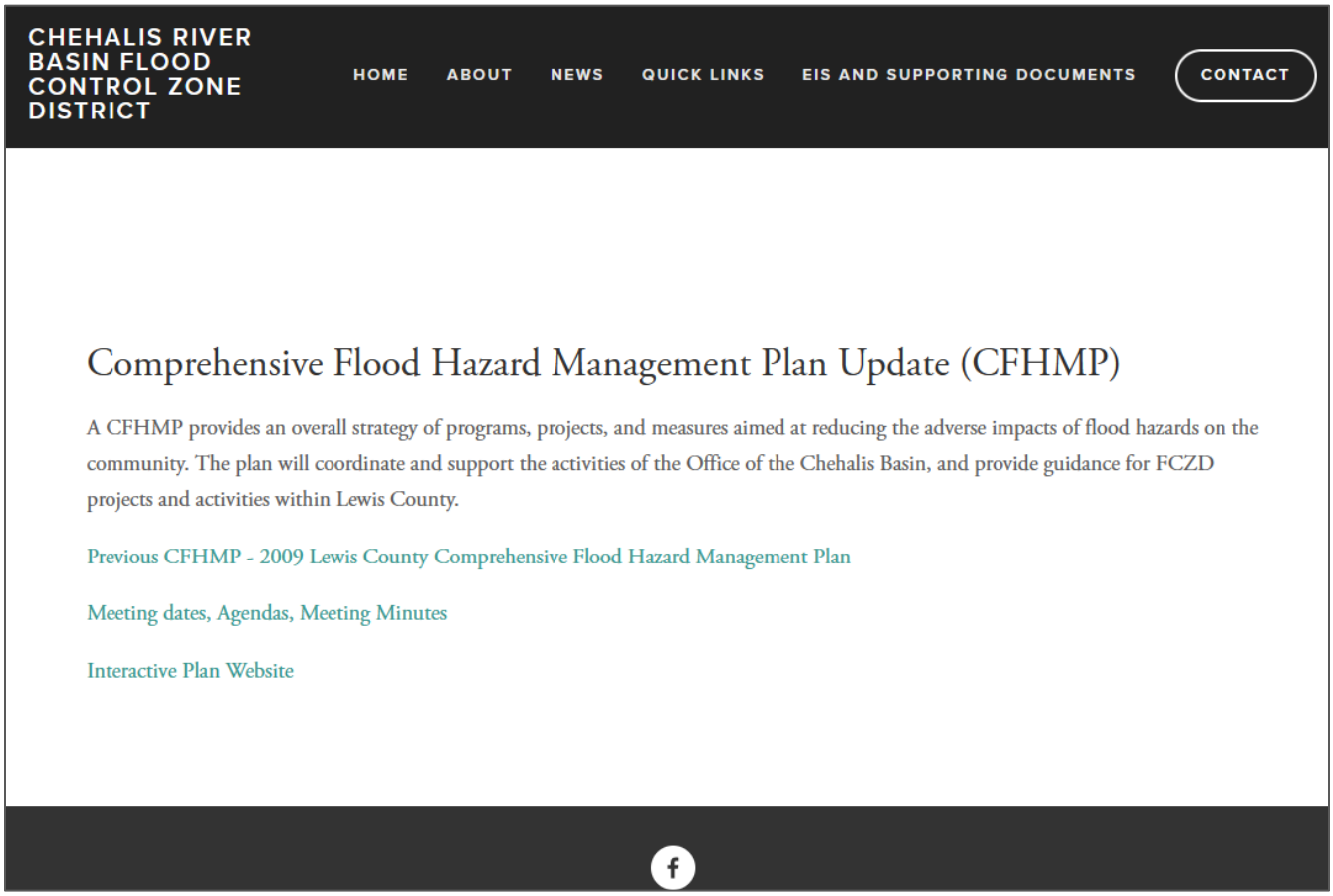
CFHMP website address:
https://arcg.is/1KW8vS

For questions, please contact Betsy Dillin at 360-740-1138.

Click here

Our mailing address is:
351 NW North St.
Chehalis, WA 98532
360-740-1138

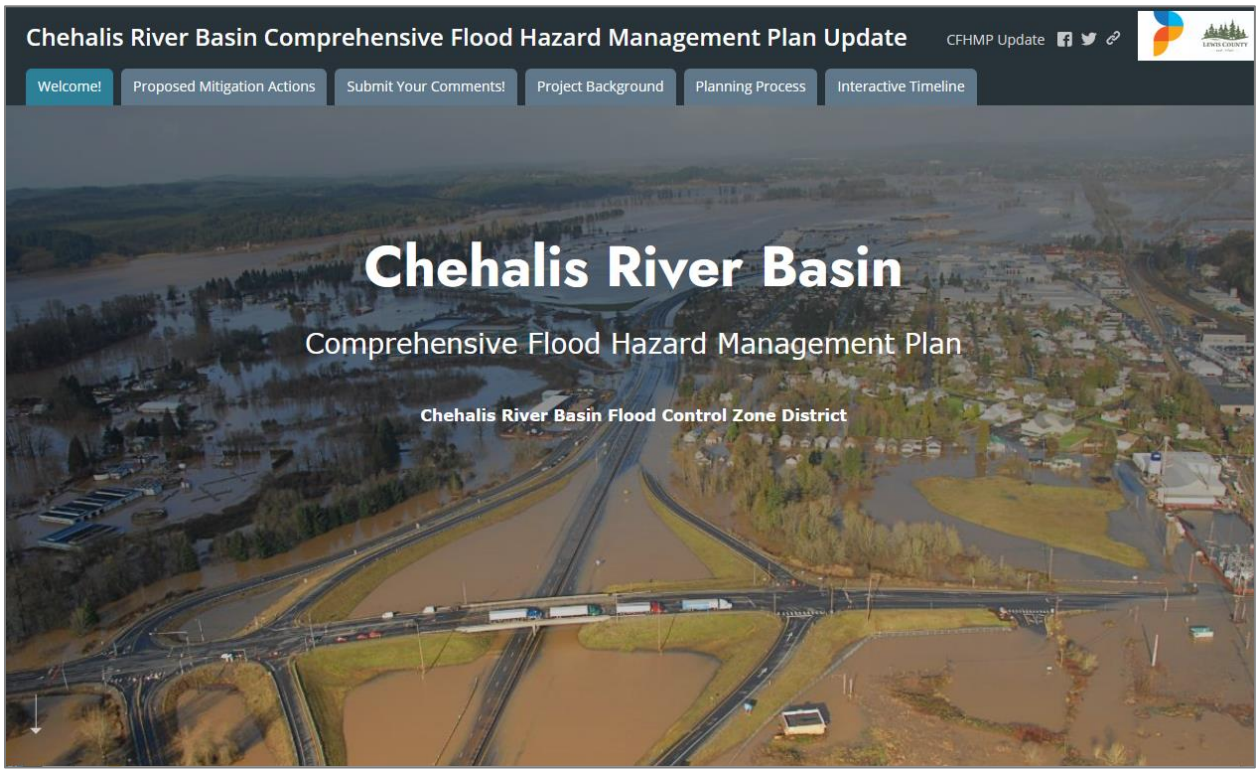
Figure 2-4. FCZD Website.

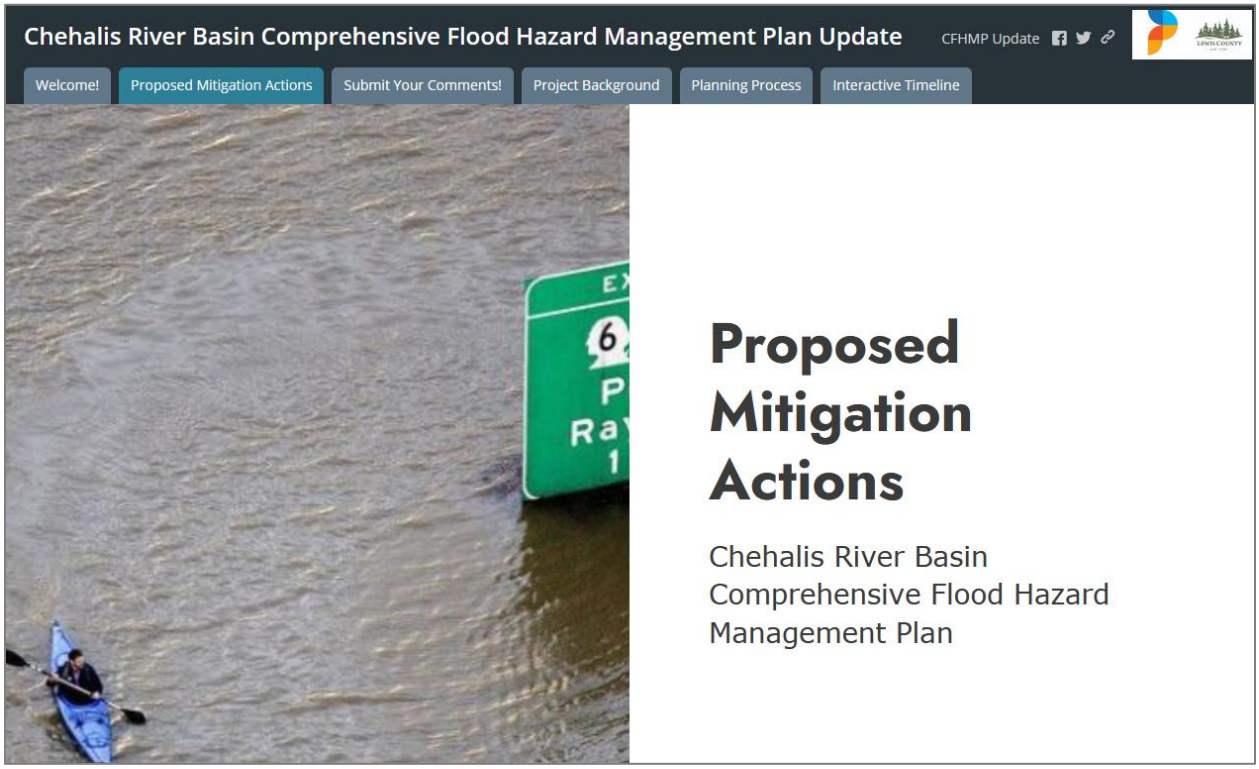


2.6.2 Public Outreach Opportunity #2

ADD OUTREACH DETAILS AFTER COMPLETE.

Figure 2-5. Public Outreach #2 – Story Map Pages.





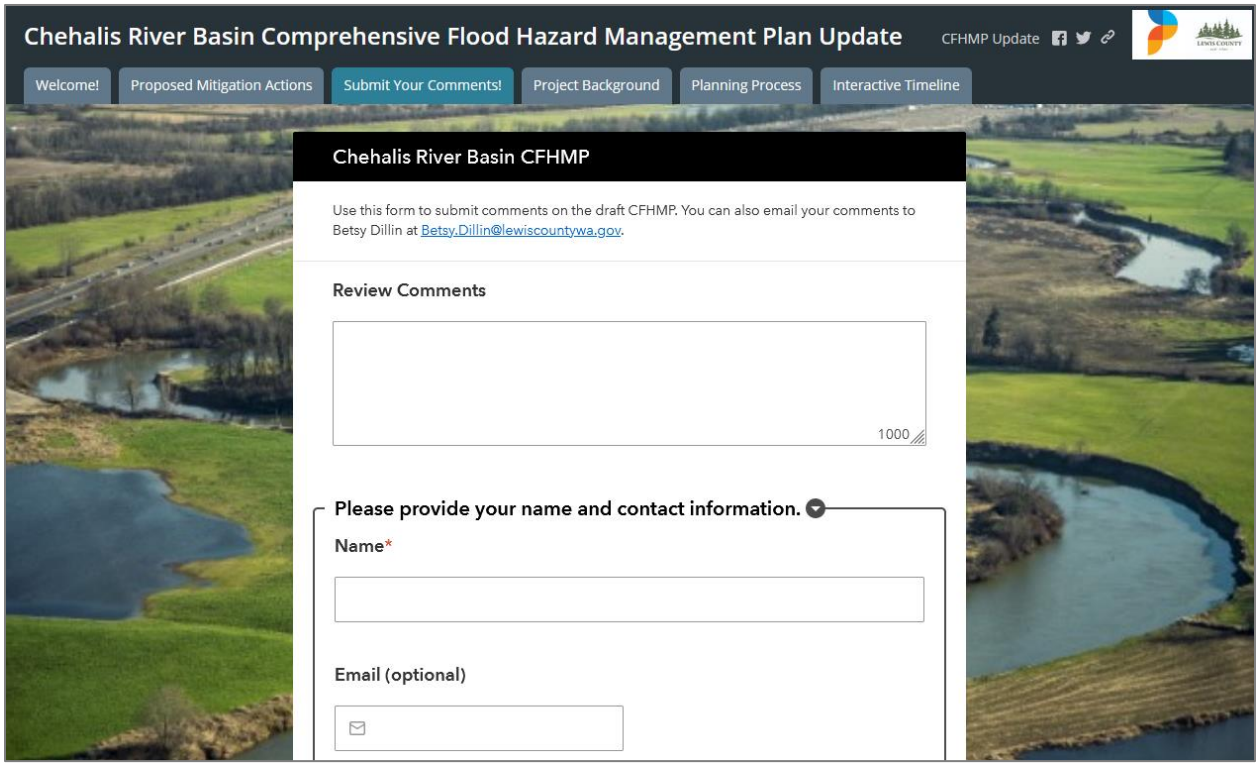

Chehalis River Basin Comprehensive Flood Hazard Management Plan Update
CFHMP Update
Welcome!
Proposed Mitigation Actions
Submit Your Comments!
Project Background
Planning Process
Interactive Timeline
Chehalis River Basin CFHMP
Use this form to submit comments on the draft CFHMP. You can also email your comments to Betsy Dillin at Betsy.Dillin@lewiscountywa.gov.
Review Comments
1000
Please provide your name and contact information.
Name*
Email (optional)

Figure 2-6. Public Outreach #2 – Press Releases.

Chehalis River Basin
Flood Control Zone District

Erik P. Martin, P.E., District Administrator
351 NW North St
Chehalis, WA 98532-1900

NOTICE OF OPEN HOUSE
CHEHALIS RIVER BASIN FLOOD CONTROL ZONE DISTRICT

NOTICE is hereby given that the Chehalis River Basin Flood Control Zone District Supervisors will host an open house for the public to learn more about the draft Chehalis River Basin Comprehensive Flood Hazard Management Plan. This open house will be both in-person and online using Zoom.

WHEN: **Wednesday, September 1, 2021**
TIME: **5:30 p.m. – 6:30 p.m.**
WHERE: **Lewis County Commissioners Hearing Room, second floor**
351 N.W. North Street, Chehalis WA 98532

The Comprehensive Flood Hazard Management Plan (CFHMP) is focused on the portion of Lewis County within the Chehalis River Basin. The goal of the plan is to minimize the long-term risk to life and property from flooding. The CFHMP evaluates the risk and vulnerability to flooding and identifies mitigation actions the community can take to reduce the impacts of flooding. It also includes goals, objectives, and policies to support the local agencies when making decisions related to flooding.

For the past two years, a stakeholder committee of local officials and citizens have been meeting to develop the plan. The committee is ready to present to the plan to the public for review and comment. The public comment period ends on September 30, 2021.

During the open house, the project team will provide an overview of the planning process, the results of the risk assessment, and the proposed mitigation actions. If you are unable to attend the open house, you can visit our interactive website to learn more about the plan and provide comments. You can download the plan and find out more information at: https://www.chehalisriverbasinfczd.com/cfhmp.

Please submit comments on the draft CFHMP by September 30, 2021 using the comment form on the project website or by emailing the Project Manager, Betsy Dillin. Contact Betsy for more information at 360-740-1138 or by emailing Betsy.Dillin@lewiscountywa.gov.

DATED this 24th day of August 2021.

Lara McRea

Lara McRea, Interim Clerk of the Board

Notice sent to media:
August 24, 2021

2.7 Plan Development Chronology/Milestones

Table 2-4. Plan Development Milestones.

Date	Event	Description
2-25-2020	Kickoff Meeting	The project team introduced themselves to the planning partners. The County provided background on the project. The project team described the planning process.
3-24-2020	Stakeholder Meeting #1	• Stakeholder Committee organization • Past and current plan review • Critical facilities definition • Review Hazus risk assessment • Discuss public outreach plan
4-10-2021	Public Outreach #1	• Online Open House (story map) • Survey
4-28-2020	Stakeholder Meeting #2	• Risk assessment update • Confirm goals and objectives • Introduce capability assessment and SWOO • Public outreach update
6-23-2020	Stakeholder Meeting #3	• Risk assessment update • Capability assessment and SWOO • Introduce policy discussion • Public outreach update
7-21-2020	Stakeholder Meeting #4	• Policy discussion • Introduce action plan process
11-17-2020	Stakeholder Meeting #5	• Policy discussion • Introduce plan maintenance strategy
1-12-2021	Action Development Workshop	• Discussed actions • Provided
3-16-2021	Stakeholder Meeting #6	• Confirmed plan maintenance strategy • Reviewed policies • Discussed actions
5-18-2021	Planning Team Meeting	• Discussed draft plan review process and public involvement plan.
6-30-2021	Stakeholder Meeting #7	• Reviewed draft plan • Discussed public outreach and plan comment and adoption process
8-24-2021	Public Comment Period	• Begin public comment period • Comments accepted from 8-24-2021 to 9-30-2021

Date	Event	Description
9-1-2021	Public Meeting #2	•
DATE	Public Hearing	•
DATE	Plan Adoption	•

3.0 LEWIS COUNTY PROFILE

Lewis County is located in Western Washington along the I-5 corridor to the south of Puget Sound . The County stretches from the Willapa Hills in the west, though the Chehalis River basin, and east into the Cascade Mountain Ranges encompassing portions of both Mt. Rainier National Park and Mt. St. Helens National Monument. This plan focuses on the Chehalis River basin in the western portion of the County, though portions of the profile are focused county-wide.

3.1 Historical Overview

This section on the historical overview includes excerpts from the Lewis County Shoreline Inventory and Characterization Report (ICR) (Herrera, 2013).

3.1.1 Native Americans (ICR Section 3.6.1, Herrera, 2013)

Native peoples that historically inhabited the area now within Lewis County were primarily the Upper Chehalis and Cowlitz Tribes of the Southwestern Coast Salish (Hajda 1990). The Meshal and Nisqually Tribes, which lived in the northeastern part of present-day Lewis County, were Southern Coast Salish (Suttles and Lane 1990). The Suwal Tribe of the Kwalhioqua people lived in the western part of the County; they shared territory with the Cowlitz and Upper Chehalis Tribes (Krauss 1990).

Salmon was a significant food source for all of these tribes. Tribe members also gathered nuts, berries, and tubers from the forest and prairies. Most villages were located at the mouths of rivers and creeks. In general, native people lived near fishing streams in cedar longhouses during the winter months (Chehalis Tribe 2009; Irwin 2011). In spring, they would move to prairies to dig camas and wapato. Some of the tribes would move to higher ground in summer and fall to harvest berries and hunt game.

The Upper Chehalis lived along the banks of the Chehalis River (Wilma 2008; Chehalis Tribe 2008). They were expert fishers and paddlers of shallow shovelnose canoes. In addition to salmon, their primary staple, they harvested steelhead, eels, freshwater clams, and crayfish. They also used the Chehalis and Cowlitz River systems as trading routes, and they traded among the several bands of both Upper and Lower Chehalis Tribes, as well as with other peoples (U-S-History.com, undated).

The Cowlitz people inhabited an area south of the Cowlitz River—and south of the Upper Chehalis, Meshal, and Nisqually people (Irwin 2011). The Cowlitz people are divided into two main groups: the Upper Cowlitz and Lower Cowlitz. The Upper Cowlitz occupied villages east of present-day Mossyrock and camped at higher elevations in the Cascades. They were known for their hunting expertise (Irwin 2011). The more populous Lower Cowlitz occupied numerous villages along the Cowlitz River from Mossyrock southward to within one or two miles of the Columbia River. The Cowlitz were horse people and, like other peoples in the region, they used trails and rivers (canoes) to visit and trade with other tribes.

The Meshal people lived near the Chehalis River headwaters in the Cascade Range. Having horses, they often traded with tribes east of the mountains (Wilma 2008).

According to legend, the Nisqually people came north from the Great Basin, crossed the Cascades, and settled their first village in the Skate Creek basin (within the Cowlitz River watershed), just south of the

Mashel River watershed (Nisqually Indian Tribe 2010). Later, they settled near the Mashel River. Their lands extended to Puget Sound. Salmon and fishing are culturally significant, and salmon remains the mainstay of their diet (Nisqually Indian Tribe 2010).

Little has been recorded about the Suwal (Kwalhioqua) (Krauss 1990). They hunted game, gathered berries and roots, and also fished. Their relations with other tribes and Europeans "were beset with conflict" (Krauss 1990). By the mid-1850s, most of the Kwalhioqua had disappeared.

3.1.2 Euro-American Settlement (ICR Section 3.6.2, Herrera, 2013)

Between 1818 and 1846, the United States and Great Britain jointly occupied the Pacific Northwest. The Hudson's Bay Company established trading posts at Fort Nisqually on Puget Sound and at Fort Vancouver on the Columbia River. By the early 1800s, Hudson's Bay Company traders were using the Cowlitz Trail to travel between Fort Vancouver and Fort Nisqually (Wilma 2008). The Cowlitz Trail was originally a Native American portage between the Chehalis and Cowlitz Rivers (Wilma 2008) and had been used for hundreds of years as part of the natives' trading routes (Tumwater 2005). In 1845, the first European settlers traveled from Fort Vancouver to the mouth of the Deschutes River near present-day Tumwater, Washington (Tumwater 2005). To do so, they built a wagon road along the Cowlitz Trail, beginning at Cowlitz Landing, near present-day Toledo (Yakima Valley Historical Society, undated). Today, most of the Cowlitz Trail has disappeared due to road construction and other human activities (Tumwater 2005).

In Lewis County, communities with good water access developed first. By the 1850s, there was a small settlement at Cowlitz Landing that catered to settlers traveling north to Puget Sound (Tumwater 2005). In the 1860s, Cowlitz Landing had a store, a hotel, a post office (first post office in the county), and several other buildings. Because of the dynamic nature of the Cowlitz River, which has altered its course so much during the past 150 years, no trace of Cowlitz Landing remains.

In 1851, Stuart Schuyler Saunders settled near the Chehalis River at what would become Saundersville; and then, in 1872, renamed Chehalis (Winlock 2008, Wall 2008, and Chehalis 2013). Chehalis became the county seat in 1873, shortly after the Northern Pacific Railroad was built from Kalama, on the Columbia River, through Chehalis. The railroad extended from Kalama, on the Columbia River, to the Chehalis River in 1872 and on to Tacoma in 1873 that same year. The first town center was on West Main Street, near the railroad. The town center shifted down West Main Street to the corner of Chehalis Avenue and West Main; that second town center was destroyed by fires in 1892 (Chehalis 2013). The third city center was built along Market Boulevard and is the city's present historic downtown central business district (Chehalis 2013).

In 1875, after having lived in the area since 1851, African American George Washington filed a plat on a town he called Centerville. The town was on the Northern Pacific Railroad line at the confluence of the Chehalis and Skookumchuck Rivers (Ott 2008). The town was renamed Centralia in 1883 (Ott 2008) and was incorporated as Centralia in 1886 (Wilma 2008).

The first two settlers in Winlock, C.C. Pagget and Jacky Nealy, arrived in 1871 (Wall 1952). They acquired land on both sides of the railroad line (which was not yet built) in the town's present location. The town was founded in 1873 (Wall 1952).

Morton was first settled by James Fletcher in 1871. It was named Morton in 1889 and was incorporated in 1913 (Wikipedia 2013). In the 1950s, the world's longest railroad tie dock ran along the railroad tracks east of Morton (Sparkman 1994), and the town was known as the "tie mill capital of the world" (Wikipedia 2013).

By 1883, the towns in Lewis County included Centralia, Chehalis, Morton, Mossyrock, Napavine, Pe Ell, Toledo, Vader, and Winlock.

In the 1880s, the US Army Corps of Engineers cleared snags from the Chehalis River, which allowed steamers to travel from Grays Harbor as far upstream as the railroad connection at Chehalis (Wilma 2008). The river dredging and railroad made it possible to exploit the county's timber resource. Lumbering became the principal industry in Lewis County, attracting new immigrants to the region (Wilma 2008). Although the US government preserved large tracts from settlement in 1897 (later the Gifford Pinchot National Forest), timber could be cut on those lands. Logging and milling operations attracted thousands of workers in the early 1900s. The timber industry dropped off in the 1920s, followed by the Great Depression in the 1930s. The county economy rebounded in the 1940s as World War II increased demand for wood and agricultural products (Wilma 2008).

3.1.3 Historic Uses of the River and Floodplain

The logging and agricultural industry had a great effect on the river and its floodplains. For decades, snags, log jams, and other obstructions were removed from the river bed and wetland and riparian areas were cleared along the riverbanks to create more room for agricultural uses and land development as the population increased.

The logging industry used splash dams from the 1880s to the 1920s within the main stems of the Chehalis River and South Fork Chehalis River, and tributaries including Elk Creek, Hope Creek, Deep Creek, and the Skookumchuck River. Splash dams were temporary dams constructed to store water and harvested logs. When the splash dam was destroyed, flood waters quickly transported the logs downstream. The fast flowing influx of logs scoured the riverbed, removing all sediment and gravel. Remnants of the splash dams remained in place until the 1940, when they were removed. Splash dams and obstruction removal significantly simplified the river system and the effects are still felt today. The river has not been able to reclaim the diversity and complexity that existed prior to settlement (Army Corps of Engineers, 2002).

3.2 Physical Setting

Lewis County is bounded on the east by the crest of the Cascade Mountain Range and extends west to the Willapa and Doty Hills. The County crosses three physiographic provinces: the Cascade Range, the Puget-Willamette Lowlands, and the Pacific Coast Range. The Chehalis River valley occupies most of the western parts of the County, and the Cowlitz River valley occupies most of the central and eastern parts. A small portion of the mountainous north central part of the County contains the Nisqually and Deschutes watersheds. The uplands of the eastern County are composed of rugged mountainous and alpine topography, modified by glacial activity and drained by rivers that flow generally westward. The landscape is characterized by long, steep slopes and relatively straight, parallel drainages. Ridge tops have an average elevation of approximately 4,000 feet.

3.2.1 Watersheds

The County includes watersheds associated with four major rivers: the Chehalis River, Cowlitz River, Deschutes River, and Nisqually River. This plan is focusing on the Chehalis watershed, which encompasses the western portion of the county, including the Cities of Centralia, Chehalis, and Napavine and Town of Pe El. The Chehalis watershed is the most vulnerable watershed in the County. Not only does it flood with the greatest frequency, it is also the county's population center with significant residential, commercial, and industrial development located within the expansive floodplain.

WRIA 23 – Upper Chehalis Basin

Chehalis River

The Chehalis River originates in the Cascade foothills surrounding the Cities of Centralia and Chehalis, and eventually flows into Grays Harbor at Aberdeen. The river basin, located at the southern end of the Puget Trough, has a total drainage area, including tributaries, of approximately 2,114 square-miles. The valley is characterized by a broad, well-developed floodplain, and low terraces surrounded by highly dissected uplands of low to moderate relief, that have broad, rounded ridges. Many perennial streams drain these ridges. Elevations within the basin range from 170 feet at Chehalis to over 5,000 feet at the headwaters. Most uplands in the basin average 300 to 600 feet in elevation. A low divide occurs between the Chehalis River basin and the Cowlitz watershed to the south a few miles south of Chehalis, between the communities of Napavine and Winlock. At their closest point, the Chehalis and Cowlitz Rivers, the two largest rivers in southwestern Washington, are only 16 miles apart.

The Chehalis River valley is characterized by the Willapa Hills in the west and by the Cascade foothills in the east, with broad, developed floodplains downstream of its confluence with the south fork of the Chehalis River. The river gradient from its source to the floodplain is steep with an average gradient of 16 feet per mile. The Chehalis River uplands are undergoing tectonic uplifting. This lowering and lifting of the Chehalis River valley changes the gradients of streams and other waterbodies. The tectonic action, along with the heavier precipitation and sedimentary rock in the Chehalis-Centralia floodplain, generates bed load material that must be moved from the river channel. Sedimentary rock is usually weaker and easier to erode, and this process is hastened by high peak flows. A river channel with a low gradient tends to form meanders as a way to remove heavy bed material. The change in channel gradient from tectonic activity can compound this meandering action.

The Chehalis River, in the Centralia-Chehalis valley, has a meandering channel that occupies a fairly uniform floodplain averaging over one mile wide. Most of the valley is inundated during a severe flood such as the January 1990 flood. Tributaries to the Chehalis River in the Chehalis-Centralia valley include Dillenbaugh Creek, Newaukum River, Salzer Creek, Coal Creek, China Creek, Skookumchuck River, and Coffee Creek (Lewis County, 2008).

Skookumchuck River

The Skookumchuck River, one of the major Chehalis River tributaries, joins the Chehalis River, and is approximately 41 miles in length. It originates in the Mt. Baker-Snoqualmie National Forest northeast of the City of Centralia, and empties into the Chehalis River at Centralia. The total drainage area for the Skookumchuck River is 181 square miles. Elevations within the basin range from 150 feet at the mouth to 3,800 feet at the headwaters, with approximately two-thirds of the basin located below an elevation of 1,000 feet. The slope of the Skookumchuck River from its source to the town of Bucoda is steep,

falling an average of 19 feet per mile. Below Bucoda, the slope flattens to about five feet per mile near Centralia. Except for the uppermost portion, the Skookumchuck River flows as a meandering channel in a floodplain, varying in width from a few hundred feet to 0.5 mile.

Three developments are notable within the Skookumchuck River system. The first is the City of Centralia, which occupies several square miles at the lower end of the basin. The second development is Skookumchuck Dam, located about 20 miles upstream from Centralia and operated by PacifiCorp. Skookumchuck Dam was completed in 1971 and has been considered several times for flood control use. The third development of note in the Skookumchuck Basin is the Centralia Steam Generating Plant on Hanaford Creek. Authority has been granted for this coal-fired facility to divert up to 54 cubic feet per second (cfs) of water from the Skookumchuck River.

The Skookumchuck River is regulated by the Skookumchuck Dam, which is owned by Scottish Power (PacifiCorp). Skookumchuck Dam is located at RM 21.9, just upstream from Bloody Run Creek. The dam is an earthfill structure approximately 190 feet high with a crest elevation of 497 feet. Construction of the dam was completed in January 1971. The primary purpose of the project is water supply for the Centralia coal-fired power generator plant. Outflow from the reservoir is either over the spillway crest at elevation 477 feet or through the outlet works with intake gates at elevations 449, 420, and 378 feet. The discharge capacity of the outlet works is approximately 220 cfs when the pool elevation is at the spillway invert. Because of this limited outlet capacity, the reservoir typically fills early in the flood control season and passes subsequent floods over the 28,000 cfs capacity spillway. The normal active storage capacity of the reservoir is 38,700 acre-feet (ac-ft) between elevations 400 feet (normal minimum operating pool) and 492 feet (maximum operating pool). Additional usable storage of 3,170 ac-ft is available between elevations 378 feet (invert of the lowest intake) and 400 feet. Dead storage is approximately 1,420 ac-ft between elevations 378 and 340 feet. The land use in the Skookumchuck River floodplain is generally agricultural in the upper reaches with increasing urbanization towards the mouth. The most developed portion of the floodplain is from the mouth to RM 4.5 with the City of Centralia's central residential/business district being within the floodplain on the left bank near RM 2.0 (City of Centralia, 2008).

Newaukum River

The Newaukum River is the second major tributary to the Chehalis River in Lewis County. The Newaukum River's headwaters are in the Cascade foothills southeast of the City of Chehalis. At the USGS gauge near Chehalis, where it flows into the Chehalis River, the Newaukum River has a drainage area of 155 square-miles. Elevations in the Newaukum River basin range from approximately 180 feet near the confluence with the Chehalis River to 3,200 feet in the upper basin. The Newaukum River is made up of three forks, the north, middle, and south forks. Upstream sections on both the north and middle forks, above Forest, have slopes of 83 feet per mile; the south fork has a slope of 188 feet per mile above Onalaska. The average channel slope for the entire drainage is 35 feet per mile.

Dillenbaugh Creek

Dillenbaugh Creek flows into the Chehalis River, from the east at Chehalis. It originates in the steep foothills southeast of Chehalis and has a drainage area of approximately 15 square-miles. The gradient of Dillenbaugh Creek in the upper reaches is approximately 70 feet per mile. After it flows out onto the Newaukum River floodplain, the gradient drops as Dillenbaugh Creek parallels the Newaukum and Chehalis Rivers for nearly three miles before finally flowing into the Chehalis River. Dillenbaugh Creek collects much of the City of Chehalis' storm drainage in the lower reach.

Salzer Creek
Salzer Creek flows into the Chehalis River, from the east just south of the Centralia city limits, and drains 24.5 square-miles. The basin originates in the low-lying hills east of Centralia-Chehalis and has a maximum elevation of about 800 feet. The stream gradient of Salzer Creek is relatively flat. Coal Creek, a major tributary of Salzer Creek, has a drainage area of 6.4 square-miles and has a steeper slope (Lewis County, 2008).

China Creek
China Creek is a relatively small, short stream that flows through the City of Centralia to the Chehalis River. The watershed extends about five miles east of the Chehalis River at Centralia. It encompasses approximately 4.4 square miles, ranging in elevation from 180 feet to 570 feet. Much of the land is moderately steep. Most of the channel consists of pipes and box culverts through Centralia. China Creek is utilized as part of the City's stormwater drainage system.

Coffee Creek
Coffee Creek is a tributary of the Skookumchuck River. With headwaters in Thurston County, Coffee Creek flows south through the Zenkner Valley to the Skookumchuck River north of Centralia. The watershed encompasses 6.2 square miles of moderately sloping hills. Watershed elevations range from 186 feet at the confluence with the Skookumchuck River to 645 feet at the northern tip of the watershed. The stream gradient is low in the lower four miles of the watershed. Coffee Creek has been moved from its natural location to a periphery channel bordering the edge of adjacent hills and the valley floor.

Coal Creek
Coal Creek is a small tributary of Salzer Creek that flows west and northwest for approximately 20.5 miles. The drainage area is 6.4 square-miles, with steep channel slopes east of I-5.

Lincoln Creek
Lincoln Creek flows into the Chehalis River just north of the City of Galvin. Lincoln Creek originates in the hills west of Centralia gathering water from Cooks Hill and Doty Hills. The gradient of Lincoln Creek is relatively flat winding through the Lincoln Creek Valley (City of Centralia, 2008).

3.2.2 Geology

The geology of Lewis County is composed primarily of igneous and sedimentary bedrock of the Tertiary Period, and unconsolidated glacial sediments of the Pleistocene Epoch. Subsequent to formation of the bedrock, between 7 and 55 million years ago, the surface of the area underwent geologic uplift, raising the volcanic and sedimentary rocks above sea level. Deformation, in the form of faulting and folding, accompanied the uplift. Landslides and erosion followed in the western part of the County; glaciation, glaciofluvial deposition, erosion, and recent volcanic activity followed in the eastern half of the County.

Bedrock Geology
The oldest rocks in Lewis County are the basalt and basaltic breccia flows of the Doty Hills, in the western part of the County. The flows consist of augite basalt that is generally structureless, although pillow and columnar structures are commonly observed. This rock is of middle to late Eocene age, or about 40 to 55 million years old. It is submarine in origin, having poured out from fissures in the ocean floor.

Much of the area west of the Cascades was covered by the ocean and had a shallow, fluctuating coastline during the late Eocene and Oligocene Epochs (27 to 40 million years ago). Alluvial sand and silt of the eroding, older Cascade area mountains were being deposited into this shallow water. These alluvial deposits were compressed and hardened over time and became sedimentary rock. Closer to the older Cascade core, the sediment, in some areas, was deposited in freshwater, and is characterized by thin beds of carbonaceous shale and coal, such as those in Hanaford Creek and along the Tilton River, north of Morton.

As the erosion of the older part of the Cascades was occurring during the middle to late Eocene and into the Oligocene, new volcanic eruptions were emitting flows of molten rock that would eventually rebuild the foothills and mountains of the present-day Cascades. The most prominent flows occurred during the late Eocene and are composed of extrusive basic igneous rock, mainly andesite, andesitic volcanic breccia, and, to a lesser extent, basalt. Slightly older, nonmarine siltstone and sandstone are interbedded with the volcanos in a few areas. Massive volcanic flows continued throughout the Oligocene and into the Miocene, depositing andesite and andesitic breccia that are in evidence today in the mountainous areas north of Randle.

Dikes of acid igneous rock, primarily diorite, granodiorite, quartz monzonite, and some granite, later penetrated the existing geologic formations in the eastern part of Lewis County. These structures are common in the southeastern corner of the County, at Tumwater Mountain and Vanson Peak. Erosion from the Cascades during the Miocene Epoch (7 to 27 million years ago) deposited alluvium in broad, shallow basins of stagnant water. This material was eventually consolidated and became the very soft, or weak, siltstone bedrock found in the Wilkes Hills, southeast of Toledo. The siltstone is characterized by interbedded coal, preserved organic matter, and leaf impressions.

Glacial Geology

The Pleistocene Epoch (2 million to 10,000 years ago) in Lewis County was marked by several episodes of erosion and sculpting of existing landforms, and deposition of glaciofluvial sand and gravel, and glacial till. The oldest glacial sediments in Lewis County are the glaciofluvial deposits of the Logan Hill Formation. The Logan Hill Formation is composed of highly weathered sand, gravel, silt, and clay, approximately one million years old, derived from the Tertiary rocks of the Cascades. The outwash was deposited from the massive glacier, flowing westward from the crest of the Cascades, that carved out the Cowlitz and Tilton River valley troughs. Streams flowing from the melting glacial ice transported, sorted, and deposited the material in a fan shaped, broad plain at the front of the foothills. The extent or perimeter of this plain is roughly defined by the communities of Salkum (east), Chehalis (northwest), Napavine and Winlock (west), and Vader (southwest).

Younger glacial till deposits of the Hayden Creek Formation make up the terraces or plains of the upper Nisqually River valley. These deposits are the result of glaciation of the upper Nisqually. Till and outwash of the Hayden Creek Formation also occupy the large U-shaped valley of the Cowlitz River and its tributaries, and the surrounding glacially smoothed uplands. These deposits are visible in roadcuts between Salkum and Morton on US Highway 12 and between Onalaska and Morton on State Highway 508. Typically, they are covered by a thick layer of highly weathered volcanic ash. This ash was apparently aerially deposited on the ice of the valley glaciers during the late Pleistocene, then later laid down like a blanket over the underlying till and outwash when the ice receded.

Small cirque glaciers developed in the Cascades during the late Pleistocene at elevations above 2,500 feet. These glaciers formed primarily on the north slopes of ridges and extended down drainages to the north and northeast, sculpting out bow shaped cirques, hanging valleys, rocky ridgecrests, aretes, and U-shaped valleys. Thin till deposits from this event remain near the heads of alpine drainages and adjacent side slopes. Ice recessional sand and gravel were deposited near the end of the Pleistocene (approximately 12,000 years ago) as ice was making its final retreat. Coarse glacial outwash was deposited as terraces in both the Cowlitz and Nisqually River valleys. The outwash deposits in these two valleys were derived from glaciers occupying them. Coarse outwash sand and gravel were also deposited in the Chehalis River valley at and surrounding the City of Centralia. These deposits were derived from the Puget Lobe of the Cordilleran Ice Sheet, which originated in British Columbia, covered all of the Puget Lowland, and terminated just north of Lewis County.

As the ice sheet receded, meltwater, flowing from the ice, filled part of the Chehalis River Valley with clean quartzitic sand and hard, rounded pebbles, cobbles, and stones. In addition to the dramatic eruptions of Mt. St. Helens during the 1980s, Lewis County has experienced many eruptions of Cascade volcanoes. Mazama ash, from the 6,600-year-old event that resulted in the formation of Crater Lake in southern Oregon, can be found in most upland soils in the western part of the County. Ash layers from Mount Rainier and numerous Mt. St. Helens eruptions, in addition to Mazama ash, are present in upland soils of the central and eastern parts of the County.

The dominant geologic process that has operated within the last 10,000 years in Lewis County is erosion. Erosion of bedrock, glacial, and tephra deposits has resulted in the deposition of alluvium in the valley or lowland areas of Lewis County. Along the Nisqually River and in the Cowlitz River valley, the alluvium is derived primarily from coarse-textured glacial outwash, volcanic ash, and pumice. As a result, the alluvium in those valleys is coarse and non-cohesive in nature. Fresh alluvium is deposited adjacent to the Cowlitz and Nisqually Rivers by seasonal floods. The Chehalis River and its tributaries drain dominantly older, rounded, lower relief hills of the west half of the County. These hills – composed of softer, more highly weathered, and finer-grained rock – supply alluvium to the Chehalis River that is finer in texture than that of the Nisqually and Cowlitz River valleys (Lewis County, 2008).

3.2.3 Climate

The Lewis County Chehalis River Basin area has a predominately marine climate characterized by mild temperatures both summer and winter. Extreme temperatures are unusual for the area because prevailing westerly winds bring maritime air over the basin and provide a moderating influence throughout the year.

During the spring and summer, high-pressure centers predominate over the northeastern Pacific, sending a northwesterly flow of dry, warm air over the basin. The dry season extends from late spring to midsummer, with precipitation frequently limited to a few light showers. Average summer temperatures are in the 70s or 80s (degrees Fahrenheit), but occasionally hot, dry easterly winds cross the Cascade Mountains and raise daytime temperatures into the 90s. The Aleutian low-pressure center normally predominates during the winter, causing a counterclockwise circulation of cool, moist air over the basin and prevailing southwesterly winds. The area from the Pacific Ocean to the crest of the Olympic Mountains, the western slopes of the Cascade Range, and the Black and Willapa Hills receives the full force of winter storms. Virtually every fall and winter (October through March), strong winds and heavy precipitation occur throughout the basin. Storms are frequent and may continue for several days.

Successive secondary weather fronts with variable rainfall, wind, and temperatures may move onshore at daily intervals or less.

Precipitation in the basin is affected by distance from the Pacific Ocean, elevation, and seasonal conditions. Generally, the southern slopes of the Olympic Range and the more easterly, higher slopes along the Cascade Range receive the greatest precipitation. The Black Hills in the northeast portion of the basin and Willapa Hills between the coast and the Centralia-Chehalis area often receive moderate to heavy rainfall during the movement of oceanic storms through the basin.

The greatest amount of rainfall occurs between the months of October and March. The abundance of rainfall during this period is due to the frequent storm systems that pass over Western Washington. In Centralia and Chehalis, monthly rainfall totals for this period typically range between five and eight inches. For the rest of the year, average monthly rainfall totals range only between 0.8 and two inches. In Centralia, annual precipitation averages 41 inches, with a record low of 28 inches and a record high of 60 inches. In the Willapa Hills, the average rainfall is 120 inches per year (WA Ecology, 2017).

Heavy rainfall is often carried into the region in an atmospheric river. An atmospheric river is a band of moisture in the sky that resembles a river, bringing heavy rain or snowfall that can last for days. Over the past 40 years, atmospheric rivers have caused more than 80 percent of flood damage along the west coast (NASA, 2021). The 2007 flood was caused by an atmospheric river, which brought 12 to 26 inches over a four-day period (WA Ecology, 2016).

Snowfall in the region is not heavy, but potential does exist for extremely large amounts on occasion. The average annual snowfall is approximately nine inches, with recorded extreme annual maximums at 45 inches. Most of the snowfall occurs in the month of January, with the monthly average at about 4.5 inches. Snowfall occurs occasionally at Chehalis and Centralia, but warm temperatures typically limit any snow accumulation over prolonged periods.

The weather station at Centralia has recorded temperature extremes of 105 to -16 degrees. The mean monthly temperature is 52 degrees with the monthly means of January and July being 39 and 65 degrees respectively.

Winds in the region rarely exceed 30 mph; winds of this speed usually only occur during the fall and winter months in conjunction with rainstorms and/or thunderstorms that pass through the vicinity. Approximately 10 percent of the winds between the months of November and February have speeds between 15 and 30 mph, compared with approximately two percent of the winds for the other months. The rest of the wind speeds typically range between zero and 15 mph, about 90 percent of the time. Wind speeds have been measured in excess of 70 mph during the winter months. The majority of the highest wind speeds measured have originated from the south and southwest directions (City of Centralia, 2008).

3.2.4 Fish and Wildlife

Fish

The upper Chehalis River provides habitats supporting Chinook and Coho (silver) salmon, steelhead, lamprey, and sea run cutthroat trout. In addition, native cutthroat and rainbow trout reside in the Upper Chehalis River. The Skookumchuck hatchery releases Coho salmon fingerlings supplied by in the upper

Chehalis River. The mainstem of the Chehalis River from the Skookumchuck River to the Newaukum River provides water for migration of fall and spring Chinook, Coho, and chum. Limited rearing and spawning is expected to occur in this reach. This may be attributed to high water temperatures during the summer months and urban and agriculture non-point pollution reducing river oxygen levels. The entire mainstem of the Chehalis River and 31 linear miles of tributaries are utilized by salmon.

The Skookumchuck and Newaukum Rivers, primary tributaries to the Chehalis, also provide spawning and rearing waters for Coho, spring Chinook, and fall Chinook salmon. In addition, chum have been located on the North Fork of the Newaukum River. Spawning and rearing of these fish occur on the Skookumchuck River between the Skookumchuck Dam and the confluence with the Chehalis River. Above the Skookumchuck Dam, salmon use is limited due to salmon migration barriers at dam locations. All of the Skookumchuck mainstem and 41 linear miles of tributary streams are believed to currently provide salmon production.

The Newaukum River watershed has four river reaches supporting vital fish habitat. All of the mainstem, 17 miles of the North Fork, and all of the South Fork are utilized for salmon production. In addition, four linear miles of the Newaukum mainstem tributaries, 41 linear miles of the north fork tributaries, and 17 miles of the south fork tributaries are used for salmon production. These streams furnish cold water temperatures and deep pools suited for maturation of adult spring Chinook. Chinook spawning within the north fork of the Newaukum River is generally restricted to the lower 10 miles because of stream diversions. The south fork of the Newaukum River below Kearney Creek generally provides the best rearing habitats for juvenile Coho and spring Chinook within the Newaukum River watershed (Lewis County, 2008).

Wildlife

Lewis County encompasses many different ecosystems, from evergreen coniferous forest to lowland marshes. The variety of habitats available in the County has made it ideal for numerous types of wildlife. The riparian corridors adjacent to the rivers in Lewis County are especially important to birds and small mammals because riparian areas tend to have highly diverse vegetation as well as protected access to water; many species of wildlife are dependent upon them. Passerine and water birds, in particular, rely on the riparian corridors for food and nest sites. Of the 53 bird species commonly found in Lewis County, 42 (or 79 percent) are dependent upon the riparian and wetland habitats typically associated with river systems.

There are four primary categories of wildlife within the Chehalis River watershed: big game, upland wildlife, fur-bearers, and waterfowl. Lists of birds and mammals in Lewis County are in Tables 8-8 and 8-9, respectively. Upland wildlife account for the greatest number of species in the basin. The upper Chehalis River, above the confluence with the Newaukum River, provides habitat for big game (black tailed deer, black bear, and elk), game birds (pheasant, grouse, and pigeons), and fur-bearers (beavers, minks, muskrats, and river otters). Seasonal flooded areas along the upper Chehalis River and its tributaries create habitats for various waterfowl. The upper Chehalis River is within the Pacific Flyway for migratory birds. The Chehalis River segment above Grand Mound also supports a diversity of wildlife. Forested areas support cover for big game species such as deer, bear, and elk as well as many upland bird species. Fur-bearing animals and waterfowl found in the upper Chehalis River are also found upstream of Grand Mound.

The Newaukum River basin also provides habitats for diverse wildlife. Big game includes black tailed deer, black bears, and cougar. Upland species of native blue and ruffed grouse, ring necked pheasant,

mountain quail, cottontail rabbit, mourning dove, and band tailed pigeon are found in the agricultural or forested areas. Fur-bearers consist of beaver, muskrat, mink, raccoon, weasel, river otter, skunk, red fox, coyote, and possum. Waterfowl include mallard, pintail, wood duck, coot, Canada goose, and blue heron. In addition, ground squirrels, forest rodents, and amphibians and reptiles are found to reside in the Newaukum River basin.

Protected species of songbirds, birds of prey, and Northern spotted owl also inhabit the Chehalis River basin. Bald eagles and ospreys use all of the major rivers in Lewis County, especially in the winter months. Both bald eagles and ospreys are dependent upon the riparian and shoreline habitats associated with the rivers in Lewis County for food and nest sites (Lewis County, 2008).

3.3 Development Features

3.3.1 Land Use

Lewis County lies in southwestern Washington with a total landmass of 2,452 square-miles, and measures about 90 miles (east to west) by 25 miles (north to south).

Incorporated and unincorporated urban growth areas are designated and zoned for urban levels of development. Incorporated cities plan for and designate land uses within their corporate boundaries consistent with adopted comprehensive plans and development regulations. Unincorporated UGAs, areas adjacent to incorporated cities, were designated consistent with the GMA and are intended for urban development. UGAs represent about 0.7 percent of the County. Such areas are expected to develop at higher intensities and eventually be annexed into the cities and zoned for residential, commercial, and industrial uses. For a full discussion of land use within incorporated cities, refer to each city's comprehensive plan.

Unincorporated Lewis County land use is regulated consistent with historic and traditional land use patterns and at intensities consistent with rural levels of public services. For example, approximately three-quarters of the 2,452 square-miles of Lewis County is devoted to long-term natural resource use – timber, agriculture, or mineral. Less than one-quarter of the land is designated for rural, non-resource uses, including rural residential, commercial, and industrial uses.

Under current zoning, unincorporated areas of Lewis County are classified into the following land use categories:

1. Resource Lands
    a. Forest Resource Land – commercial forestry activities
    b. Agricultural Resource Land – commercial farming activities
    c. Mineral Resource Land – commercial mineral extraction
2. Rural Zones
    a. Rural Development Districts – rural uses, including residential, limited commercial
    b. Small Towns – high intensity rural settlements
    c. Crossroad Commercial – high intensity commercial activities
    d. Freeway Commercial – rural interchange activities
    e. Rural Residential Centers – high density residential subdivisions

f. Rural Area Industrial – high intensity industrial activities
g. Tourist Service Areas – public recreational areas
h. Airport Obstruction Zone

3. Urban Zones
   a. Urban Growth Areas
   b. Master Planned Resorts

Open space land is designated in the County Comprehensive Plan and includes parks, wilderness areas, resource lands, and corridors. The open space designation overlays other zoning and makes up about 75 percent of the County. Open space corridors follow stream and river valleys and are comprised of steep slopes, agricultural resource land, and flood hazard areas. Unlike park and recreation areas, open space lands may be either public or private ownership and are often not available to public access. Privately owned lands in flood hazard areas (over 40,000 acres) and lands currently managed by Tacoma City Light under conservation easements (over 15,000 acres) are part of this latter category.

For a more complete discussion of existing and future land uses within the Chehalis River Basin, refer to the following:

- Lewis County Comprehensive Plan
- City of Centralia Comprehensive Plan
- City of Chehalis Comprehensive Plan
- City of Napavine Comprehensive Plan
- Town of Pe Ell Comprehensive Plan
- Growth Management Act, Chapter 36.70A RCW
- Shoreline Inventory and Characterization Report

3.3.2 Critical Facilities and Infrastructure

Critical facilities and infrastructure are those that are essential to the health and welfare of the population. These become especially important after a hazard event. Critical facilities typically include police and fire stations, schools and emergency operations centers. Critical infrastructure can include the roads and bridges that provide ingress and egress and allow emergency vehicles access to those in need, and the utilities that provide water, electricity and communication services to the community. Also included are facilities that hold or carry significant amounts of hazardous materials with a potential to impact public health and welfare in a hazard event. Through a facilitated process, the Stakeholder Committee established a definition of critical facilities for this Comprehensive Flood Hazard Management Plan that includes but is not limited to the following:

A critical facility is any property that, if flooded, would result in severe consequences to public health and safety. Facilities and infrastructure that are critical to public health and safety and that are especially important following flood events include, but are not limited to:

- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic, or water-reactive materials;
- Hospitals, nursing homes, and dedicated care centers that contain occupants who may not be sufficiently mobile to avoid death or injury during a flood;

- Law enforcement and detention facilities, fire stations, government facilities, vehicle and equipment storage and maintenance facilities, and emergency operations centers that are needed for flood response activities before, during and after a flood;
- Educational facilities, including K-12 and community colleges; major road and rail systems including bridges and airports; and
- Public and private utility facilities that are vital to maintaining or restoring normal services to flooded areas before, during, and after a flood.

An inventory of facilities that meet this definition was created and input to the computer model used to assess risk for this Flood Plan (FEMA's Hazus model). The Flood Plan used an inventory of critical facilities and infrastructure maintained by Lewis County GIS. Not all critical facilities within the Chehalis River basin are reflected in this data.

Figure 3-2 shows the location of critical facilities in the planning area and Figure 3-3 shows the location of critical infrastructure. Due to the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with Lewis County. Table 3-1 and Table 3-2 provide summaries of the general types of critical facilities and infrastructure in the planning area. All critical facilities and infrastructure were analyzed to help identify the flood risk and mitigation actions. Chapter 7 assesses facilities that are exposed and vulnerable to the flood hazard.

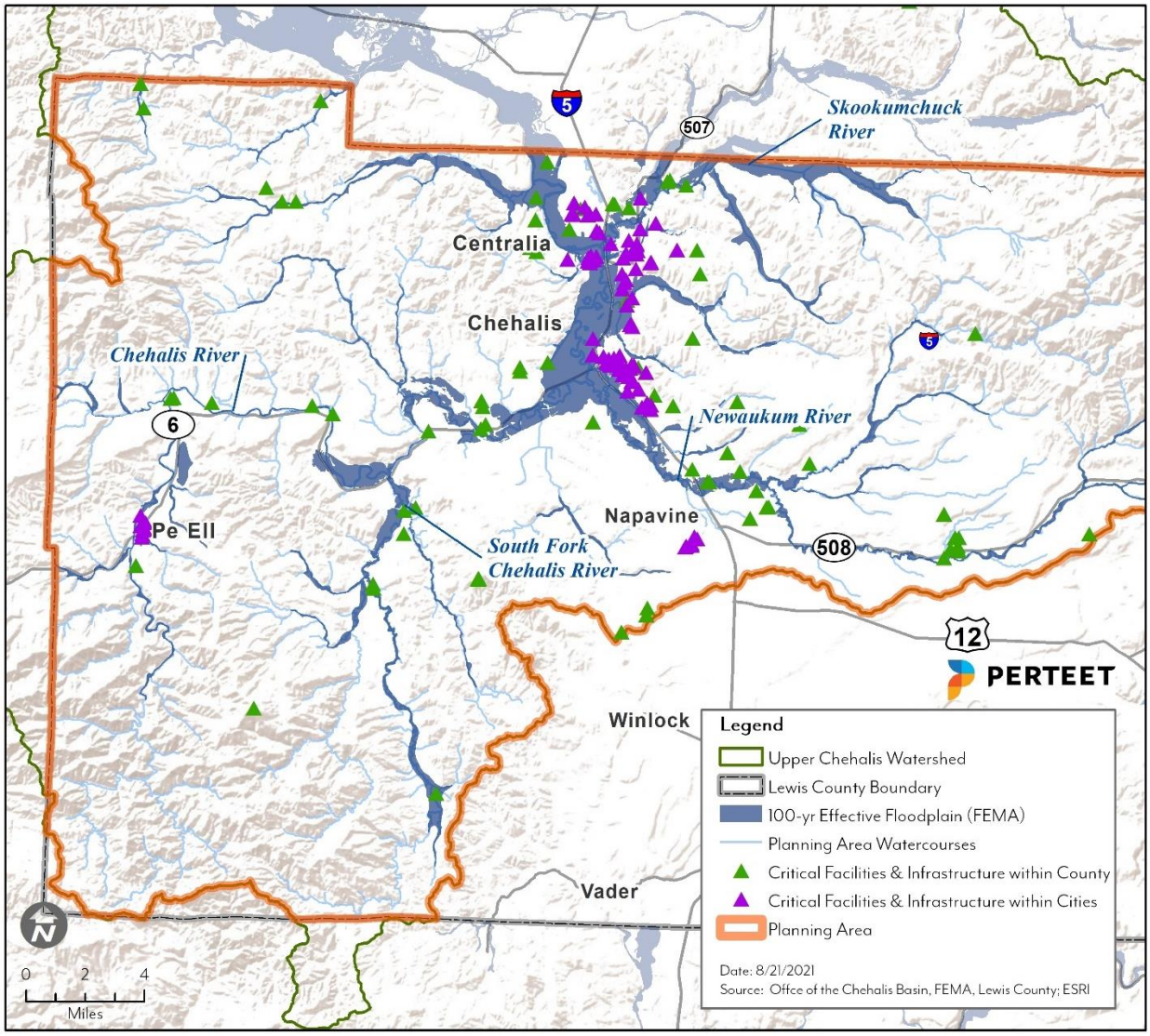
Table 3-1. Critical Facilities within the Chehalis River Basin.

City	Police and Fire Stations	Medical Care	Schools and Educational Facilities	Hazardous Materials Facilities	Dams	Other Essential Facilities	Total
Unincorporated	23	6	9	5	37	3	**83**
Chehalis	3	10	8	2	0	13	**36**
Centralia	2	16	9	0	0	6	**33**
Napavine	1	0	3	0	0	2	**6**
Pe Ell	1	2	1	0	0	2	**6**

Table 3-2. Critical Infrastructure within the Chehalis River Basin.

City	Transportation Systems	Communications Facilities	Airports	Potable Water Facilities	Wastewater Facilities	Total
Unincorporated	9	30	7	5	2	**53**
Chehalis	2	5	1	4	1	**13**
Centralia	1	2	0	3	0	**6**
Napavine	0	0	0	2	0	**2**
Pe Ell	0	0	0	0	1	**1**

Figure 3-1. Map of Critical Facilities and Infrastructure.



Road Transportation

The road system in Lewis County is made up of local public and private roads, interstate, US highways, and state routes. There are over 1,888 miles of public and private roads within the County. The County maintains 1,065 miles of roadways, 196 bridges, and 5,110 culverts. The nine cities (Centralia, Chehalis, Morton, Mossyrock, Napavine, Pe Ell, Toledo, Vader, and Winlock) are responsible for their own roadways within their city limits. Unless there is an agreement between the County and the cities, the County currently maintains the roadways in the unincorporated UGAs.

The Chehalis-Centralia area lays 85 miles midway between the metropolitan areas of Seattle, Washington, and Portland, Oregon. The primary north-south transportation corridor passing through Lewis County and the Cities of Centralia and Chehalis is Interstate 5. Interstate 5 passes through the Chehalis River floodplain and is affected by flooding. The roadway was closed for four days in 1996 and 2007, and two days in 2009, causing millions of dollars of freight delays (WA Ecology, 2020).

US Highway 12 traverses Lewis County from east to west and crosses the Cascade Mountains at White Pass. White Pass is the only major all-season route south of Seattle and north of the Columbia River allowing access to eastern Washington.

Railroad Transportation
Several rail lines are located within the Chehalis River Basin. The mainline BNSF Railway Company railroad crosses through Lewis County and the Chehalis River floodplain. Amtrak provides passenger railway service to Centralia along the BNSF rail line. There are also rail lines operated by the Puget Sound and Pacific Railroad, the Union Pacific Railroad, and Tacoma Rail.

Air Transportation
The Chehalis-Centralia airport is located within Chehalis city limits and provides regional services. The airport is owned by the City of Chehalis.

3.4 Demographics

Some populations are at greater risk from hazard events such as floods because of decreased resources or physical abilities. Elderly people, for example, may be more likely to require additional assistance. Research has shown that people living near or below the poverty line, the elderly (especially older single men), the disabled, women, children, ethnic minorities, and renters all experience, to some degree, more severe effects from disasters than the general population (Rufat et al., 2015). These vulnerable populations may vary from the general population in risk perception, living conditions, access to information before, during and after a hazard event, capabilities during an event, and access to resources for post-disaster recovery. Indicators of vulnerability – such as disability, age, poverty, and minority race and ethnicity – often overlap spatially and often in the geographically most vulnerable locations. Detailed spatial analysis to locate areas where there are higher concentrations of vulnerable community members would help to extend focused public outreach and education to these most vulnerable citizens.

This section includes demographic data for the entire Lewis County, including areas outside of the Chehalis River Basin.

3.4.1 Population Characteristics

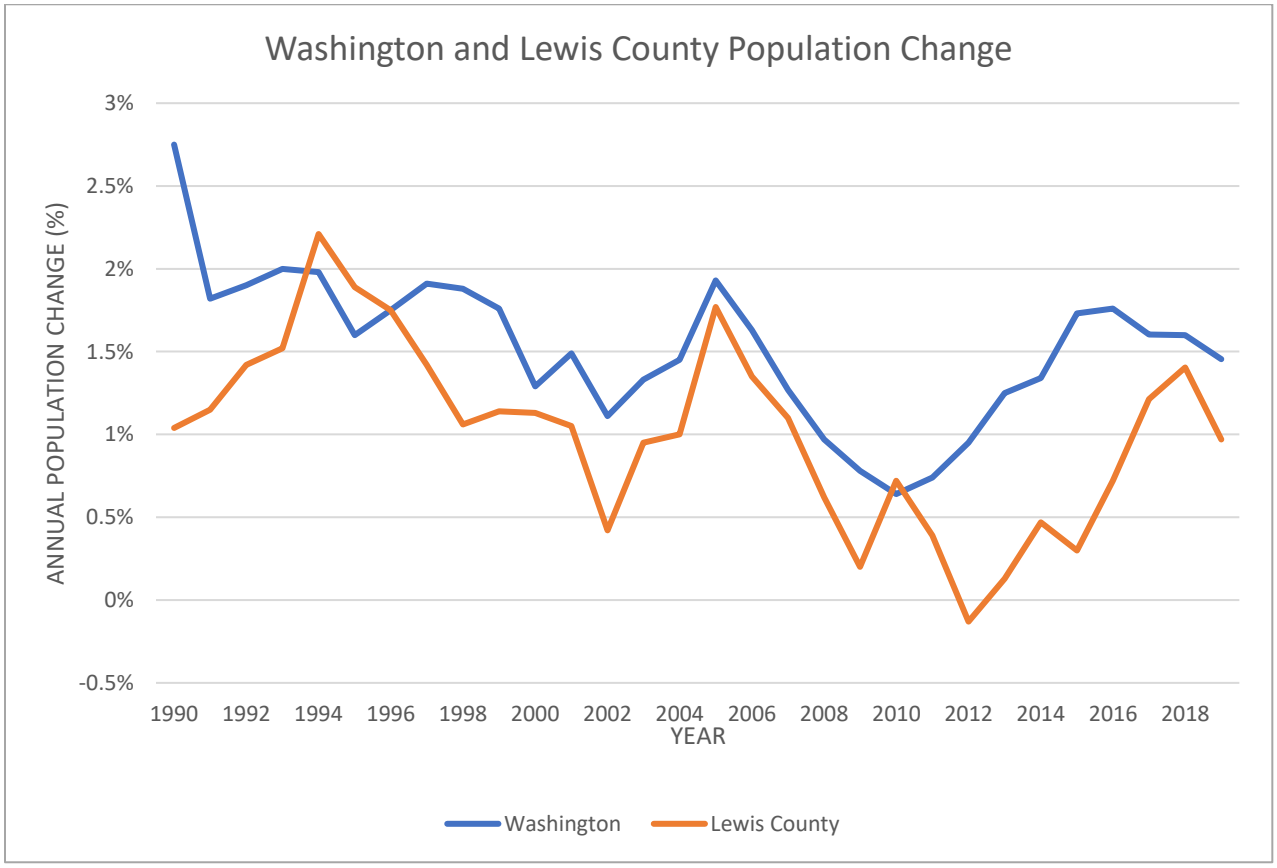
Knowledge of the composition of the population and how it has changed in the past and how it may change in the future is needed for making informed decisions about the future. Information about population is a critical part of planning because it directly relates to land needs such as housing, industry, stores, public facilities and services, and transportation. The Washington State Office of Financial Management estimated Lewis County's population at 79,480 as of April 2019, making it the 16th largest county by population in the state (OFM, 2019).

Population changes are useful socio-economic indicators. A growing population generally indicates a growing economy, while a decreasing population signifies economic decline. Figure 3-2 shows the Lewis County population change from 1990 to 2019 compared to that of the State of Washington (Washington OFM, 2021). The County grew faster than the statewide average through the early-to-mid 1990s but has

since had a growth rate somewhat below, and mirroring, that of the state. Table 3-3 shows the county population from 2005 to 2019.

The Washington Office of Financial Management has developed forecasts of future population as shown in Table 3-4. The projections for medium-growth expectations for Lewis County estimate a population of 89,178 in Lewis County by 2040; a 12-percent increase from 2019.

Figure 3-2. Washington and Lewis County Population Change.



Source: OFM, 2020

Table 3-3. Recent Lewis County Population Growth.

Year	Lewis County Population	Year	Lewis County Population	Year	Lewis County Population
2005	71,600	2010	75,455	2015	76,660
2006	72,900	2011	76,000	2016	76,890
2007	74,100	2012	76,300	2017	77,440
2008	74,700	2013	76,200	2018	78,380
2009	75,200	2014	76,300	2019	79,480

Source: OFM, 2019

Table 3-4. Projected Future Lewis County Population.

Year	Lewis County Population
2020	80,220
2025	83,425
2030	85,438
2035	87,449
2040	89,178

Source: OFM, 2017

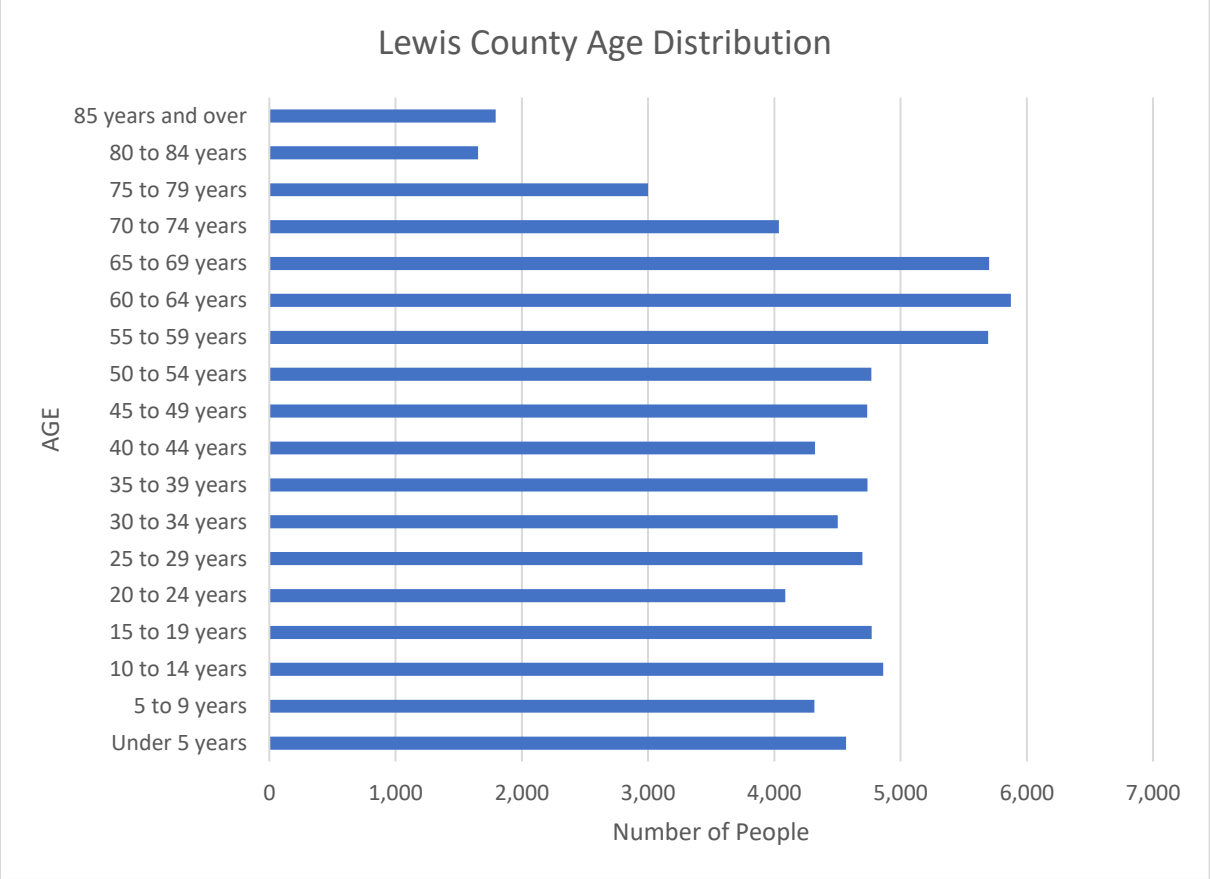
3.4.2 Age Distribution

As a group, the elderly are more apt to lack the physical and economic resources necessary for response to hazard events and are more likely to suffer health-related consequences making recovery slower. They are more likely to be vision, hearing, and/or mobility impaired, and more likely to experience mental impairment or dementia.

Additionally, the elderly are more likely to live in assisted-living facilities where emergency preparedness occurs at the discretion of facility operators. These facilities are typically identified as "critical facilities" by emergency managers because they require extra notice to implement evacuation. Elderly residents living in their own homes may have more difficulty evacuating their homes and could be stranded in dangerous situations. This population group is more likely to need special medical attention, which may not be readily available during natural disasters due to isolation caused by the event. Specific planning attention for the elderly is an important consideration given the current aging of the American population.

Children under 14 are particularly vulnerable to disaster events because of their young age and dependence on others for basic necessities. Very young children may additionally be vulnerable to injury or sickness; this vulnerability can be worsened during a natural disaster because they may not understand the measures that need to be taken to protect themselves from the flood hazard.
The overall age distribution for Lewis County is illustrated in Figure 3-3. Based on the most recent five-year estimates (2015-2019) from the US Census Bureau's American Community Survey, 20.7 percent of the planning area's population is 65 or older, compared to the state average of 15.1 percent. According to US Census data, 44.2 percent of the over-65 population has a disability of some kind and 6.7 percent have incomes below the poverty level. The Census estimates that 15.3 percent of children under 18 in Lewis County live below the poverty line (US Census, 2019).

Figure 3-3. Lewis County Age Distribution.



Source: US Census, 2019

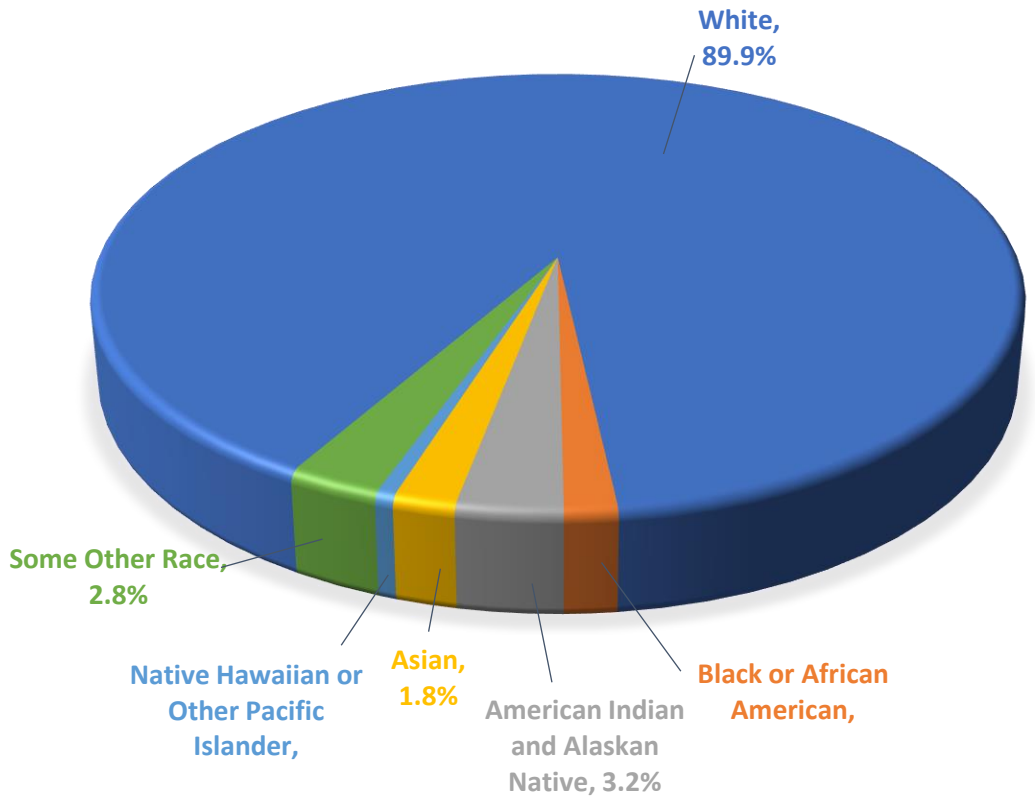
3.4.3 Race, Ethnicity, and Language

Research shows that minority groups are less likely to be involved in pre-disaster planning and experience higher mortality rates during a disaster event (Gibbs and Montagnino, 2006). Post-disaster recovery can be ineffective and is often characterized by cultural insensitivity. Since higher proportions of ethnic minorities live below the poverty line than the majority white population, poverty can compound vulnerability.

According to the most recent five-year estimates (2015-2019) from the US Census Bureau's American Community Survey, the racial composition of the planning area is predominantly white, at 95.0 percent. The largest non-white populations are those identifying as American Indian and Alaska Native at 3.4 percent and those identifying as "some other race" at 3.0 percent. Figure 3-4 shows the racial distribution in Lewis County (US Census, 2019). Those identifying as Hispanic or Latino, of any race, make up 10.2 percent of the population.

Lewis County has a 5.2 percent foreign-born population. Of the foreign-born residents, 63.9 percent were born in Latin America. Other than English, the most commonly spoken language in the planning area is Spanish, with 7.0 percent of the population speaking Spanish at home. The Census estimates that 3.6 percent of the residents speak English "less than very well" (US Census, 2019).

Figure 3-4. Lewis County Race Distribution.



Source: US Census, 2019

3.4.4 Disabled Populations

The 2010 US Census estimates that 54 million non-institutionalized Americans with disabilities live in the US. This equates to about one-in-five persons. People with disabilities are more likely to have difficulty responding to a hazard event than the general population. Local government is the first level of response to assist these individuals, and coordination of efforts to meet their access and functional needs is paramount to life safety efforts.

It is important for emergency managers to distinguish between functional and medical needs in order to plan for incidents that require evacuation and sheltering. Knowing the percentage of population with a disability will allow emergency management personnel and first responders to have personnel available who can provide services needed by those with access and functional needs.

According to the 2015-2019 five-year Census estimates, there are nearly 15,000 individuals with some form of disability in Lewis County, representing 19.4 percent of the total population. Of those, 47 percent are ages 65 and older, and 1.1 percent are under five-years old. Over 10 percent (10.7%) of the disabled population in Lewis County are living with an ambulatory difficulty that may increase the difficulty of emergency evacuations or response (US Census, 2019).

3.5 Economy

This section includes economic data for the entire Lewis County, including areas outside of the Chehalis River Basin.

3.5.1 Income

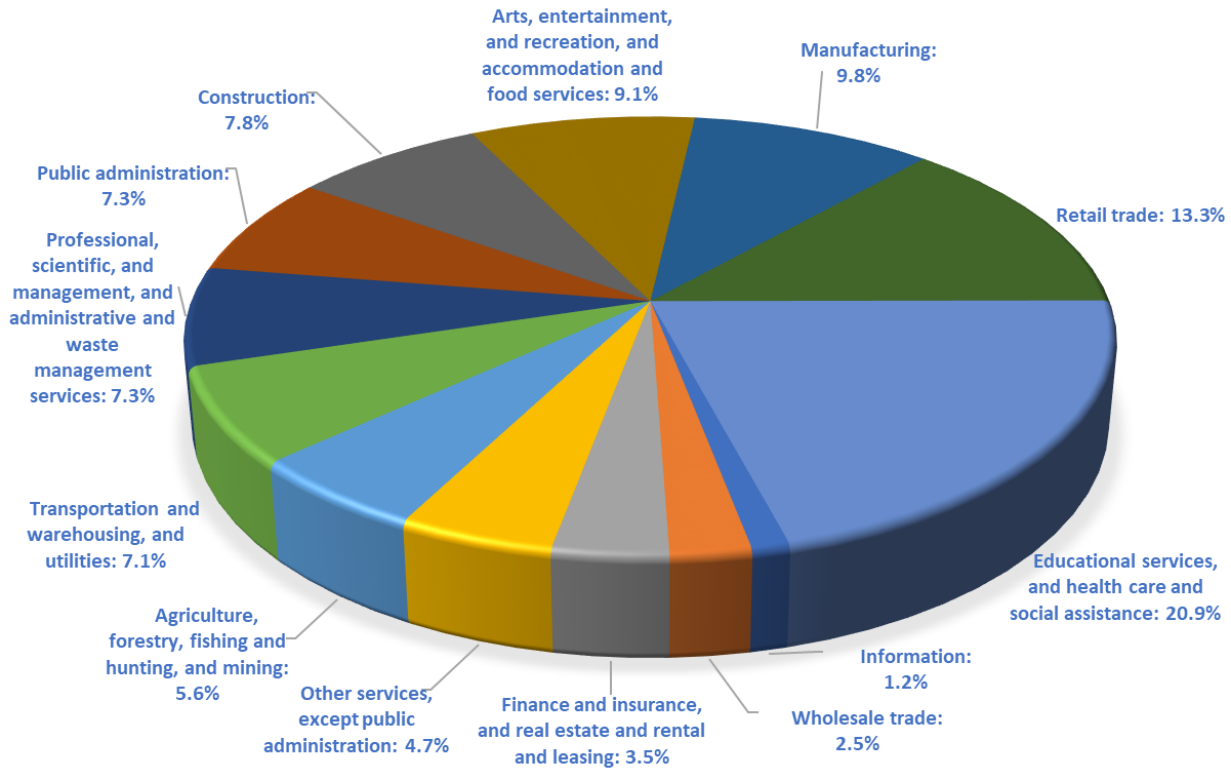
In the United States, individual households are expected to use private resources to prepare for, respond to, and recover from disasters to some extent. This means that households living in poverty are disadvantaged when confronting hazards such as flooding. Additionally, the poor typically occupy more poorly built and inadequately maintained housing located in high-hazard risk areas such as floodplains and floodways. Mobile or modular homes, for example, are more susceptible to damage in floods than other types of housing. Furthermore, residents below the poverty level are less likely to have insurance to compensate for losses incurred from natural disasters. This means that residents below the poverty level have a great deal to lose during an event and are the least prepared to deal with potential losses. The events following Hurricane Katrina in 2005 illustrated that personal household economics significantly impact people's decisions on evacuation. Individuals who cannot afford gas for their cars will likely decide not to evacuate.

Based on the most recent five-year estimates (2015-2019) from the US Census Bureau's American Community Survey, per capita income in Lewis County was $27,127 and the median household income was $53,484. It is estimated that about 11.8 percent of workers over the age of 16 receive an income of $75,000 to $99,999 per year and 7.5 percent of workers' incomes are above $100,000 annually. The Census Bureau estimates that 13.1 percent of the population in Lewis County lives below the poverty level (US Census, 2019).

3.5.2 Industry, Businesses, and Institutions

The planning area's economy is strongly based in the education/health care/social service industry (20.8 percent of employment), followed by retail trade (13.3 percent), and manufacturing (9.8 percent). Information (1.2 percent), wholesale trade (2.5 percent), and finance and insurance, including real estate (3.5 percent) make up the smallest source of the local economy. Figure 3-5 shows the breakdown of industry types in Lewis County. (US Census, 2019)

Figure 3-5. Industry in Lewis County.



Source: US Census, 2019

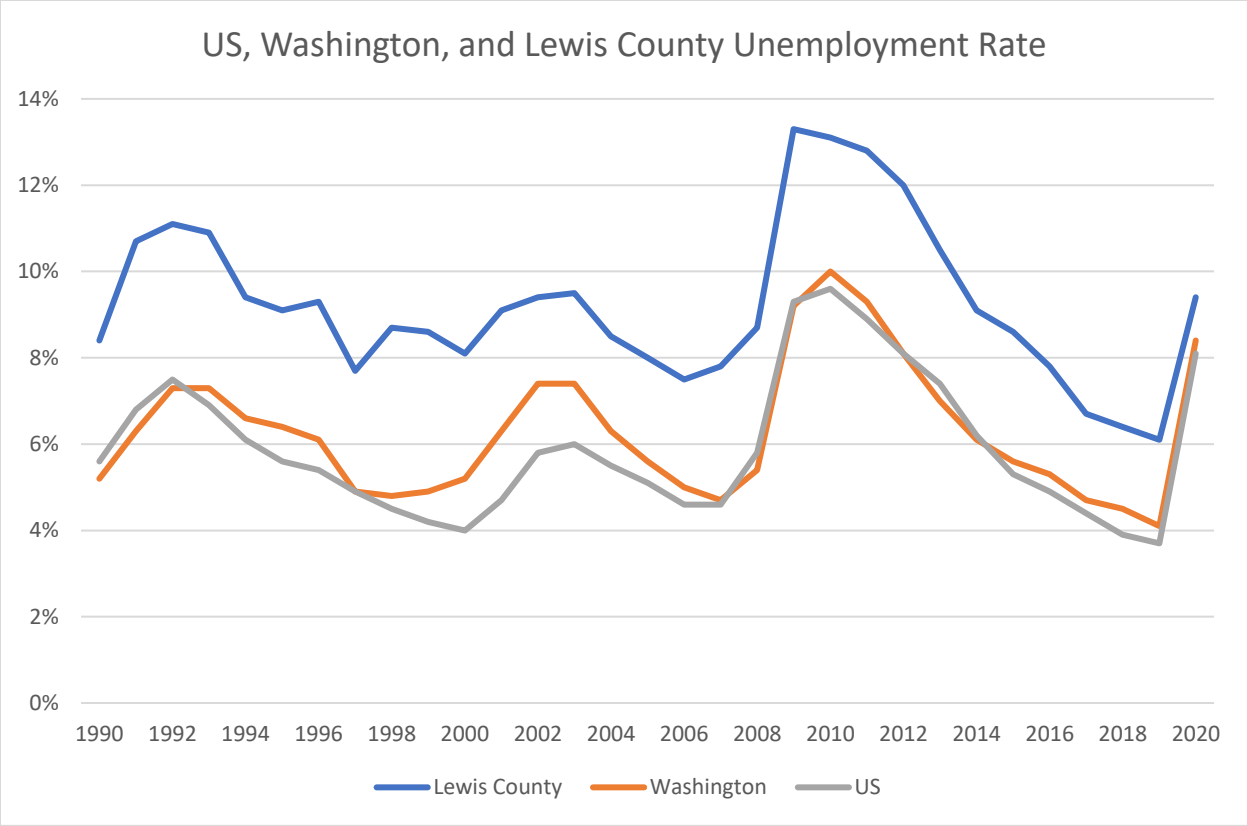
The Centralia-Chehalis Chamber of Commerce presented the Lewis County Economic Profile in partnership with Western Washington University in 2019, which provided a basic overview of the local economy including factors that impact it such as major employers and tourism. The Port of Chehalis and businesses located within support approximately 1,500 jobs, while over 2,100 jobs are supported by the 30 businesses within the Port of Centralia. Tourists spend approximately $35,784,000 on recreation in Lewis County annually (WWU, 2019).

3.5.3 Employment Trends and Occupations

According to the 2015-2019 five-year American Community Survey, 53.4 percent of Lewis County's population 16-years old or older is in the labor force, including 64.6 percent of women in that age range and 76.1 percent of men (US Census, 2019).

Figure 3-6 compares unemployment trends from 1990 through 2014 for the United States, Washington, and Lewis County, based on data from the state Employment Security Department (Washington ESD, 2021). Lewis County's unemployment rate was lowest in 2019 at 6.1 percent. The rate peaked at 13.3 percent in 2009 and has experienced a sharp decline since then. However, due to the onset of the COVID-19 Pandemic in the United States in March 2020, the unemployment rate for Lewis County, the State of Washington, and the United States as a whole, increased sharply.

Figure 3-6. US, Washington, and Lewis County Unemployment Rate.

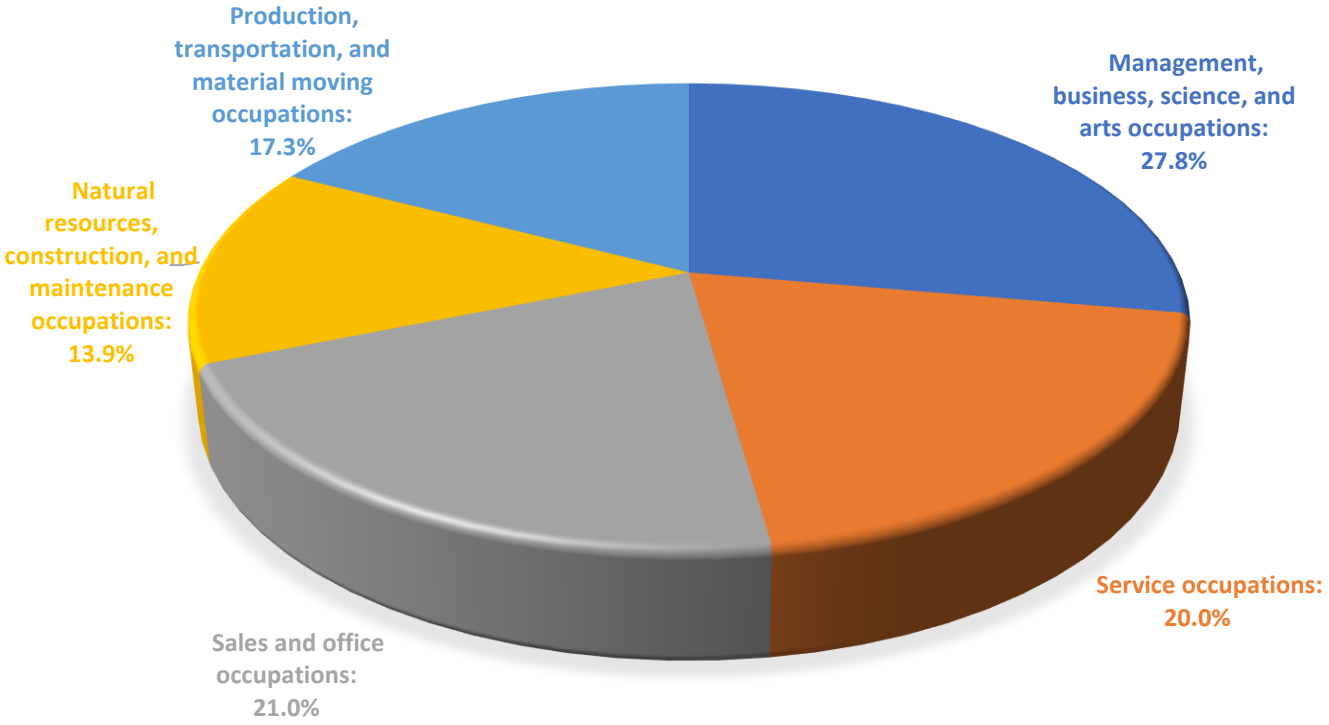


Source: ESD, 2021

Figure 3-9 shows US Census estimates of employment distribution by occupation category (US Census, 2013). Management, business, science, and arts occupations make up 27.8 percent of the jobs in Lewis County. Sales and office occupations make up 21 percent.

The US Census estimates that 79.5 percent of workers in the County commute alone (by car, truck, or van) to work (US Census, 2019).

Figure 3-9. Occupations in Lewis County.



Source: 2019 US Census

4.0 REGIONAL CONSISTENCY

4.1 Regional Plan Coordination

The Chehalis River Basin has a long history of flooding. After the devastating flooding in 2007, communities within the watershed organized together to form the Chehalis River Basin Flood Authority (Flood Authority) in 2008. Founding documents were signed by Lewis County, Grays Harbor County, Thurston County, the Chehalis Tribe, and cities of Centralia, Chehalis, Aberdeen, Montesano, and Towns of Pe Ell and Bucoda. Over time, the Cities of Oakville, Cosmopolis, Napavine, and Hoquiam also joined as members.

The purpose of the Flood Authority is to work with project sponsors to identify and fund mitigation projects that address flooding problems throughout the basin using a coordinated approach. The goal is to reduce flood damage while improving floodplain functions.

Since 2008, the Flood Authority has sponsored local level projects, such as retrofit programs for private property, regulatory projects such as reviews and analysis of local regulations, and regional projects such as developing and managing a flood warning system for the entire watershed and planning for a flood retention facility at the headwaters of the river.

At the same time, the Chehalis Basin Strategy was created to reduce flooding risk and improve fish and wildlife habitat. In 2016, the Office of the Chehalis Basin was formed within the Department of Ecology to manage the Chehalis Basin Strategy.

Since its creation, the Chehalis Basin Strategy has conducted and/or reviewed almost 1,000 studies across the basin, gathered input and ideas from the public, identified options for both large-scale and community-scale flood damage reduction projects, and developed a draft Aquatic Species Restoration Plan. In 2017, the Office of the Chehalis Basin released the Final Programmatic Environmental Impact Statement to evaluate the overall strategy to reduce flooding in the basin. In 2020, the Office of the Chehalis Basin released a draft SEPA Environmental Impact Statement and the Army Corps of Engineers released a draft NEPA Environmental Impact Statement to evaluate specific actions within the Strategy: the proposed flood retention facility at the headwaters of the Chehalis River in Lewis County and a levee at the Chehalis-Centralia Airport

Currently, the Flood Authority and the Office of the Chehalis Basin are separate entities managed by separate boards, but with the same goal of implementing the Strategy. The Flood Authority generally focuses on local level projects, and the Office of the Chehalis Basin is focused on large scale regional projects and the environmental review process.

In 2011, the Chehalis Basin Flood Control Zone District was formed within Lewis County to manage local flooding issues. This Flood Plan will establish a true coordinated plan in support of all flood risk reduction within Lewis County's Chehalis River Basin and will be maintained and implemented by the Chehalis River Basin Flood Control Zone District. The Chehalis River Basin Flood Control Zone District is the project sponsor and applicant for the flood retention facility and airport levee.

For more information on the proposed Chehalis Basin Strategy actions proposed within Lewis County, see Section 12.6.

4.2 Regional Plan Consistency Review

This plan was developed to meet the needs specific to Lewis County and the Flood Control Zone District but remain consistent with the overall goals of the watershed.

Several agencies or organizations have plans that encompass or include this Flood Plan's study area. The project team review the following plans to ensure consistency in regional planning efforts:

- 2010 Chehalis River Basin Comprehensive Flood Hazard Management Plan. Chehalis River Basin Flood Authority.
- Chehalis Basin Strategy: Reducing Flood Damage and Enhancing Aquatic Species. September 16, 2014.
- Chehalis River Basin Floodplain Management Assessment Master Report. April 2015.
- Comprehensive Flood Hazard Management Plan for Confederated Tribes of the Chehalis Reservation. March 17, 2009.
- City of Centralia Comprehensive Flood Management and Natural Hazards Mitigation Plan. December 9, 2008.
- Hazard Identification and Vulnerability Analysis. August 31, 2018.
- Lewis County Multi-jurisdictional Hazard Mitigation Plan. January 25, 2016.
- Lewis County Comprehensive Flood Hazard Management Plan. May 2004.
- Lewis County Comprehensive Flood Hazard Management Plan. September 2008.
- Lewis County Comprehensive Plan. 2020.
- City of Centralia Comprehensive Plan. 2018.
- City of Chehalis Comprehensive Plan. 2017.
- Lewis County Shoreline Management Program. 2017.
- Shoreline Inventory and Characterization Report for Lewis County. October 17, 2013.

In addition to the plans listed above, the planning team reviewed several documents, reports, and studies prepared over the past years to inform the Chehalis Basin Strategy. All documents used in the preparation of this report are listed within the references. Some of these documents include:

- Chehalis Basin Strategy Final Programmatic Environmental Impact Statement. June 2017.
- State Environmental Policy Act Draft Environmental Impact Statement for the Proposed Chehalis River Basin Flood Damage Reduction Project. February 27, 2020.
- NEPA Draft Environmental Impact Statement Chehalis River Basin Flood Damage Reduction Project. September 18, 2020.
- Lewis County Recovery Strategy. April 2009.
- FEMA NFIP Policy and Claims Information. May 2021.
- FEMA Flood Insurance Study for Lewis County. July 17, 2006.
- USGS Stream Gage Data. May 2021.

PART 2 – RISK ASSESSMENT

5.0 RISK ASSESSMENT METHODOLOGY

5.1 Purpose of Risk Assessment

This part of the Flood Plan evaluates the risk of the flood hazard in the planning area (CRS Step 5). Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards such as flooding. It allows emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. The process focuses on the following elements:

- Exposure identification – Determine the extent of people, property, environment, and economy exposed to the effects of the natural hazard.
- Vulnerability evaluation – Estimate potential damage from the natural hazard and associated costs.

The risk assessment describes the flooding hazard, the planning area's vulnerabilities, and probable event scenarios. The following steps were used to define the risk:

- Identify and profile the flooding hazard (CRS Step 4); the following information is given:
  - Principal sources of flooding in the planning area
  - Major past flood events
  - Geographic areas most affected by floods
  - Estimated flood event frequency
  - Estimates of flood severity
  - Warning time likely to be available for response
  - Existing flood protection programs and projects
  - Secondary hazards associated with the flood hazard
  - Potential impacts of climate change on flooding
  - Expected future trends that could affect the flood hazard
  - Scenario of potential worst-case flood event
  - Key issues related to flood hazard management in the planning area.
- Determine exposure to the flood hazard – Exposure was determined by overlaying flood maps with an inventory of structures, facilities, and systems to determine which of them would be exposed to flood events.
- Assess the vulnerability of exposed facilities – Vulnerability of exposed structures and infrastructure was determined by interpreting the probability of occurrence of each flood event and assessing structures, facilities, and systems that are exposed. In addition, the repetitive loss areas in the County were reviewed, mapped, and evaluated.

5.2 Risk Assessment Approach

5.2.1 FEMA's Hazus Software

In 1997, FEMA developed the standardized Hazards US (Hazus) model to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. Hazus was later expanded into a multi-hazard methodology, Hazus-MH, with new models for estimating potential losses from hurricanes and floods. The use of Hazus for hazard mitigation planning offers numerous advantages:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that it can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates FEMA review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Is administered by the local government and can be used to manage and update a flood hazard management plan throughout its implementation.

Hazus is a GIS-based software program that includes extensive inventory data, such as demographics, building stock, critical facilities, transportation facilities and utilities. It uses multiple models to estimate potential losses from natural disasters. The program maps hazard areas and estimates damage and economic losses for buildings and infrastructure.

To estimate damage that would result from a flood, Hazus uses pre-defined relationships between flood depth at a structure and resulting damage, with damage given as a percent of total replacement cost. These are referred to as depth-damage curves and are based on data from the Federal Insurance Administration and the Corps of Engineers. Curves defining these relationships have been developed for damage to structures and for damage to typical contents for a variety of residential, commercial and public structures. By inputting flood depth data and known property replacement cost values, users can generate dollar-value estimates of damage that will result from any given flood event.

Hazus provides default data for inventory, vulnerability and hazards; this default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis, depending on the format and level of detail of information:

- Level 1 – All of the information needed to produce an estimate of losses is included in the software's default data. This data is derived from national databases and describes in general terms the characteristic parameters of the modeled area.
- Level 2 – More accurate estimates of losses require more detailed information about the modeled area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics and building inventory, as well as data about utilities and critical facilities. This information is needed in a GIS format.
- Level 3 – This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the modeled area. Level 3

involves establishing new damage curves, which is not necessary for flood hazard analyses, because those damage functions are well established.

To assess the flood hazard for this Flood Plan, a Level 2, user-defined analysis was performed for both general building stock and critical facilities. Findings from this analysis are covered in Chapter 7.

5.2.2 Sources of Data Used in Hazus Modeling

Data loaded into Hazus included property replacement cost values and detailed structure information derived from address, parcel, and tax assessor data provided by Lewis County. When available, an updated inventory was used in place of the Hazus defaults for critical facilities and infrastructure.

Replacement cost is the cost to replace the entire structure with one of equal quality and utility. Replacement cost is based on industry-standard cost-estimation models published in RS Means Square Foot Costs. It is calculated using the RS Means square foot cost for a structure, which is based on the Hazus occupancy class (e.g., multi-family residential, commercial retail trade), multiplied by the square footage of the structure from the tax assessor data. For single-family residential structures, the construction class and number of stories factor into determining the square foot costs.

Flood hazard areas for the 100-year effective flood were delineated using new FEMA digital flood data where available (from Digital Flood Insurance Rate Maps) and older FEMA digital flood data (Q3 data) where digital mapping has not yet been developed. Lewis County supplemented the Q3 data by digitizing the floodways and base flood elevations into GIS. Table 5-1 summarizes the sources of data used in the Hazus model for this Flood Plan.

5.2.3 Flood Depth Grids

An important input to Hazus for modeling flood damage is a flood depth grid, which defines the depth of floodwater at points covering the flooded area for any given flood event. For this Flood Plan, the Office of the Chehalis Basin provided depth grids to the Planning Team that were imported directly into Hazus. The following depth grids were provided:

- 100-year modeled floodplain
- 100-year modeled floodplain with flood reduction projects
- 10-year modeled floodplain
- 10-year modeled floodplain with flood reduction projects
- Climate change modeled floodplain (mid-range)
- Climate change modeled floodplain with flood reduction projects (mid-range)

The depth grids do not include all tributaries into the Chehalis River that have FEMA identified 100-year floodplains; therefore, the results cannot be directly compared to the effective 100-year floodplain Hazus results within the unincorporated county. See Section 7.1 for more information on the differences between the floodplain boundaries.

The climate change model is based on the “mid-range” projections estimating a 26 percent flow increase. See Section 9.4.3 for more information on the climate change model.

The flood reduction projects are described in Section 12.1.

To develop the FEMA 100-year effective Hazus model, the County provided the Planning Team used digitized effective FIRM data provided by Lewis County to generate a depth grid within Hazus.

Table 5-1. Hazus Model Data Documentation.

Data	Source	Date	Format
Building information for residential, commercial, and mobile homes (square footage, use description, year built, number of stories, garage type, construction class, building material, foundation type)	Lewis County	2019	Digital (GIS) format
Chehalis Basin Finished Floor Analysis – 2017 Update	Anchor QEA, Watershed Science & Engineering (WSE)	2017	Digital (GIS) format
Building replacement cost	RS Means	2019	Paper format
Population data (2010 U.S. Census)	Hazus v4.2 SP03	2010	Digital (GIS and tabular) format
FEMA Effective Digital Flood Insurance Rate Map data	FEMA	07/2006	Digital (GIS) format
FEMA Flood Insurance Rate Maps	Lewis County	1981, 1982	Digital (GIS) format
Depth grids	Anchor QEA	2019	Digital (GIS) format
LiDAR digital elevation model, 6-foot horizontal resolution	Puget Sound LiDAR Consortium (PSLC)	2012	Digital (raster) format
Digital elevation model, 10-meter horizontal resolution	US Geological Survey	Unknown	Digital (raster) format

5.2.4 Limitations

Loss estimates, exposure assessments and vulnerability evaluations rely on the best available data and methodologies. However, results are subject to uncertainties associated with the following factors:

- Incomplete scientific knowledge about flood hazards and their effects on the built environment.
- Approximations and simplifications necessary to conduct a study.
- Incomplete or outdated inventory, demographic, or economic parameter data.
- The unique nature, geographic extent, and severity of the flood hazard.
- Mitigation actions already employed.
- The amount of advance notice residents have to prepare for a flood event.
- FEMA adheres to a protocol for map revision. Understanding that flood hazard areas are dynamic and constantly changing, FEMA attempts to keep its maps current by adhering to this protocol. It should be understood that at any point in time a current map may not reflect current conditions.

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate. The results do not predict precise results and should be used only to understand relative risk.

6.0 LEWIS COUNTY FLOOD PROFILE

6.1 General Concepts

A floodplain is the area adjacent to a flood source such as a river, creek, alluvial fan, or lake that becomes inundated during a flood. Floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined in a canyon.

When floodwaters recede after a flood event, they leave behind layers of rock and mud. These gradually build up to create a new floor of the floodplain. Floodplains generally contain unconsolidated sediments (accumulations of sand, gravel, loam, silt, and/or clay), often extending below the bed of the stream. These sediments provide a natural filtering system, with water percolating back into the ground and replenishing groundwater. These are often important aquifers, the water drawn from them being filtered compared to the water in the stream. Fertile, flat, reclaimed floodplain lands are commonly used for agriculture, commerce, and residential development.

Connections between a river and its floodplain are most apparent during and after major flood events. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood and erosion control. When a river is separated from its floodplain with levees and other flood control facilities, natural, built-in benefits can be altered or significantly reduced.

6.1.1 Measuring Floods and Floodplains

The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels. The flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a one-percent chance of being equaled or exceeded in any given year. The “annual flood” is the greatest flood event expected to occur in a typical year. These measurements reflect statistical averages only; it is possible for two or more floods with a 100-year or higher recurrence interval to occur in a short time period. The same flood can have different recurrence intervals at different points on a river.

The extent of flooding associated with a one-percent annual probability of occurrence (the base flood or 100-year flood) is used as the regulatory boundary by many agencies. Also referred to as the special flood hazard area (SFHA), this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe

DEFINITIONS

Flood – The inundation of normally dry land resulting from the overland flow of water from any source.

Floodplain – The land area along the sides of a body of water that becomes inundated with water during a flood.

100-Year Floodplain – The area flooded by a flood event that has a one-percent chance of being equaled or exceeded each year. This is a statistical average only; a 100-year flood can occur more than once in a short period of time. The one-percent annual chance flood is the standard used by most federal and state agencies.

the elevation of water that will result from a given discharge level, which is one of the most important factors used in estimating flood damage.

6.1.2 Floodplain Ecosystems

Floodplains can support ecosystems that are rich in plant and animal species. A floodplain can contain 100 or even 1,000 times as many species as a river. Wetting of the floodplain soil releases an immediate surge of nutrients: those left over from the last flood, and those that result from the rapid decomposition of organic matter that has accumulated since then. Microscopic organisms thrive and larger species enter a rapid breeding cycle. Opportunistic feeders (particularly birds) move in to take advantage. The production of nutrients peaks and falls away quickly, but the surge of new growth endures for some time. Species growing in floodplains are markedly different from those that grow outside floodplains. For instance, riparian trees (trees that grow in floodplains) tend to be very tolerant of root disturbance and very quick-growing compared to non-riparian trees.

6.1.3 Effects of Human Activities

Because they border water bodies, floodplains have historically been popular sites to establish settlements. Human activities tend to concentrate in floodplains for a number of reasons: water is readily available; land is fertile and suitable for farming; transportation by water is easily accessible; and land is flatter and easier to develop. But human activity in floodplains frequently interferes with the natural function of floodplains. It can affect the distribution and timing of drainage, thereby increasing flood problems. Human development can create local flooding problems by altering or confining drainage channels. This increases flood potential in two ways: it reduces the stream's capacity to contain flows, and it increases flow rates or velocities downstream during all stages of a flood event. Human activities can interface effectively with a floodplain as long as steps are taken to mitigate the activities' adverse impacts on floodplain functions.

6.2 Principal Types of Flooding in the Chehalis River Basin

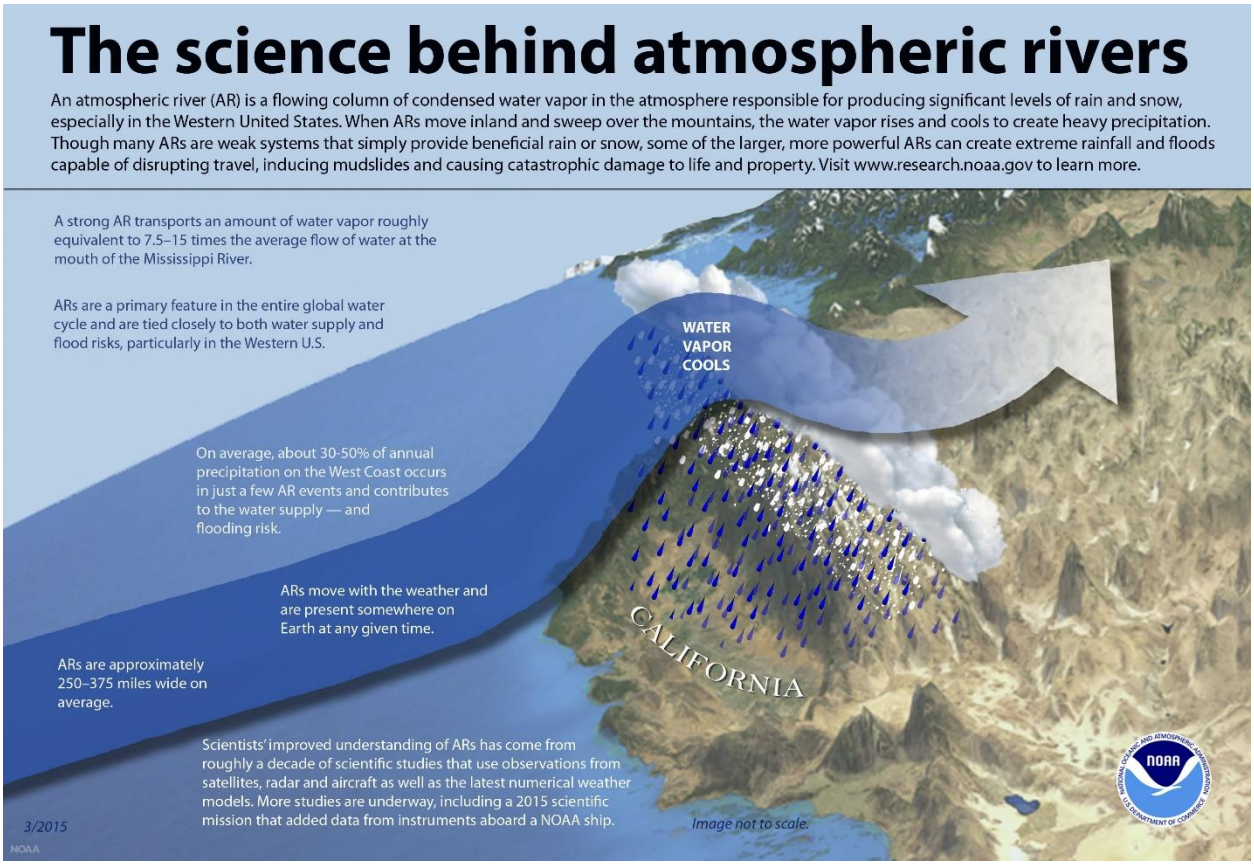
Stage flooding is the most common types of flooding that occurs in the Chehalis River Basin. Stage flooding occurs during periods of heavy rains, and flooding can last several days after a storm. Flash flooding occurs during the summer with cloudburst-type rainstorms, in the winter with extremely heavy rainfall, or when debris dams the river and suddenly bursts. Since 1880, the Chehalis River Basin within Lewis County has experienced flooding ever 4.7 years on average (Lewis County, 2009b).

6.2.1 Stage Flooding

Stage flooding is largely the result of heavy rain events due to atmospheric rivers, and to a lesser degree to rain-on-snow events. Atmospheric rivers funnel large quantities of precipitation in a short time span. (WA Ecology, 2017) The magnitude and duration of stage floods can vary significantly depending on the quantity of precipitation, where the precipitation is falling, and duration of storm events (Lewis County, 2008). Stage flooding is prevalent in the flat river valley surrounding Centralia and Chehalis, where water rises and inundates large areas of the cities and county. Areas that regularly become inundated along the mainstem Chehalis River – including backwater flooding on Coffee, China, Salzer, and Dillenbaugh Creeks – typically contain slow-moving water. Inundation by floodwaters disrupts transportation routes such as I-5, the main north south transportation route between Seattle and Portland; forces evacuation

of homes and commercial establishments; and can temporarily put sewage treatment plants out of service. A main line of the Burlington Northern Railroad also crosses the floodplain from east to west on the Chehalis River near Chehalis. The tracks are subject to damage at various locations during large floods. The Chehalis-Centralia airport is protected by a dike system, but the dikes were overtopped during the January 1990 and December 2007 flood event, closing the airport (Lewis County, 2008).

Figure 6-1. The Science Behind Atmospheric Rivers.



Source: NOAA

6.2.2 Flash Flooding

Flash flooding is flooding characterized by a quick rise and fall of water level from intense rainstorms or debris dams bursting. Flooding during the 2007 flood was characterized as flash flooding due to debris that clogged the river, which released as a 4- to 18-foot wall of water that "crashed through the blockages and ripped through the valley floor (Lewis County, 2009b)."

6.3 Major Flood Events

Presidential disaster declarations are typically issued for hazard events that cause more damage than state and local governments can handle without assistance from the federal government, although no specific dollar loss threshold has been established for these declarations. A presidential disaster declaration puts federal recovery programs into motion to help disaster victims, businesses, and public entities. Some of the programs are matched by state programs. Lewis County has experienced 19 flood

events since 1964 for which presidential disaster declarations were issued, as summarized in Table 6-1, and many more floods that did not qualify as a presidential disaster declaration. Table 6-1 contains presidential disaster declarations for the entire county, including outside of the Chehalis River Basin.

Review of these events helps identify targets for risk reduction and ways to increase a community's capability to avoid large-scale future events. Still, many flood events do not trigger federal disaster declarations, but have significant impacts on the communities impacted. These events are also important to consider in establishing recurrence intervals for flooding. The following sections provide an overview of some of the more significant floods in the County.

Table 6-1. Presidential Disaster Declarations in Lewis County.

DR#	Declaration Title	Incident Start Date	Watershed
185	Heavy rains and flooding	December 29, 1964	N/A
300	Heavy rains, melting snows, and flooding	February 9, 1971	Chehalis
322	Severe storms and flooding	February 1, 1972	Chehalis
414	Severe storms, snowmelt, and flooding	January 25, 1974	N/A
492	Severe storms and flooding	December 13, 1975	Cowlitz
545	Severe storms, mudslides, and flooding	December 10, 1977	Cowlitz
784	Severe storms and flooding	November 22, 1986	Chehalis
852	Severe storms and flooding	January 6, 1990	Chehalis
883	Severe storms and flooding	November 9, 1990	Chehalis
896	Severe storms and high tides	December 20, 1990	Nisqually
981	Severe storms and high wind	January 20, 1993	Chehalis
1079	Severe storms, high wind, and flooding	November 7, 1995	Cowlitz
1100	High winds, severe storms, and flooding	January 26, 1996	Chehalis, Cowlitz
1734	Severe winter storm, landslides, mudslides, and flooding	December 1, 2007	Chehalis
1817	Severe winter storm, landslides, mudslides, and flooding	January 6, 2009	Chehalis
4253	Severe winter storm, straight-line winds, flooding, landslides, mudslides, and a tornado	December 1, 2015	Chehalis, Cowlitz
4309	Severe winter storms, flooding, landslides, mudslides	January 30, 2017	Chehalis
4539	Severe storms, flooding, landslides, and mudslides	January 20, 2020	Chehalis
4593	Severe winter storms, straight-line winds, flooding, landslides, and mudslides	December 29, 2020	Chehalis

Source: FEMA, 2021a; Lewis County, 2016

6.3.1 2007 Chehalis River Flood

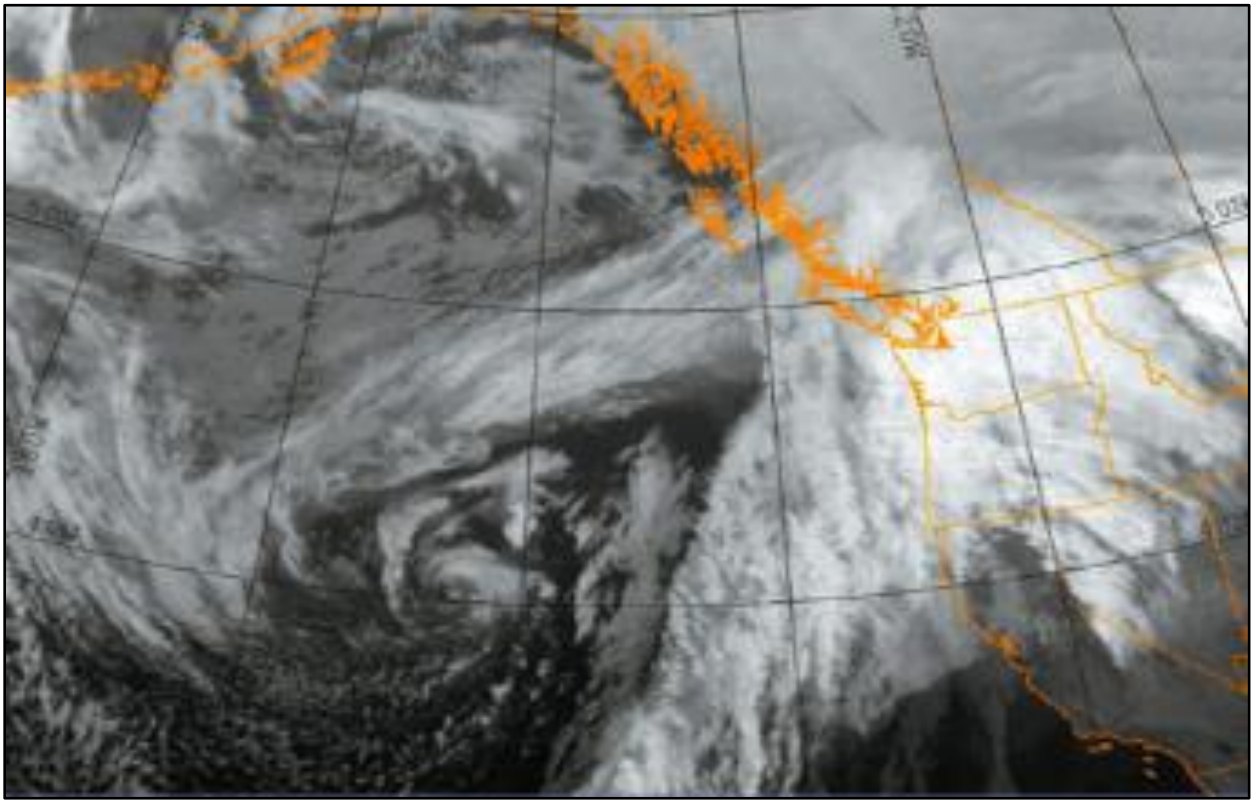
The December 2007 Chehalis River Flood is the current flood of record for Lewis County and is estimated to have a recurrence interval of 500-years in the upper watershed and 100-year in the Chehalis and Centralia area, breaking several records for peak flows. In the upper watershed near the headwaters in

the Willapa Hills, stream flow was more than double their previous peak and more than 67 percent greater than the current 100-year flood estimates. The storm caused flooding records to be set at Grand Mound, Porter, Doty, and the South Fork Chehalis gaging stations. (WATERSHED, 2012)

Cause

An atmospheric river brought record rainfall to the Willapa Hills beginning December 1, 2007. Figure 6-2 shows a satellite photo of the storm system. By December 3, 2007, rainfall in the Willapa Hills reached 14-inches of rainfall in 24 hours, setting a record for 24-hour precipitation totals. The stream gage in Doty rose from three-feet to thirty-feet in seventeen hours. At one point, there was about 12-feet of flowing water over Interstate 5.

Figure 6-2. Satellite Photo of December 2007 Storm System.



Source: Lewis County, 2009b

Damages

The 2007 storm caused an estimated $166 million in damages in Lewis County alone. The Lewis County 2007 Flood Recovery Strategy released in 2009 (Lewis County, 2009b) summarized the following damage or destruction:

- 1,262 residential structures damaged or destroyed (779 within UGAs)
- 239 commercial/industrial structures damaged or destroyed (178 within UGAs)
- 10 fire district vehicles damaged or destroyed
- Five fire district stations damaged or destroyed
- 10,077 acres of farmland impacted
- 4,776 acres of farmland debris cleanup

- 227,778 linear feet of fence damaged
- 1,886 acres of farmland re-seeded
- 1,836 linear feet of ditch cleaned
- 1,600 commercial livestock disposed (400 cattle)
- 1,655 landslides mapped (actual number estimated to be 30-50 percent greater)
- $1,524,960 of damages to County roads
- $4,479,000 of damages to state highways within Lewis County
- $47,070,000 economic impact from four-day I-5 closure
- 26-day full closure of SR 6, and 47-day partial closure with flaggers
- $1,513,307 of Port of Chehalis rail line and bridge repairs
- $346,164 of damages at Chehalis-Centralia Airport
- 2,552 documented drums and containers recovered
- 793 documented tires recovered
- $14,933,782 allocated to Lewis County from FEMA
- $68,321,072 allocated to Lewis County from FHWA
- $40,338,076 in flood insurance claims
- $23,314,900 in SBA loans approved

The Lewis County December 3, 2007 Chehalis River Flooding Event Description (Lewis County, 2009a) summarized the following:

- $45,000,000 in local business inventory losses, damages, clean-up costs, and lost revenue.
- 500 rescues were performed, using 25 boats and 7 helicopters
- Boistfort water system was out of service for over three months
- 400 school children were reported to be homeless after the flood

6.3.2 Other Historical Flooding Events

The following are notable flooding events in Lewis County (McDonald, 2007):

- December 1887 – The earliest significant flood documented in the Chehalis and Centralia area.
- November 1909 – A rain and windstorm caused damage to roads, railroad tracks, and mills. Floodwater may have been the highest in 25-years.
- December 1915 – Heavy rains cause worst storm in city's history, according to long-time residents. Flooding occurred throughout the basin.
- January 1919 – Newspapers declare flood to be worst in city's history.
- December 1933 – Torrential rainfall designated December 1933 as the wettest month in history and causes flooding that leads to severe damage or transportation infrastructure.
- December 1937 – Rainfall causes the severe flooding, currently designated at the 8th highest flood at the Ground Mound gaging station.
- January 1972 – A rainstorm caused an all-time high in Centralia, which currently ranks as the 7th highest flood at the Centralia gage station and the 9th highest flood at the Ground Mound gaging station. News reports document I-5 flooding, log jams, and debris flows and declared the flood to be the worst in history.

- November 1986 – A storm caused the 4th worst flood at the time, flooding the interstate, county roads, and schools. A wood treatment plant in Chehalis flooded, releasing 10,000 gallons of improperly stored pentachlorophenol (PCP), creosote, and other hazardous chemicals into floodwaters that inundated residential neighborhoods. The site became a superfund in 1989 and was delisted in 2020.
- 1990 – Six inches of rain in six days in January led to heavy flooding and all-time highs at the time on the Skookumchuck River and Chehalis River. Additional flooding occurred in February and November.
- February 1996 – Heavy rainfall caused wide-spread flooding throughout Washington, and at the time a record setting peaks on the Skookumchuck River and Chehalis River. Water levels exceeded the estimated 100-year flood, which led Centralia to begin requiring homes to be elevated one-foot above the 1996 flood levels. The flood currently ranks the second highest flood at the Ground Mound gaging station and remains the highest flood on the Skookumchuck River.
- December 2007 – The current highest flood at the Ground Mound gaging station.
- January 2009 – Heavy rain caused high flows throughout the Chehalis River basin. The flood was the 5th largest flood in 82 years of records at the Grand Mound gaging station, and the 7th largest in 71 years at the Doty gaging station (WATERSHED, 2012).
- December 2015 – Heavy rain caused flooding county-wide. Along the Cowlitz, flood was reported to be the worst since 2006 rescues and road closures due to road damage (The Chronicle, 2015).

6.4 Location

Lewis County has significant floodplains county-wide. Within the Chehalis River Basin, floodplains with detailed studies are designated along the Chehalis River, South Fork Chehalis River, Elk Creek, Sand Creek, Lake Creek, Stearns Creek, Newaukum River, Berwick Creek, Dillenbaugh Creek, Coal Creek, Salzer Creek, China Creek, Skookumchuck River, Coffee Creek, and Hanaford Creek. There are several creeks with approximate floodplains, and there are other unmapped flood hazard areas throughout the County. The hazard areas range from urban settings around the cities of Centralia, Chehalis, Pe Ell, and Napavine to rural areas along the smaller tributaries.

Several creeks and rivers feed into the Chehalis River within or near the cities, creating converging flooding hazards from different sub-watersheds. In Chehalis, the Newaukum River and Dillenbaugh Creek merge into the Chehalis River on the south. Dillenbaugh Creek flows through the city on the east side of I-5, creating flood hazards on both sides of the freeway. On the north end of Chehalis, Coal Creek and Salzer Creek merge together before crossing under I-5 and joining the Chehalis River. Centralia's flood hazards include Coal Creek at the south end, China Creek near the middle, and the Skookumchuck River and China Creek near the north.

Flooding in portions of the planning area has been extensively documented by gage records, high water marks, damage surveys, and personal accounts. Several sources of flood data exist. To map the extent and location of the flood hazards for this plan based on the effective regulatory floodplain, the 2006 Flood Insurance Study (special flood hazard areas) was used. To map actual conditions with more current data, the plan referenced depth grids generated in 2019 for the 100-year flood (similar boundaries to the 2007 flood), the 100-year climate change flood, and the 10-year flood.

See Figures 6-3 to 6-6 for maps showing boundaries of the floodplains used for this analysis. These maps also include the effective 100-year floodplain to demonstrate the limitations in the ability to compare the data. While viewing these maps, it is important to understand that in several areas the boundaries of the floodplains appear similar. However, this is due to floodwaters reaching its limit. Once the limit is reached instead of spreading wider, floodwaters get deeper.

Figure 6-3. 100-Year Effective Floodplain.

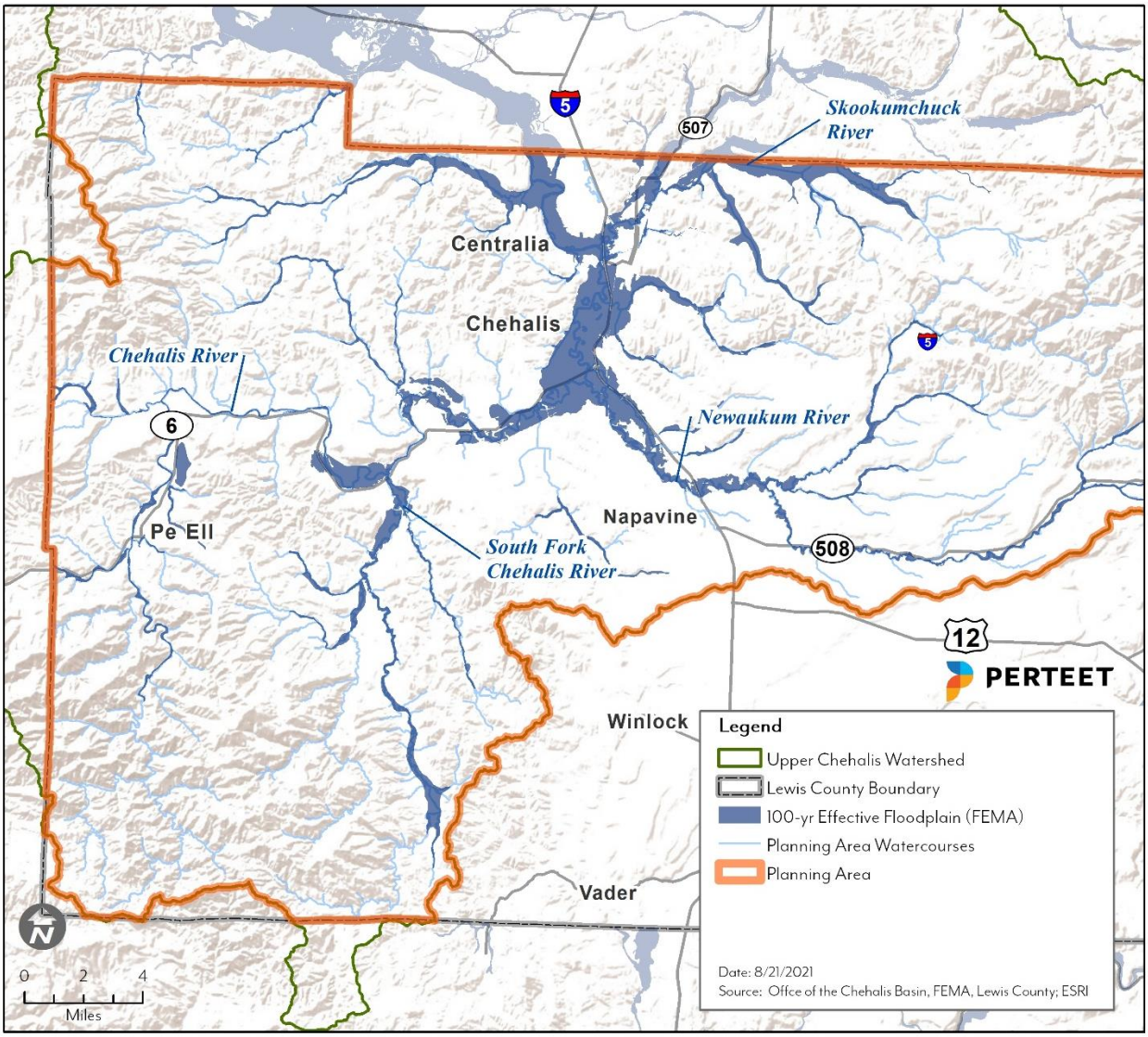


Figure 6-4. 100-Year Modeled Floodplain.

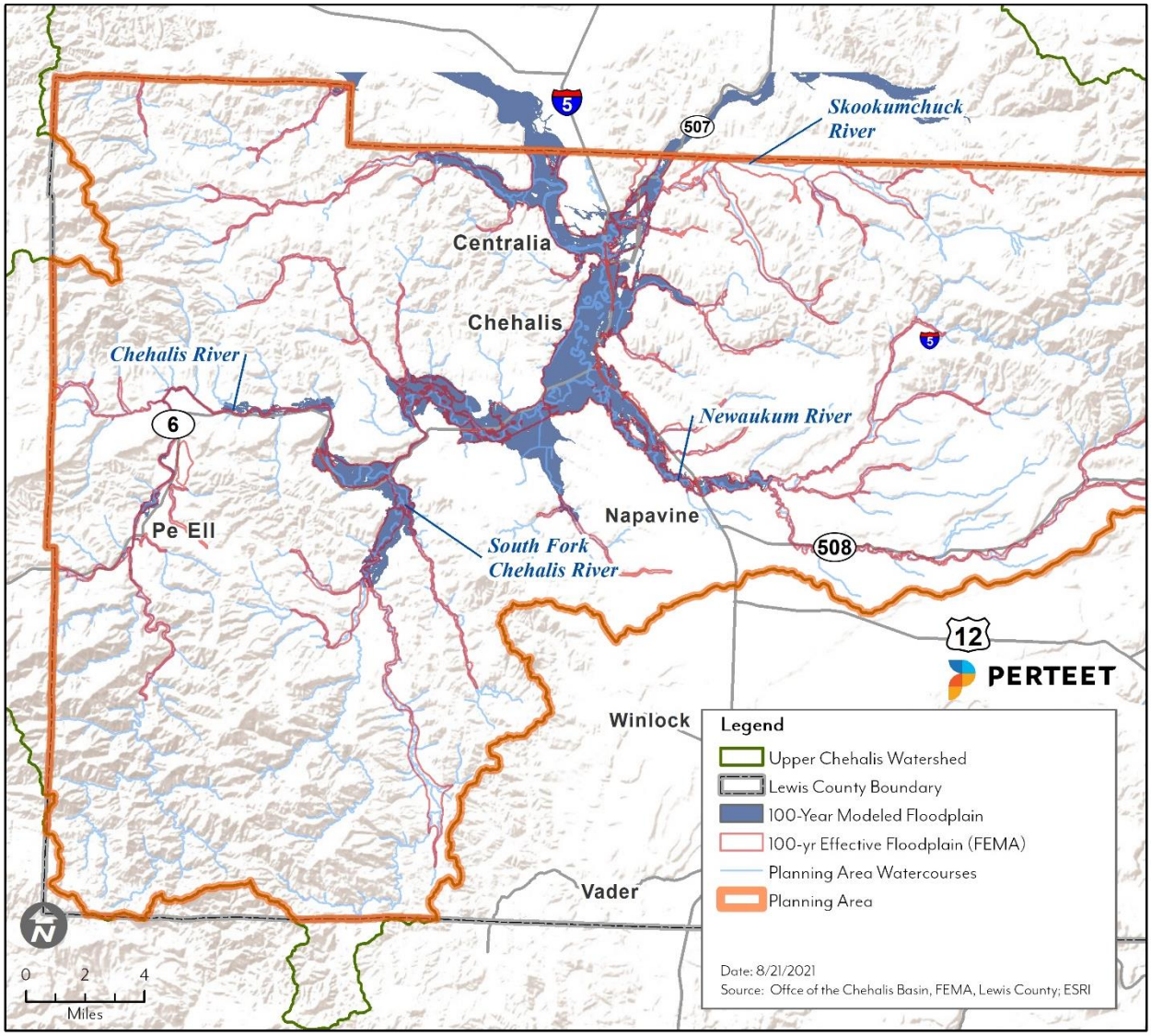


Figure 6-5. 100-Year Climate Change Floodplain.

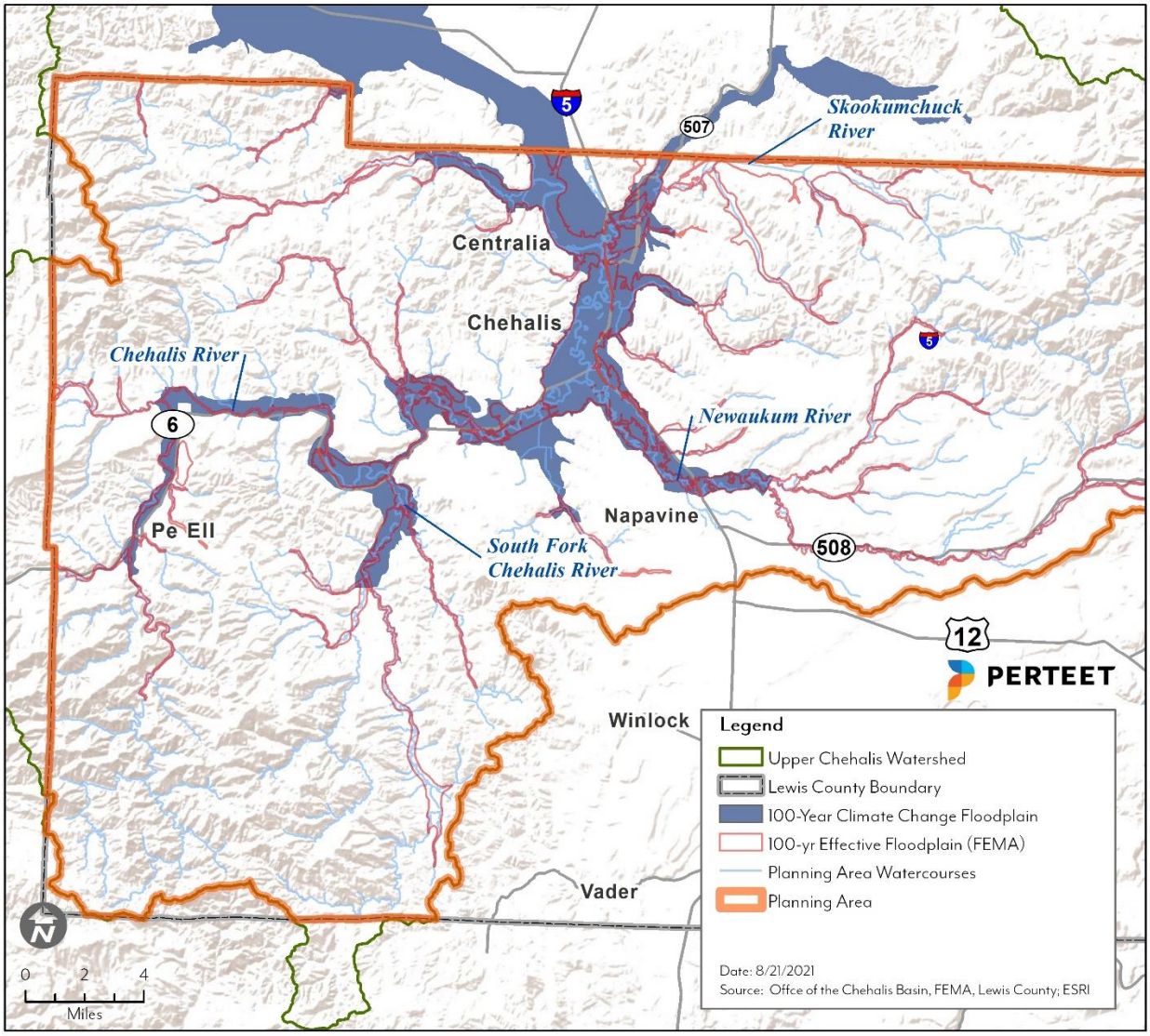
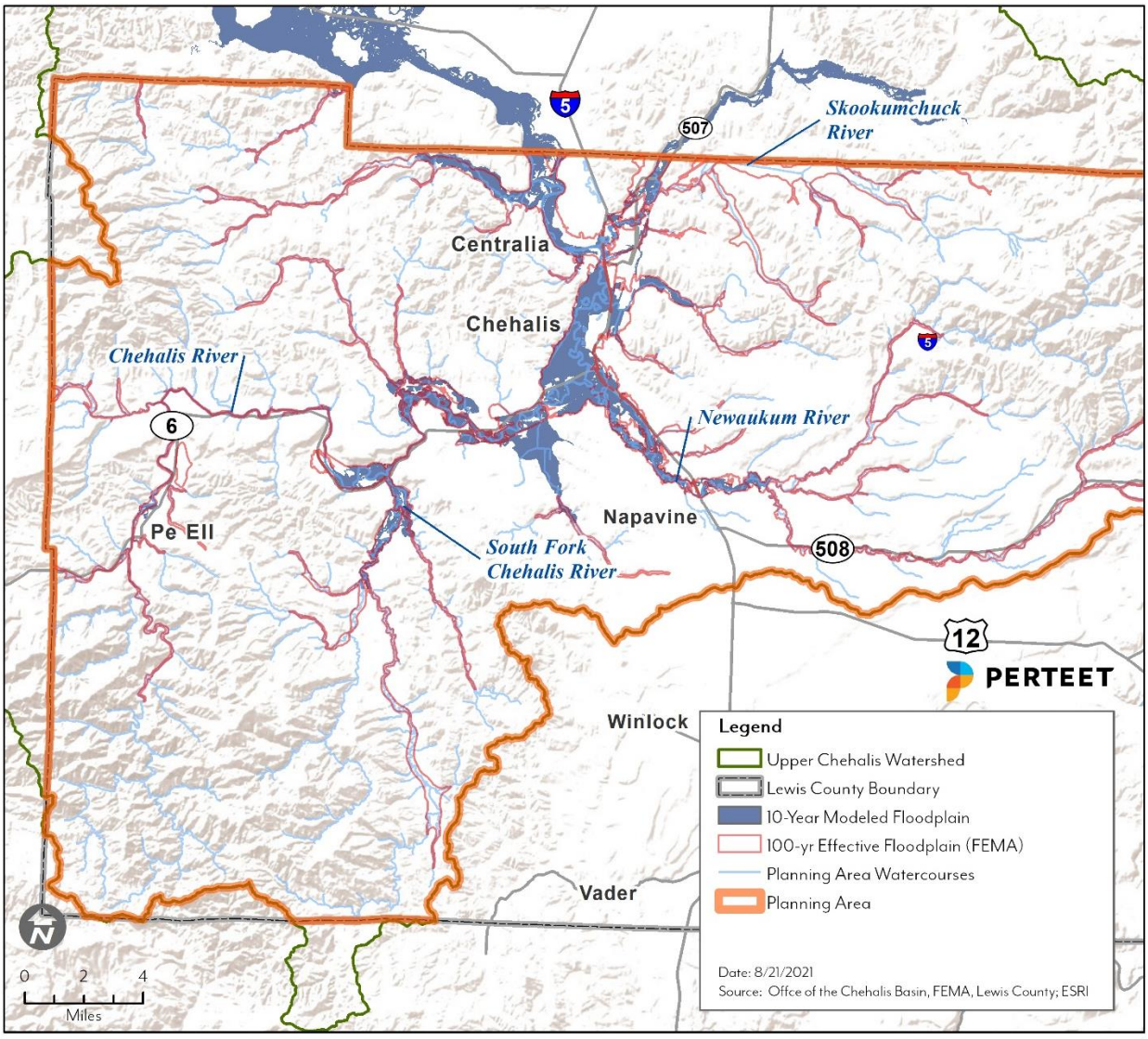


Figure 6-6. 10-Year Modeled Floodplain.



6.5 Frequency

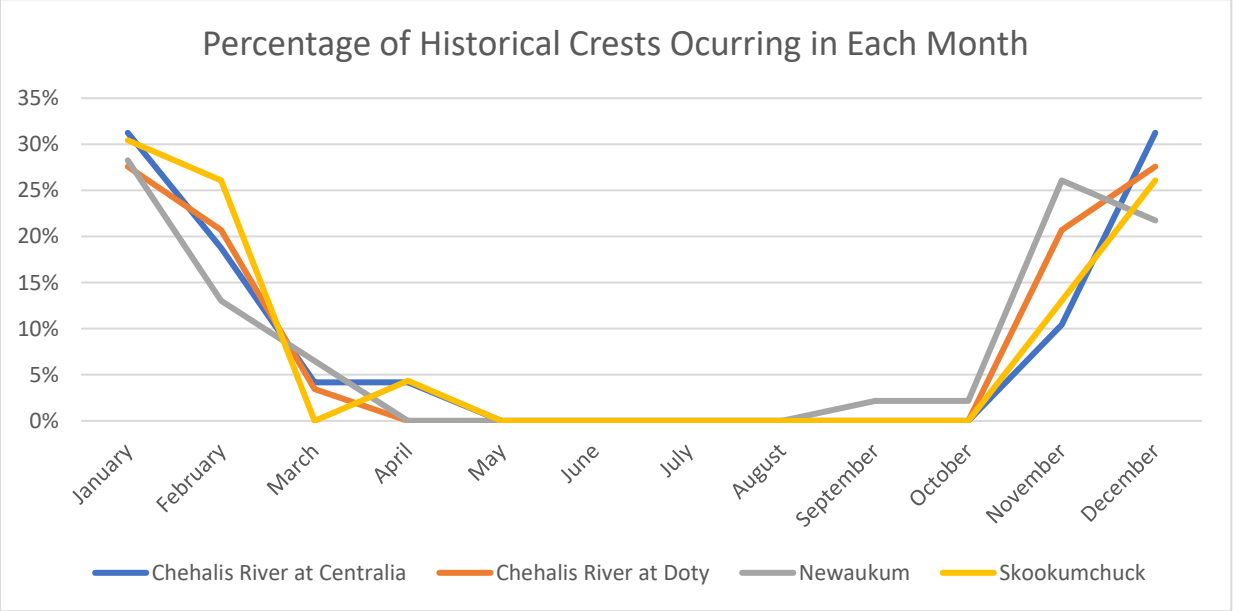
Floods are commonly described as having a 10-, 50-, 100-, and 500-year recurrence interval, meaning that floods of these magnitudes have (respectively) a 10-, 2-, 1-, or 0.2-percent chance of occurring in any given year. These measurements reflect statistical averages only; it is possible for two or more rare floods (with a 100-year or higher recurrence interval) to occur within a short time period. Assigning recurrence intervals to historical floods on different rivers can help indicate the intensity of an event over a large area.

The rivers and other perennial streams in Lewis County follow an annual cycle, with peak flow from November to February. There have been no documented floods in May, June, July, or August, and only a few floods in March, September, and October. The National Weather Service (2021) provides historical fiver flow data at its gages throughout the watershed. Historical crest data on their website begins in

1971 for the Doty gage, 1950 for the Centralia gage and Skookumchuck gage, and 1975 for the Newaukum gage.

Figure 6-7 shows which months have the most historical crests according to the National Weather Service.

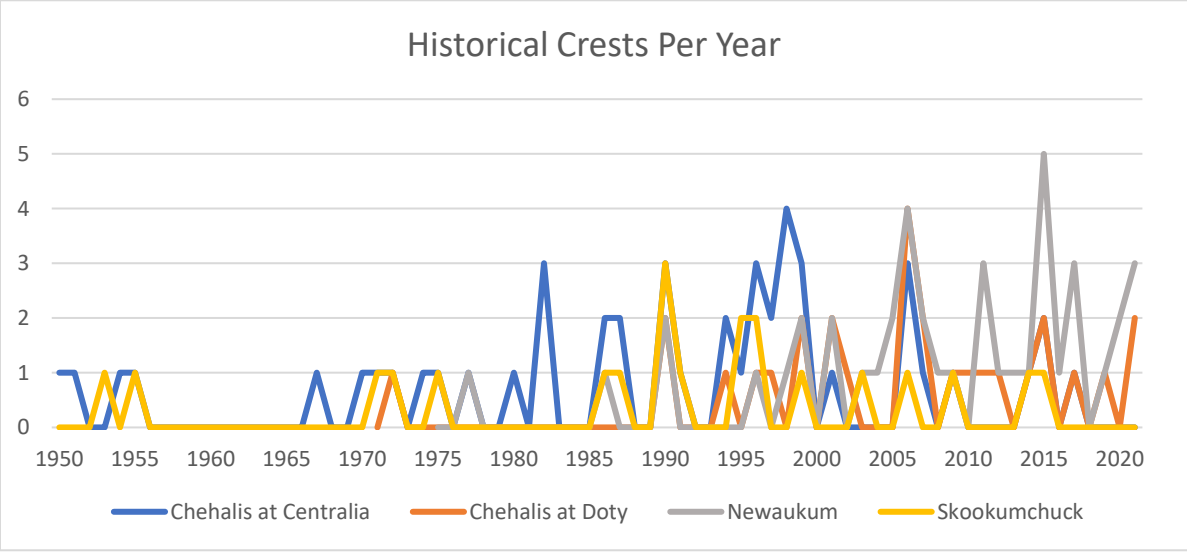
Figure 6-7. Percentage of Historical Crests Occurring in Each Month.



Source: NWS, 2021

Recent history has shown that Lewis County can expect an average of one episode of minor river flooding each winter. Large, damaging floods typically occur every two to five years, and in several years more than one record setting flood has occurred in one flood season. See Figure 6-8.

Figure 6-8. Historical Crests Per Year.



Source: NWS, 2021

6.6 Severity

Flooding in the Chehalis River Basin is increasing in frequency and severity. The largest floods on record have all occurred within the past thirty years. The chances of having the FEMA 100-year flood has increased by 33 percent (Rukelshaus Center, 2014).

The FEMA 100-year flood was defined in September 1979, before the largest and most damaging floods occurred in the basin (FEMA, 2006). FEMA will update the FIRM maps in Lewis County; however, in the meantime the 100-year flood is based on statistics which do not include the peak floods that occurred in 1996 and 2007, and other floods of record in 1986, 2009, and 2020. FEMA prepared draft updated flood maps in 2010 with a higher discharge than the current maps, but the process stalled. At this time of this report, FEMA is not working on map updates in Lewis County and does not know when map updates may happen (FEMA, 2021d).

According to the FEMA Flood Insurance Study (2006), the discharge at the Grand Mound gaging station used to map the 100-year floodplain is 55,000 cfs and the 500-year flood discharge is 70,000 cfs. In comparison with more current modeling updates develop for the Chehalis Basin Strategy and used in this plan, the estimated 100-year flood discharge at Grand Mound is 75,000 cfs. The discharge during the current flood of record in 2007 was 79,100 cfs (WA Ecology, 2017). The climate change models estimate an increase from 26 percent to 50 percent (Mauger, 2021 and McNamara, 2020). See Table 6-2 for a comparison of discharge rates at the Grand Mound gaging station. Additional discharge rates are not provided in this plan as the data is outdated and will change when FEMA updates the county-wide FIRMs.

Table 6-2. Discharge rates at the Grand Mound Gaging Station.

Data Point Location	Discharge (cubic feet/second)
FEMA 100-Year Flood (effective floodplain)	56,000
FEMA 500-Year Flood	70,000
1996 Flood Actual	74,800
100-Year Modeled Flood	75,000
2007 Flood Actual (Flood of Record)	79,100
Mid-Range Climate Change	102,200
High End Climate Change	128,600

6.7 Warning Time

6.7.1. Lewis County Flood Warning System

After the 2007 flood and formation of the Chehalis River Basin Flood Authority, regional stakeholders led a process to improve the existing flood warning system that was based primarily on the National Weather Service's (NWS) Advanced Hydrologic Prediction System. The result is a robust, publicly accessible, web-based system that provides several sources of information, including rainfall, stream, wind, temperature and other weather data. The system lacks an automated warning system. Lewis

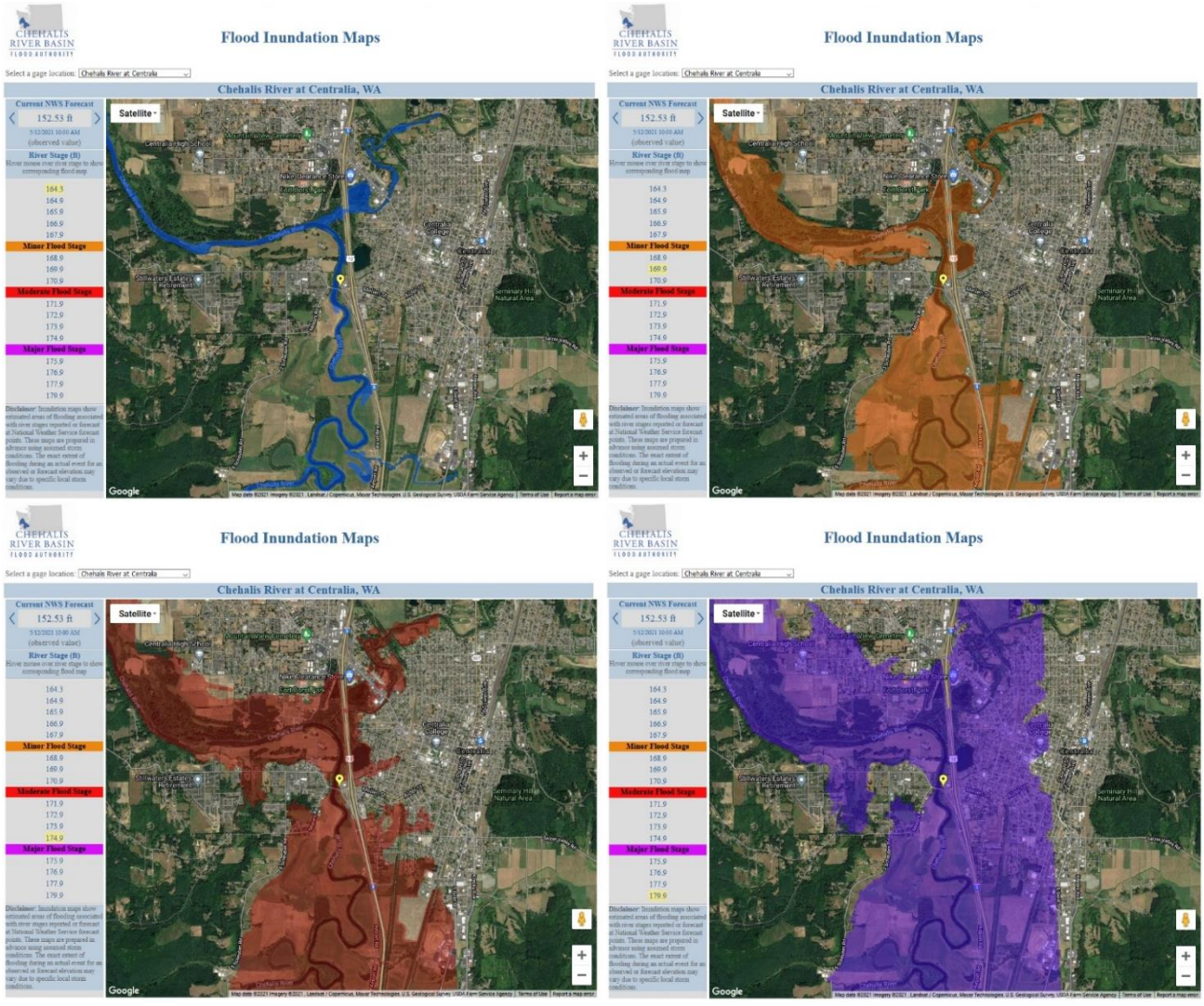
County Emergency Management monitors the system and sends local alters using the “Lewis County Alert” system.

The current flood warning system website address is: http://www.chehalisriverflood.org/. The site includes several features from more than 250 sensors to help residents be aware of flooding conditions and increase their level preparedness, including:

Inundation Mapping

Figure 6-9 shows the inundation map for the Chehalis River at Centralia for four flood stages: no flooding (blue), minor flooding (orange), moderate flooding (red), and major flooding (purple). The inundation mapping helps residents and emergency services be better prepared by understanding which areas will flood at different river levels.

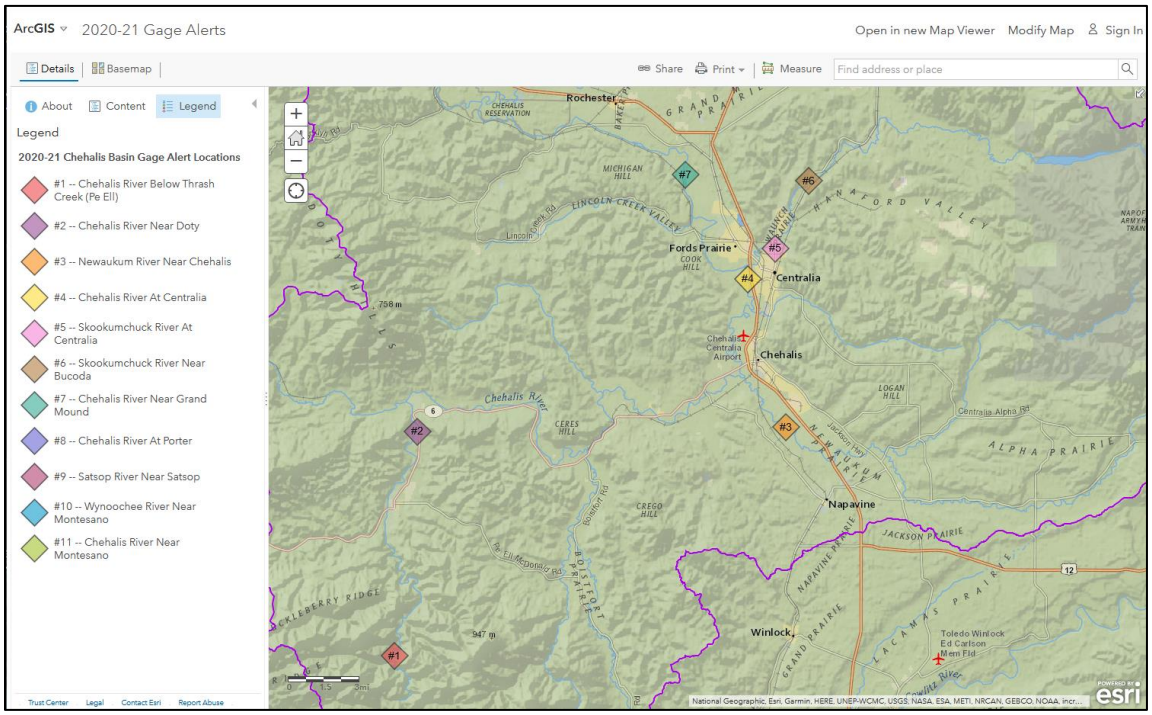
Figure 6-9. Flood inundation mapping.



Stream Alerts

Within Lewis County, there are seven gages providing river and stream status and forecast information with alerts (Gages #1-#7 shown on Figure 6-10). Users can sign up to receive an email alert.

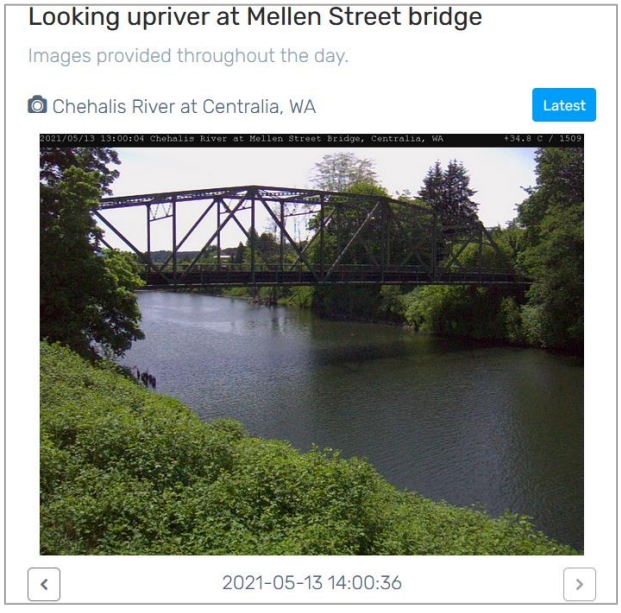
Figure 6-10. Gage alert locations within Lewis County.



Webcams

The flood warning system website provides two webcams for users to visually check river conditions. One of the webcams is in Centralia (Figure 6-11).

Figure 6-11. Centralia webcam.



6.7.2 Flood Watch and Warning System

The NWS issues flood watches and warnings when forecasts indicate rivers may approach bank-full levels or when other types of localized flooding are possible. When a flood watch is issued, the public should prepare for the possibility of a flood. When a flood warning is issued, the public is advised to stay tuned to a local radio station for further information and be prepared to take quick action if needed. A flood warning means a flood is imminent, generally within 12 hours, or is occurring. Local media typically broadcast NWS watches and warnings and weather apps send notification to cell phones. If a flash flood warning is issued, which indicates that sudden or violent flooding is imminent or occurring, the Emergency Alert Service will alarm on NOAA weather radios and cut into local media broadcasts. Flash flood warnings will also trigger wireless emergency alerts on smart phones.

Official thresholds for flood warnings have been established by the National Weather Service on the major rivers within Lewis County are shown in Table 6-3.

There are several more stream gages across the county for areas that do not currently have river forecasts or predetermined flood stages. These gages are monitored for situational awareness during flood events.

Table 6-3. National Weather Service Flood Stages.

	Flood Stage in Feet			
Gage Location	Major Flood	Minor Flood	Flood Stage	Action Stage
Chehalis River near Doty	324.5	323.5	318	315.5
Chehalis River at Centralia	175.5	172	168.5	166
Chehalis River near Grand Mound	144	142.5	141	138.5
Skookumchuck River at Centralia	191	190	189	187
Newaukum River near Chehalis	205.5	204.5	202.5	200.5

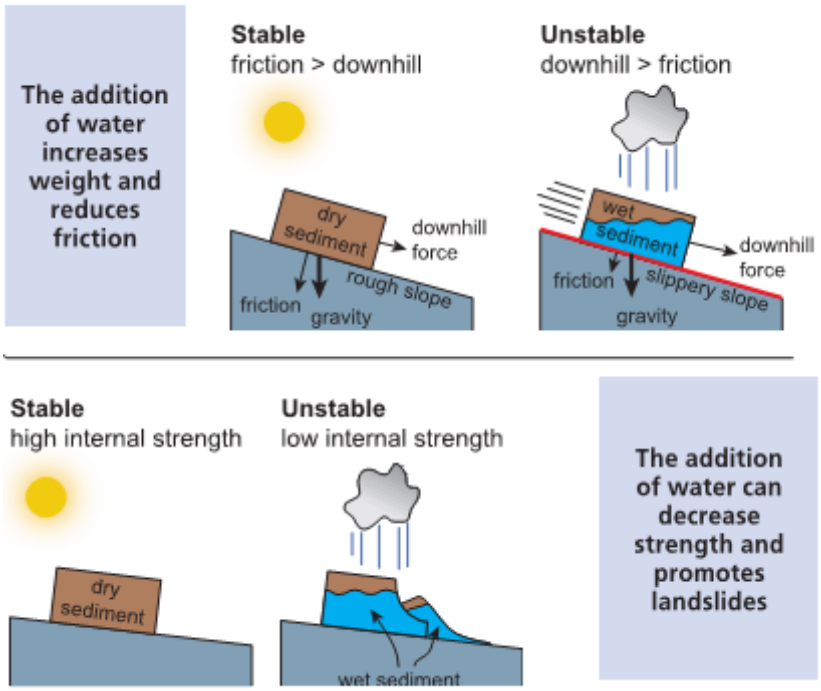
6.8 Secondary Hazards

6.8.1 Landslides

Landslides are a common occurrence in Lewis County and the Chehalis Basin. In Lewis County, landslides generally occur along cuts in a hillside, usually along roads or highways. Landslides occur when material on a slope is unable to withstand gravity. Several different triggers can lead to landslides (DNR, 2017):

- Heavy rainfall often causes landslides as the water lowers the strength of the material, which makes it less able to withstand the force of gravity (Figure 6-12).
- Earthquakes create intense shaking and cause the ground to move which causes material which was stable to be unstable.
- Vegetation removal, mining, excavation and other human activities can weaken the material.
- Erosion along the base of a slope from rivers can weaken the materials (Figure 6-12).

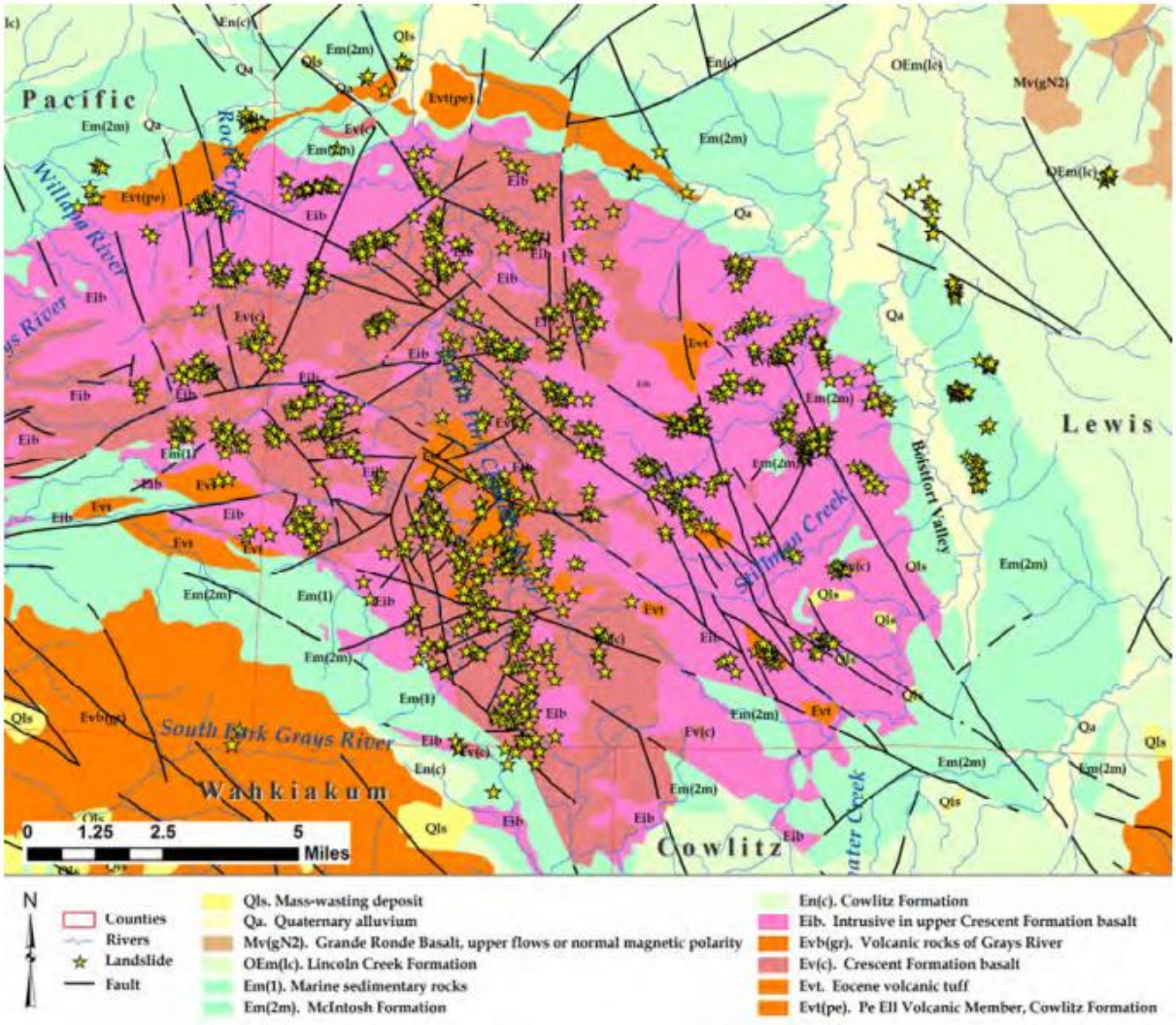
Figure 6-12. Water and Landslides.



Source: DNR, 2017

During the 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 State Route 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. The Department of Natural Resources recorded over 1,600 landslides in the Chehalis Basin headwaters during a landslide reconnaissance after the floods (DNR, 2008). Figure 6-13 shows the locations of the recorded landslides in the headwaters of the Chehalis Basin, in the southwest portion of Lewis County. Woody debris and sediment, and material from these landslides clogged channels at bridges, creating temporary dams and causing widespread deposition of logs and debris, especially around the Boistfort valley (Lewis County, 2016).

Figure 6-13. Recorded Landslides in the Headwaters of the Chehalis River Basin as a result of the 2007 storm.



Source: DNR, 2008

Other notable landslides in Lewis County include (Lewis County, 2016):

- As a result of the 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.
- The winter storms of January 29 through March 11, 1999 brought snow, heavy rains, high winds, and landslides. Heavy saturated soils and unstable conditions on the hillside above Kresky Avenue in Chehalis resulted in a large mass land movement. It caused severe damage with repair costs 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.
- During 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.

- In 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.
- After heavy rains in November 1994, 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 cleanup cost an estimated $1.2 million.

6.8.2 Erosion

Erosion is the deterioration and wearing away of riverbanks. Erosion causes issues with infrastructure and private property located along the riverbanks and creates sediment issues downstream. The Chehalis Basin experiences the following types of erosion:

- Channel migration is the lateral movement of a river when it naturally meanders through soft, erodible banks. A study of the Chehalis River between Pe Ell and Chehalis found that between 1945-2013 the channel migrated on average between 0.5 to 20 meters annually.
- Bank erosion often occurs with heavy flows or high velocity, often along the outside of river bends. Bank erosion also occurs after there is a disruption in flow, such as a logjam, that creates a new flow pattern.
- Channel incision is the eroding of the riverbed, lowering the elevation of the river and often disconnecting it from the floodplain (WA Ecology, 2017).

6.8.3 Other Hazards

Flooding can create several other secondary hazards beyond landslides and erosion. In 1986, after the closure of the American Crossarm & Conduit Company, a major flood caused improperly stored tanks full of pentachlorophenol (PCP), a carcinogen, as well as creosote and other hazardous chemicals to tip over. The flood contaminated 25 to 30 residential structures and required millions of dollars to clean up. The site eventually became a superfund site, and was delisted in 2020 (Yaw, 2020).

And in 2007, after the flood waters began receding, fire fighters became busy fighting fires from wet hay spontaneous combusting (Lewis County, 2009a). After hay becomes wet, either from rain, flooding, or other water sources, microbes begin growing in the hay that create chemical reaction that may result in fire. These reactions cause heat which lead to fire (WSU, 2007).

6.9 Future Trends

Lewis County is anticipating an additional 10,000 residents by 2040 (OFM, 2017). In 1990, Washington State adopted the Growth Management Act, which among other things required Lewis County to establish urban growth boundaries, rural areas, and natural resource lands. The County and all of the cities have adopted plans and development regulations that are currently in compliance with the Growth Management Act.

The County's and Cities' Comprehensive Plans have adopted goals, objectives, policies, and actions with regards to frequently flooded areas. These plan components strive to steer future trends in development away from increasing flood risks in Lewis County. Lewis County's critical areas regulations regulate how development and redevelopment can safely occur on lands that contain critical areas. Additionally, Lewis County and its cities participate in the NFIP and have adopted flood damage prevention ordinances in response to its requirements. Lewis County has committed to maintaining its good standing under the NFIP through actions identified in this plan.

6.10 Scenario

The primary water courses in the planning area flood at regular intervals, generally in response to a succession of intense winter rainstorms. Storm patterns of warm, moist air usually occur between early November and late February. Major roads could be blocked, preventing critical access for many residents and responders. High in-channel flows could cause water courses to scour, possibly washing out roads and creating additional isolation issues. Resources would be stretched thin resulting in delays in repairing and restoring critical facilities and infrastructure. The mapped and identified floodplains in the County are where most impacts from flooding would be concentrated.

The Draft SEPA EIS prepared for the Proposed Chehalis River Basin Flood Damage Reduction Project (WA Ecology, 2020) identified mid-century (2030-2060) to late-century (2060 to 2080) flooding impacts in the no action alternative. The no action alternative assumes that large flood control projects will not occur, but existing activities, programs, and trends will continue to occur. The no action alternative evaluates a major flood (38,000 cfs at Ground Mound) and a catastrophic flood (75,100 cfs at Ground Mound, similar to 1996 and 2007 floods). The Draft EIS describe the following scenarios for the no action alternative for a late-century catastrophic flood:

- I-5 at Chambers Way will be under 8.4-feet of floodwater for almost 60 hours.
- SR 6 at Boistfort Road will be under 7.5-feet of floodwater for 17 hours.
- Several local roads in the Chehalis-Centralia area will be under 2- to 7-feet of water for 27-57 hours.
- The Chehalis-Centralia airport will be inundated by 8.2-feet of floodwater.
- Fire Station 3 for District 16 will be under 4.5-feet of water.
- Valley View Health Center will be under 3.2-feet of water.
- Washington Elementary School will be inundated by over 4-feet of water.
- Washington State Patrol will be under 3.8-feet of water.
- Centralia Police Station will be under 0.23-feet of water.

6.11 Challenges, Gaps, and Issues

The planning team has identified challenges, data gaps and issues associated with full identification and understanding of flood hazards in the planning area. These include, but not limited to the following:

- The currently available flood hazard mapping for the County does not accurately reflect the true flood risk. A significant amount of modeling data exists in the basin. There are inconsistencies between various results that could result in increased risk.

- There needs to be a sustained effort to continue gathering historical damage data, such as high-water marks on structures and damage reports, to measure the cost-effectiveness of potential mitigation projects.
- Ongoing flood hazard mitigation and FCZD operations and maintenance will require funding from multiple sources including the development of local revenue streams.
- Existing floodplain-compatible uses such as agricultural and open space need to be maintained. During times of moderate to high growth there is pressure to convert these areas to more intensive uses.
- There needs to be a coordinated flood hazard mitigation effort among county jurisdictions affected by flood hazards.
- Education for residents in flood hazard areas about flood preparedness and the resources available during and after floods should continue.
- There is a lack of consistency in regional flood hazard management policy in the planning area.
- As the planning area continues to grow, there will be increased pressures for development in areas subject to flood risk.
- Identified floodplain restoration/reconnection opportunities should be implemented to reduce flood risk.
- Post-flood disaster response and recovery actions need to be clearly identified.
- Current or greater staff capacity is required to maintain the existing level of flood hazard management within the planning area.
- Flood hazard management actions require interagency coordination.

7.0 FLOOD HAZARD EXPOSURE

7.1 Population

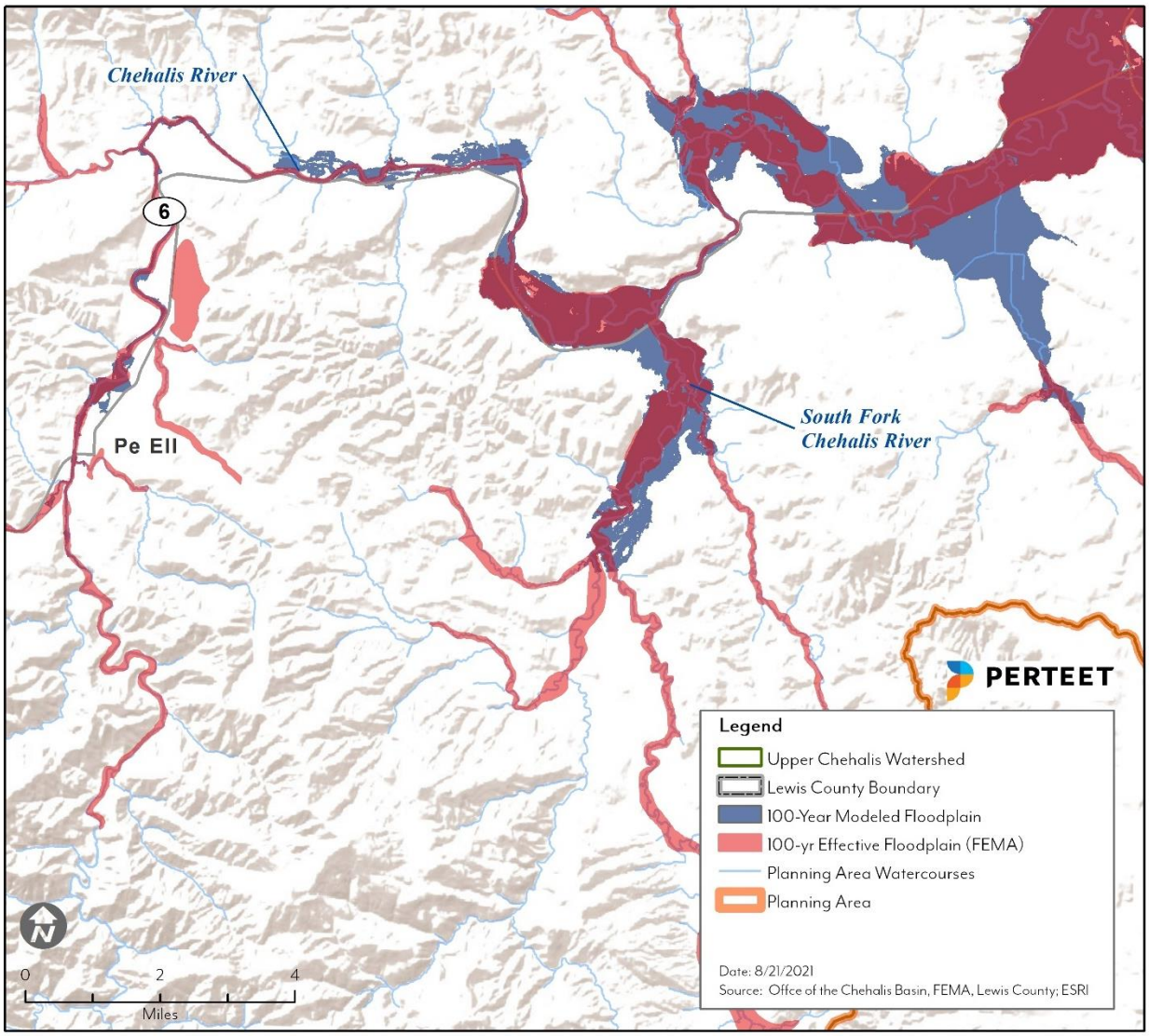
Population counts of those living in the 100-year FEMA effective floodplain, 100-year modeled floodplain, and 10-year modeled floodplains were generated by analyzing structures in the floodplain. The total planning area population from the 2010 Census was multiplied by the ratio of the number of residential structures in each floodplain to the total number of residential structures. Using this approach, the populations in each floodplain were estimated as follows:

- 100-year effective floodplain – 5,346 (10.3 percent the planning area population)
- 100-year modeled floodplain – 8,808 (16.9 percent of the planning area population)
- 100-year climate change floodplain – 12,483 (24.0 percent of the planning area population)
- 10-year modeled floodplain – 1,909 (3.6 percent of the planning area population)

Note that in the unincorporated county and in Pe Ell the modeled floodplains cannot be directly compared to the effective floodplain. In the unincorporated county the model does not include many of the smaller tributary creeks that feed into the Chehalis River, and in Pe Ell the model does not include Stowe Creek. Direct comparisons between the modeled floodplain and the effective floodplain can be made within the Cities of Centralia, Chehalis, and Napavine.

Figure 7-1 demonstrates the differences between the 100-year effective floodplain and the modeled floodplain and shows how the FEMA effective floodplain continues upstream of the model at many tributaries. These differences are also shown on the maps in Figures 6-4, 6-5, and 6-6. While the majority of these areas are very rural and there are not many structures within the floodplain to affect damage estimates, the difference in area is significant.

Figure 7-1. Differences Between Effective and Modeled Floodplain.



7.2 Property

7.2.1 Structures in the Floodplain

The Hazus model determined the number and use of the structures within the floodplain. Table 7-1 summarizes the total structures in the area of the 100-year effective floodplain, 100-year modeled floodplain, and 100-year climate change floodplain by municipality, and Table 7-2 summarizes the total area and number of structures in 10-year floodplain by municipality. See Chapter 5.2 for more information on the Hazus model.

Table 7-1. Total Area and Number of Structures in the 100-year Floodplains by Municipality.

100-Year Effective Floodplain									
		Number of Structures							
	Area (acres)	Residential	Commercial	Industrial	Agriculture	Religion	Gvmt	Education	Total
Centralia	1,666	818	88	10	0	5	0	15	936
Chehalis	1,897	238	117	19	0	0	1	8	383
Napavine	134	4	8	1	0	1	0	1	15
Pe Ell	52	17	0	0	0	0	0	1	18
Unincorporated County	24,461	849	27	10	0	1	5	16	908
Total	**28,210**	**1,926**	**240**	**40**	**0**	**7**	**6**	**41**	**2260**

100-Year Modeled Floodplain									
		Number of Structures							
	Area (acres)	Residential	Commercial	Industrial	Agriculture	Religion	Gvmt	Education	Total
Centralia	2,270	2,108	179	32	0	7	1	20	2347
Chehalis	1,852	216	111	17	0	0	1	8	353
Napavine	107	1	1	0	0	0	0	0	2
Pe Ell[1]	39	11	0	0	0	0	0	0	11
Unincorporated County[1]	19,759	674	23	9	0	1	4	18	729
Total	**24,027**	**3010**	**314**	**58**	**0**	**8**	**6**	**46**	**3,442**

100-Year Climate Change Floodplain									
		Number of Structures							
	Area (acres)	Residential	Commercial	Industrial	Agriculture	Religion	Gvmt	Education	Total
Centralia	2,858	2,963	250	52	0	16	4	23	3,308
Chehalis	1,953	260	130	32	0	1	1	8	432
Napavine	127	1	3	0	0	1	0	1	6
Pe Ell[1]	44	15	0	0	0	0	0	0	15
Unincorporated County[1]	21,519	1,122	36	9	0	3	4	21	1,195
Total	**26,501**	**4,361**	**419**	**93**	**0**	**21**	**9**	**53**	**4,956**

[1] Area and structure counts within the unincorporated county and Pe Ell cannot be compared to the 100-year effective floodplain. See Section 7.1.

Table 7-2. Total Area and Number of Structures in the 10-year Floodplain by Municipality.

10-Year Modeled Floodplain									
		Number of Structures							
	Area (acres)	Residential	Commercial	Industrial	Agriculture	Religion	Gvmt	Education	Total
Centralia	940	332	54	11	0	2	1	4	404
Chehalis	1,005	74	19	1	0	0	0	2	96
Napavine	49	0	0	0	0	0	0	0	0
Pe Ell[1]	24	5	0	0	0	0	0	0	5
Unincorporated County[1]	13,535	273	2	0	0	0	0	2	277
Total	**15,553**	**684**	**75**	**12**	**0**	**2**	**1**	**8**	**782**

[1] Area and structure counts within the unincorporated county and Pe Ell cannot be compared to the 100-year effective floodplain. See Section 7.1.

7.2.2 Exposed Value

The Hazus model estimated the value of the structure and their content within the floodplain. Table 7-3 summarizes the values in the area of the 100-year effective floodplain, 100-year modeled floodplain, and 100-year climate change floodplain by municipality, and Table 7-2 summarizes the total area and number of structures in 10-year floodplain by municipality. See Chapter 5.2 for more information on the Hazus model.

Table 7-3. Total Value of Structures and Content in the 100-year Floodplains by Municipality.

100-Year Effective Floodplain				
	Value Exposed			% of Total Value Exposed
	Structures	Contents	Total	
Centralia	$433,251,197	$335,039,837	$788,291,034	41%
Chehalis	$364,182,436	$339,472,350	$703,654,786	37%
Napavine	$15,993,252	$16,233,098	$32,216,350	2%
Pe Ell[1]	$2,321,643	$1,179,743	$3,501,386	0.2%
Unincorporated County[1]	$221,823,996	$155,867,212	$377,691,208	19.8%
Total	**$1,037,572,524**	**$867,782,240**	**$1,905,354,764**	**100%**

100-Year Modeled Floodplain				
	Value Exposed			% of Total Value Exposed
	Structures	Contents	Total	
Centralia	$727,534,673	$559,648,659	$1,287,183,332	57.3%
Chehalis	$293,656,186	$278,742,527	$572,398,712	25.5%
Napavine	$752,313	$729,758	$1,482,072	0.1%
Pe Ell[1]	$1,694,036	$847,018	$2,541,054	0.1%
Unincorporated County[1]	$221,600,130	$157,425,262	$379,025,392	17%
Total	**$1,245,237,338**	**$997,393,224**	**$2,242,630,562**	**100%**

100-Year Climate Change Floodplain				
	Value Exposed			% of Total Value Exposed
	Structure	Contents	Total	
Centralia	$1,080,309,126	$827,984,914	$1,908,294,040	59.9%
Chehalis	$378,808,275	$372,552,163	$751,360,438	23.5%
Napavine	$11,817,478	$11,794,923	$23,612,400	0.7%
Pe Ell[1]	$2,375,447	$1,187,724	$3,563,171	0.1%
Unincorporated County[1]	$300,201,615	$204,019,860	$504,221,474	15.8%
Total	**$1,773,511,941**	**$1,417,539,583**	**$3,191,051,525**	**100%**

[1] Structure and content values within the unincorporated county and Pe Ell cannot be compared to the 100-year effective floodplain. See Section 7.1.

Table 7-4. Total Value of Structures in the 10-year Floodplain by Municipality.

10-Year Modeled Floodplain				
	Value Exposed			% of Total Value Exposed
	Structure	Contents	Total	
Centralia	$131,328,644	$100,633,804	$231,962,448	58.3%
Chehalis	$44,313,476	$37,367,668	$81,681,144	20.5%
Napavine	$0	$0	$0	0%
Pe Ell[1]	$693,340	$346,670	$1,040,010	0.3%
Unincorporated County[1]	$54,121,530	$29,084,599	$83,206,129	20.9%
Total	**$230,456,990**	**$167,432,741**	**$397,889,732**	**100%**

[1] Structure and content values within the unincorporated county and Pe Ell cannot be compared to the 100-year effective floodplain. See Section 7.1.

7.2.3 Zoning in the Floodplain

Some land uses are more vulnerable to flooding, such as single-family homes, while others are less vulnerable, such as agricultural land or parks. Tables 7-5 through 7-10 show the existing zoning of all areas in the 100-year floodplains and 10-year floodplain, including vacant land and land in public/open space uses. All values were derived from GIS analysis of County data.

Table 7-5. Zoning in the Floodplain – City of Chehalis.

	100-Year Effective Floodplain		100-Year Modeled Floodplain		100-Year Climate Change		10-Year Modeled Floodplain	
Zoning Category	Area (acres)	% of total	Area (acres)	% of total	Area (acres)	% of total	Area (acres)	% of total
Commercial	910	49%	870	47%	1383	52%	247	22%
Government	591	32%	595	32%	679	14%	333	30%
Industrial	278	15%	293	16%	364	14%	180	16%
Residential	96	5%	92	5%	237	9%	56	5%
Total	**1875**	**100%**	**1850**	**100%**	**2663**	**100%**	**1125**	**100%**
UGA	297		300		417		73	

Table 7-6. Zoning in the Floodplain – City of Centralia.

	100-Year Effective Floodplain		100-Year Modeled Floodplain		100-Year Climate Change		10-Year Modeled Floodplain	
Zoning Category	Area (acres)	% of total	Area (acres)	% of total	Area (acres)	% of total	Area (acres)	% of total
Commercial	263.5	15%	332	14%	590	9%	63	4%
Healthcare	14	1%	18	1%	95	1%	6	<1%
Industrial	702	41%	174	7%	939	14%	190	12%
Open Space	213	12%	457	20%	1030	16%	429	28%
Residential	444	26%	1094	46%	3325	51%	776	50%
Master Plan	72.3	4%	178	7%	398	17%	77	5%
Total	**1708**	**100%**	**2393**	**100%**	**6500**	**100%**	**1556**	**100%**
UGA	832		979		2228		530	

Table 7-7. Zoning in the Floodplain – City of Napavine.

	100-Year Effective Floodplain		100-Year Modeled Floodplain		100-Year Climate Change		10-Year Modeled Floodplain	
Zoning Category	Area (acres)	% of total	Area (acres)	% of total	Area (acres)	% of total	Area (acres)	% of total
Commercial	133	100%	107	100%	230	100%	57	100%
Total	**133**	**100%**	**107**	**100%**	**230**	**100%**	**57**	**100%**
UGA	0		0		0		0	

Table 7-8. Zoning in the Floodplain – City of Pe Ell.

	100-Year Effective Floodplain		100-Year Modeled Floodplain[1]		100-Year Climate Change[1]		10-Year Modeled Floodplain[1]	
Zoning Category	Area (acres)	% of total	Area (acres)	% of total	Area (acres)	% of total	Area (acres)	% of total
Residential	52	100%	39	100%	156	89%	28	100%
Commercial	-	-	-	-	19	11%	-	-
Total	**52**	**100%**	**39**	**100%**	**175**	**100%**	**28**	**100%**
UGA	.4		-		-		-	

[1] The modeled floodplain does not include Stowe Creek and cannot be directly compared to the effective floodplain. See Section 7.1.

Table 7-9. Zoning in the Floodplain – Unincorporated County (Chehalis Basin).

	100-Year Effective Floodplain		100-Year Modeled Floodplain[1]	
Zoning Category	Area (acres)	% of total	Area (acres)	% of total
Agriculture	10,948	44%	11,506	58%
Commercial	73	<1%	200	1%
Rural	11,424	46%	6,467	33%
Forest	1,585	6%	116	1%
Industrial	273	1%	172	1%
Parks	26	<1%	53	0%
Mineral	535	2%	124	1%
Total	**24,864**	**100%**	**19,710**	**100%**

	100-Year Climate Change Floodplain[1]		10-Year Modeled Floodplain[1]	
Zoning Category	Area (acres)	% of total	Area (acres)	% of total
Agriculture	14,310	57%	8,760	65%
Commercial	340	1%	11	<1%
Rural	9,695	39%	4,547	34%
Forest	3	0%	90	<1%
Industrial	317	1%	10	<1%
Parks	81	0%	24	<1%
Mineral (Mine)	195	1%	108	<1%
Total	**26,941**	**100%**	**13,550**	**100%**

[1] The modeled floodplain cannot be directly compared to the effective floodplain. See Section 7.1.

7.3 Critical Facilities and Infrastructure

7.3.1 Hazardous Materials Facilities

Hazardous material facilities are those that use or store materials that can harm the environment if damaged by a flood. For this assessment, such facilities were identified through the EPA's Toxic Release Inventory (TRI) (EPA, 2021) and other facilities identified by the planning team. Seven business within the Chehalis River Basin have been identified as TRI reporting facilities or other known hazardous material containing facilities. Two businesses are partially in the 100-year floodplain. During a flood event, containers holding these materials can rupture and leak into the surrounding area, having a disastrous effect on the environment as well as residents.

7.3.2 Utilities and Infrastructure

It is important to determine who may be at risk if infrastructure is damaged by flooding. Roads or railroads that are blocked or damaged can isolate residents and can prevent access throughout the planning area. Preserving access is particularly important for emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by floods or debris also can cause isolation. Water and sewer systems can be flooded or backed up, causing health problems. Underground utilities can be damaged. Dikes and levees can fail or be overtopped, inundating the land

that they protect. The following sections provide more information on specific types of critical infrastructure. Tables 7-10 and 7-11 list the specific types of infrastructure in the floodplains.

Table 7-10. Critical Infrastructure within the floodplain.

City	Police and Fire Stations	Medical Care	Schools and Educational Facilities	Hazardous Materials Facilities	Other Essential Facilities	Total
100-Year Effective Floodplain						
Unincorporated County	2	-	1	-	4	**7**
Chehalis	-	2	-	-	-	**2**
Centralia	-	1	-	-	-	**1**
Napavine	-	-	-	-	-	**0**
Pe Ell	-	-	-	-	-	**0**
100-Year Modeled Floodplain						
Unincorporated County[1]	1	1	2	-	4	**8**
Chehalis	-	2	-	-	-	**2**
Centralia	1	2	2	-	2	**7**
Napavine	-	-	-	-	-	**0**
Pe Ell[1]	-	-	-	-	-	**0**
100-Year Climate Change Floodplain						
Unincorporated[1]	1	1	2	0	4	
Chehalis	3	5	2	0	10	**20**
Centralia	2	15	9	0	6	**32**
Napavine	-	-	-	-	-	**0**
Pe Ell[1]	-	-	1	-	-	**1**
10-Year Modeled Floodplain						
Unincorporated[1]	-	-	-	-	3	**3**
Chehalis	-	-	-	-	-	**0**
Centralia	1	-	-	-	1	**2**
Napavine	-	-	-	-	-	**0**
Pe Ell[1]	-	-	-	-	-	**0**

[1] The effective floodplain cannot be directly compared to the and modeled floodplain. See Section 7.1.

Table 7-11. Critical Infrastructure within the floodplain.

City	Transportation Systems	Communications Facilities	Airports	Potable Water Facilities	Wastewater Facilities	Total
100-Year Effective Floodplain						
Unincorporated County	1	-	-	-	1	**2**
Chehalis	-	-	1	-	1	**2**
Centralia	-	-	-	-	-	**0**
Napavine	-	-	-	-	-	**0**
Pe Ell	-	-	-	-	-	**0**
100-Year Modeled Floodplain						
Unincorporated County[1]	1	-	-	-	-	**1**
Chehalis	-	-	1	-	-	**1**
Centralia	-	-	-	-	-	**0**
Napavine	-	-	-	-	-	**0**
Pe Ell[1]	-	-	-	-	-	**0**
100-Year Climate Change Floodplain						
Unincorporated County[1]	1	-	-	-	-	**1**
Chehalis	-	2	1	-	1	**4**
Centralia	2	1	-	1		**4**
Napavine	-	-	-	-	-	**0**
Pe Ell[1]	-	-	-	-	1	**1**
10-Year Modeled Floodplain						
Unincorporated County[1]	1	-	-	-	-	**1**
Chehalis	-	-	-	-	-	**0**
Centralia	-	-	-	-	-	**0**
Napavine	-	-	-	-	-	**0**
Pe Ell[1]	-	-	-	-	-	**0**

[1] The effective floodplain cannot be directly compared to the and modeled floodplain. See Section 7.1.

Roads

The following major roads in the planning area pass through the 100-year and/or 500-year floodplain and thus are exposed to flooding. Some of these roads are built above the flood level, and others function as levees to prevent flooding. Still, in severe flood events these roads can be blocked or damaged, preventing access to some areas:

- Interstate 5
- State Route 505
- State Route 508
- US Route 12
- State Route 507
- State Route 26

Bridges

Flooding events can significantly impact bridges, which provide the only ingress and egress to some neighborhoods. There are 34 locally maintained bridges and 27 state-maintained bridges that are in or cross over the 100-year effective floodplain within the planning area.

Water and Sewer Infrastructure

Water and sewer systems can be affected by flooding. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers, and streams.

Dams

According to the Washington Department of Ecology's Inventory of Dams Report (WA Ecology, 2020), there are 37 dams in the Chehalis River Basin with Lewis County and 8 dams in Thurston County that would affect Lewis County for a total of 45 dams. Thirty-three of these dams are related to the Transalta coal mining operations.

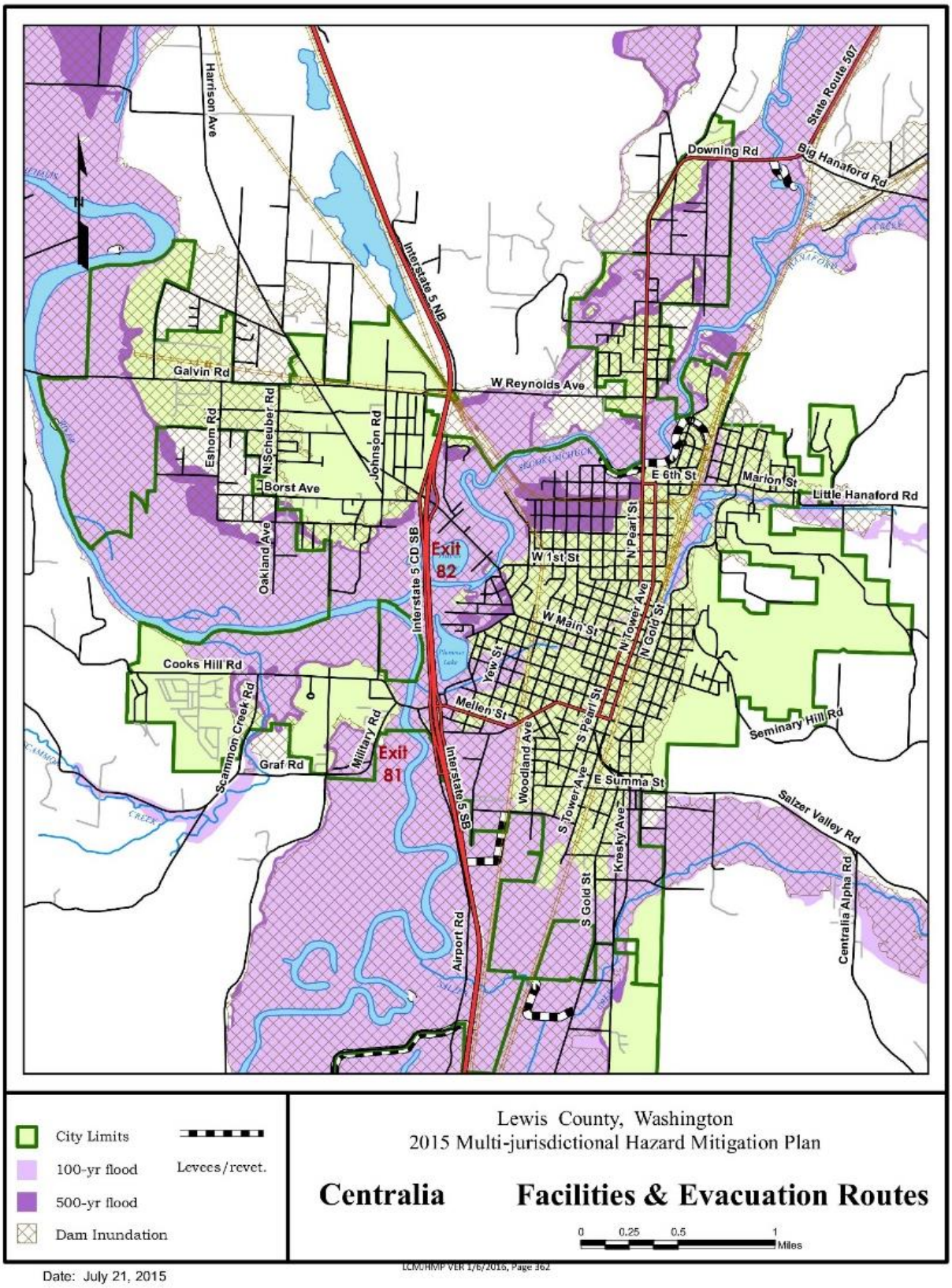
Dam failures can be caused by natural events, such as flooding or an earthquake, but they are predominantly caused by human error such as poor construction, operation, maintenance, or repair. The effects of a dam failure are highly variable, depending on the dam, the amount of water stored behind the dam, the current stream flow, and the size and proximity of the downstream population. There are many effects of a major dam failure: loss of life, destruction of homes and property, damage to roads, bridges, power lines, and other infrastructure, loss of power generation and flood control capabilities, disruption of fish stock and spawning beds, and the erosion of stream and riverbanks. In 1991, the Seminary Hill Reservoir dam owned by the City of Centralia failed due to a landslide that breached the reservoir, causing $3 million in damages and destroying two homes and damaging many others (Lewis County, 2016).

Washington State's Downstream Hazard Classification system for dams assigns a hazard rating of "Low," "Significant" or "High" for areas at risk of economic loss and environmental damage should a dam fail. Of the 37 state inventoried dams within Lewis County, one is rated high (1B). Failure of this dam, the Carslile Lake Dam on the South Fork Newaukum River, could affect a population of 31-300 lives. In Thurston County, the Skookumchuck Dam Hydro Facility is rated high (1A). Failure of this dam would affect more than 300 people, inundate major transportation routes and industries, and have long-term effects on water quality and wildlife.

The classification system does not indicate the condition of the dam. Neither of the high hazard dams mentioned above are considered to have deficiencies. One dam in Thurston County, the Kyte Dam on the Skookumchuck River, is listed on the 2018 Dam Safety Legislative Report as having a medium level of deficiency. This dam is rated 2D with 3 people at risk.

Lewis County is highly vulnerable to the failure of the Skookumchuck Dam. Due to the status as a high hazard dam, inundation mapping is included in the emergency action plans. Emergency management agencies typically have this data to support emergency response functions, however there can be limitations on the use and distribution of this data due to security concerns. The inundation area mapping is available for the Skookumchuck Dam and was reviewed during this planning process. Figure 7-2 is a graphic from the 2016 Lewis County Multi-Jurisdictional Hazard Mitigation Plan planning process that demonstrates the impact of a dam failure. This information shows that the flood flow will inundate most of Centralia and a portion of Chehalis, as well as cause significant impacts in the County. According to the Skookumchuck Dam Inundation Map (Unknown, 2002), flood waters will take approximately four hours to reach Centralia at the Downing Road / SR 507 bridge and cause the water surface to rise over 14-feet.

Figure 7-2. Skookumchuck Dam Inundation Area.



Levees

Levees are a basic means of providing flood protection along waterways in regions where development exists or is planned, and in agricultural areas. Levees typically confine floodwaters to the main river channel. Failure of a levee can lead to inundation of surrounding areas.

The causes of levee failures are structural failures, foundation failures of underlying soils, and overtopping by flood flows and waves. Contributing factors include poor construction materials, erosion by current and wave action, seepage through or under the levee, burrowing rodents, and improper repairs. Lack of adequate and regular maintenance to correct these problems also contributes to levee failure, including vegetation. Most failures are composites of several of these factors.

FEMA accredits levees as providing adequate risk reduction if levee certification and an adopted operation and maintenance plan are adequate. The criteria for which a levee can be accredited are specified in 44 CFR Section 65. Section 65.10 provides the minimum design, operation and maintenance standards levee systems must meet in order to be recognized as providing protection from the base flood on a Flood Insurance Rate Map. In order for a levee to be accredited, the owner must provide data and documentation to demonstrate that the levee complies with these requirements.

An area impacted by an accredited levee is shown as a moderate-risk area and labeled Zone X on a FIRM. This accreditation affects insurance and building requirements. The NFIP does not require flood insurance for areas protected by accredited levees, although FEMA recommends the purchase of flood insurance in these areas due to the residual risk of flooding from levee failure or overtopping. If a levee is not accredited, the area it protects will still be mapped as a high-risk area (a 100-year floodplain), and the federal mandatory purchase of flood insurance will apply (FEMA, 2012).

Even with levee certification and FEMA accreditation, there is a flood risk associated with levees. While levees are designed to reduce risk, even properly maintained levees can fail or be overtopped by large flood events. Levees reduce risk, they do not eliminate it.

In Lewis County, according to the United States Army Corps of Engineers National Levee Database (2021) there are seven levee segments that provide protection against floods within the Chehalis River Basin. Information on these levee segments has been provided in Table 7-12. None of these levee segments are accredited by FEMA. Four of the levees are active in the US Army Corps of Engineers PL 84-99 Program which provides financial support for repairs.

Table 7-12. Levee Profiles.

Levee Segment Name	Length (feet)	Property Value Protected	Level of Protection (% chance of exceedance)	PL 84-99 Status
Skookumchuck	.81 mi	$181 M	.02% chance	Active
Skookumchuck River Levee	.51 mi	N/A	N/A	Not Enrolled
Salzer Creek Levee	.44 mi	$3.58 M	.02% chance	Active
Newaukum River Levee	.45 mi	$16 M	N/A	Not Enrolled
Long Road Levee	1.64 mi	$41.6 M	5% chance	Active
Chehalis-Centralia Airport Levee	2.17 mi	$49.3 M	.02% chance	Active
Chehalis River Levee	.56 mi	N/A	N/A	Not Enrolled

Source: USACE, 2021

7.4 Environment

Flooding is a natural event and floodplains provide many natural and beneficial functions. Nonetheless, flooding can impact the environment in negative ways, especially when compounded with impacts from human development. Migrating fish can wash into roads or over levees into flooded fields. Pollution from roads, such as oil, and hazardous materials can wash into rivers and streams. During floods these pollutants can settle onto normally dry soils, polluting them for agricultural uses. Human development such as bridge abutments and levees, and logjams from timber harvesting can increase stream bank erosion, causing rivers and streams to migrate into non-natural courses.

Many species of mammals, birds, reptiles, amphibians and fish live in Lewis County in ecosystems that are dependent upon streams, wetlands and floodplains. Changes in hydrologic conditions can result in a change in the biodiversity of the ecosystem. Wildlife and fish are impacted when plant communities are eliminated or fundamentally altered to reduce suitable habitat. Wildlife populations are limited by shelter, space, food and water. Since water supply is a major limiting factor for many animals, riparian communities are of special importance. Riparian areas are the zones along the edge of a river or stream that are influenced by or are an influence upon the water body. Human disturbance to riparian areas can limit wildlife's access to water, remove breeding or nesting sites, and eliminate suitable areas for rearing young. Wildlife rely on riparian areas and are associated with the flood hazard in the following ways:

- Mammals depend upon a supply of water for their existence. Riparian communities have a greater diversity and structure of vegetation than other upland areas. As development occurs in the rural areas, wildlife habitat is lost due to the presence of people or due to nuisance. Beaver dams are often considered a nuisance due to the flooding they cause, but they are an important habitat feature that provide refuge, flood, and nesting areas to several birds and mammals.
- A great number of waterbirds, terrestrial birds, and waterfowl are associated with riparian areas. They swim, dive, feed along the shoreline, or snatch food from above. Lewis County rivers, lakes, and wetlands are important feeding and resting areas for migratory and resident waterfowl. During flood season, waterfowl often use flooded agricultural fields.
- Fish habitat throughout the county varies widely based on natural conditions and human influence. The upper reaches of the river have warmer temperatures compared to other headwaters within the basin. This affects habitat for cool water species like salmon, and creates favorable habitat for non-native species that prefer warmer water temperatures. When combined with low dissolved oxygen levels, the river becomes a barrier to cool water species and can lead to fish kill. In more urbanized areas, the river channel has been altered and reshaped, woody debris removed, and diversions installed. These alterations all affect habitat in different ways (WA Ecology, 2017).

Protection of these biological resources within the floodplains of the planning area is very important to Lewis County. Equipped with planning tools such as WRIA planning, shoreline master program planning, comprehensive planning, critical areas ordinances, and open space planning, Lewis County has been able to establish a diverse inventory of preserve areas that maintain the natural and beneficial functions of the floodplain.

8.0 FLOOD HAZARD VULNERABILITY

8.1 Population

8.1.1 Vulnerable Populations

Persons with disabilities or others with access and functional needs are more likely to have difficulty responding to a flood or other hazard event than the general population. Local government is the first level of response to assist these individuals. Coordination of efforts to meet their access and functional needs is paramount to life safety efforts. It is important for emergency managers to distinguish between functional and medical needs in order to plan for incidents that require evacuation and sheltering. Knowing the percentage of population with a disability allows emergency management personnel and first responders to have personnel available who can provide services needed by those with access and functional needs. According to the U.S. Census Bureau 2015 American Community Survey estimates, there are about 15,000 individuals in Lewis County with some form of disability, representing 19.4 percent of the county population. Approximately 21 percent (17,307 individuals) are 65 years or older (U.S. Census, 2019).

8.1.2 Public Health and Safety

Floods present threats to public health and safety. Floodwater is frequently contaminated by pollutants such as sewage, human and animal feces, pesticides and insecticides, fertilizers, oil, asbestos, and rusting building materials. The following health and safety risks are commonly associated with flood events:

- Unsafe food – Floodwaters contain disease-causing bacteria, dirt, oil, human and animal wastes, and farm and industrial chemicals. They carry away whatever lies on the ground and upstream. Their contact with food items, including food crops in agricultural lands, can make that food unsafe to eat and hazardous to human health. Power failures caused by floods damage stored food. Refrigerated and frozen foods are affected during the outage periods and must be carefully monitored and examined prior to consumption. Foods kept inside cardboard, plastic bags, jars, bottles, and paper packaging are subject to disposal if contaminated by floodwaters. Even though the packages may not appear to be wet, they may be unhygienic with mold contamination and deteriorate rapidly.
- Contaminated drinking and washing water and poor sanitation – Flooding impairs clean water sources with pollutants and affects sanitary toilets. Direct and indirect contact with the contaminants – whether through direct food intake, vector insects such as flies, unclean hands, or dirty plates and utensils – can result in waterborne infectious disease. Wastewater treatment plants, if flooded and caused to malfunction, can be overloaded with polluted runoff waters and sewage beyond their disposal capacity, resulting in backflows of raw sewage to homes and low-lying grounds. Private wells can be contaminated or damaged severely by floodwaters, while private sewage disposal systems can become a cause of infection and illnesses if they are broken or overflow. Unclean drinking and washing water and sanitation, coupled with lack of adequate sewage treatment, can lead to disease outbreaks, including life-threatening cholera, typhoid, dysentery, and some forms of hepatitis.
- Mosquitoes and animals – Prolonged rainfall and floods provide new breeding grounds for mosquitoes – wet areas and stagnant pools – and can lead to an increase in the number of

mosquito-borne diseases such as West Nile. Rats and other rodents and wild animals also can carry viruses and diseases. The public should avoid such animals and should dispose of dead animals in accordance with guidelines issued by local animal control authorities.

- Molds and mildews – Excessive exposure to molds and mildews can cause flood victims – especially those with allergies and asthma – to contract upper respiratory diseases and to trigger cold-like symptoms such as sore throat, watery eyes, wheezing and dizziness. Molds grow in as short a period as 24 to 48 hours in wet and damp areas of buildings and homes that have not been cleaned after flooding, such as water-infiltrated walls, floors, carpets, toilets, and bathrooms. Very small mold spores can be easily inhaled and, in large enough quantities, cause allergic reactions, asthma episodes, and other respiratory problems. Infants, children, elderly people, and pregnant women are considered most vulnerable to mold-induced health problems.
- Carbon monoxide poisoning – Carbon monoxide poisoning is as a potential hazard after major floods. Carbon monoxide can be found in combustion fumes, such as those generated by small gasoline engines, stoves, generators, lanterns, and gas ranges, or by burning charcoal or wood. In the event of power outages following floods, flood victims tend to use alternative sources of fuels for heating, cooling, or cooking inside enclosed or partly enclosed houses, garages, or buildings without an adequate level of air ventilation. Carbon monoxide builds up from these sources and poisons the people and animals inside.
- Hazards when reentering and cleaning flooded homes and buildings **–** Flooded buildings can pose health hazards after floodwaters recede. Electrical power systems can become hazardous. People should avoid turning on or off the main power while standing in floodwater. Gas leaks from pipelines or propane tanks can trigger explosion when entering and cleaning damaged buildings or working to restore utility service. Flood debris – such as broken bottles, wood, stones and walls – may cause wounds and injuries when cleaning damaged buildings. Containers of hazardous chemicals, including pesticides, insecticides, fertilizers, car batteries, propane tanks and other industrial chemicals, may be hidden or buried under flood debris. A health hazard can also occur when hazardous dust and mold in ducts, fans and ventilators of air-conditioning and heating equipment are circulated through a building and inhaled by those engaged in cleanup.
- Mental stress and fatigue – Exposure to extreme disaster events can cause psychological distress. Having experienced a devastating flood, seen loved ones lost or injured, and homes damaged or destroyed, flood victims can experience long-term psychological impact. The expense and effort required to repair flood-damaged homes places severe financial and psychological burdens on the people affected, in particular the unprepared and uninsured. Post-flood recovery – especially when prolonged – can cause anxiety, anger, depression, lethargy, hyperactivity, sleeplessness, and, in an extreme case, suicide. Behavior changes may also occur in children. There is also a long-term concern among the affected that their homes can be flooded again in the future.

Current loss estimation models such as Hazus are not equipped to measure public health impacts. The best level of mitigation for these impacts is to be aware that they can occur, educate the public on prevention, and be prepared to deal with these vulnerabilities in responding to flood events.

Table 8-1. Number of Persons Displaced or Requiring Shelter.

	100-Year Effective Flood		100-Year Modeled Flood[1]	
	Displaced Persons	Persons Requiring Short-Term Shelter[2]	Displaced Persons	Persons Requiring Short-Term Shelter[2]
Centralia	838	42	3112	160
Chehalis	316	13	326	13
Napavine	7	0	1	0
Pe Ell[3]	3	0	3	0
Unincorporated County[3]	322	8	634	23
Total	**1,546**	**63**	**4,076**	**195**

	100-Year Climate Change Flood[1]		10-Year Modeled Flood[1]	
	Displaced Persons	Persons Requiring Short-Term Shelter[2]	Displaced Persons	Persons Requiring Short-Term Shelter[2]
Centralia	5531	341	309	15
Chehalis	412	16	79	1
Napavine	2	0	0	0
Pe Ell[3]	5	0	1	0
Unincorporated County[3]	1,122	54	139	2
Total	**7,072**	**410**	**528**	**18**

[1] Results shown are not precise, but are estimates of needs that may occur as the result of the modeled flood.
[2] The number of persons requiring publicly provided shelter is less than the number of displaced persons because not all households will require public assistance to find short-term shelter.
[3] Number of persons within the unincorporated county and Pe Ell in the modeled floodplains cannot be compared to the 100-year effective floodplain. See Section 7.1.
Note: Sources of data used in Hazus modeling are described in Section 5.

8.2 Property

8.2.1 Loss Estimates

Hazus calculates flood losses to structures based on flooding depth and structure type. Using historical flood insurance claim data, Hazus estimates the percentage of damage to structures and their contents by applying established damage functions to an inventory. For this analysis local data on facilities was used instead of the default inventory data provided with Hazus. The results of the analyses for the scenario flood events are summarized in Tables 8-2 and 8-3.

Table 8-2. Loss Estimates for 100-Year Flood Events.

100-Year Effective Flood					
	Structures Impacted[1]	Estimated Loss Associated with Flood			% of Total Replacement Cost
		Structure	Contents	Total	
Centralia	375	$15,369,799	$18,707,084	$34,076,883	13.1%
Chehalis	275	$40,078,283	$120,759,167	$160,837,450	61.5%
Napavine	8	$240,071	$1,704,915	$1,944,986	0.7%
Pe Ell[2]	8	$171,358	$110,982	$282,340	0.1%
Unincorporated County[2]	498	$29,968,370	$34,299,083	$64,267,453	24.6%
Total	**1,164**	**$85,827,833**	**$175,581,230**	**$261,409,113**	**100%**

100-Year Modeled Flood					
	Structures Impacted[1]	Estimated Loss Associated with Flood			% of Total Replacement Cost
		Structure	Contents	Total	
Centralia	1,573	$41,757,447	$68,605,521	$110,362,968	32%
Chehalis	300	$39,522,197	$118,729,404	$158,251,600	47%
Napavine	1	$3,793	$49,304	$53,096	<0.01%
Pe Ell[2]	7	$194,279	$104,382	$298,661	1%
Unincorporated County[2]	629	$34,500,641	$32,843,798	$67,344,440	20%
Total	**2,510**	**$115,978,356**	**$220,332,409**	**$336,310,766**	**100%**

100-Year Climate Change Flood					
	Structures Impacted[1]	Estimated Loss Associated with Flood			% of Total Replacement Cost
		Structure	Contents	Total	
Centralia	2,501	$17,427,023	$186,320,558	$293,747,580	44%
Chehalis	390	$65,807,994	$187,286,018	$253,094,012	37.8%
Napavine	5	$140,551	$690,788	$831,338	0.1%
Pe Ell[2]	9	$372,452	$181,590	$554,042	0.1%
Unincorporated County[2]	985	$58,515,764	$62,213,173	$120,728,936	18%
Total	**3,900**	**$232,263,783**	**$426,692,126**	**$668,955,909**	**100%**

[1] Impacted structures are those structures with finished floor elevations below the Hazus-estimated 100-year water surface elevation for each flood event. These structures are the most likely to receive damage in a 100-year flood event.
[2] The values within the modeled floodplain cannot be compared to the 100-year effective floodplain. See Section 7.1.
Notes: Values in this table are only for purposes of comparison among results. See Section 5 for a discussion of data limitations. Sources of data used in Hazus modeling are described in Section 5.

Table 8-3. Loss Estimates for 10-Year Modeled Flood Event.

	10-Year Modeled Flood				
	Structures Impacted[1]	Estimated Loss Associated with Flood			% of Total Replacement Cost
		Structure	Contents	Total	
Centralia	225	$4,696,200	$5,143,907	$9,840,106	30%
Chehalis	61	$2,830,179	$5,243,741	$8,073,920	24.2%
Napavine	0	$0	$0	$0	0%
Pe Ell	2	$27,315	$16,799	$44,114	0.1%
Unincorporated County	189	$9,780,593	$5,351,440	$15,132,033	45.7%
Total	**477**	**$17,334,287**	**$15,755,887**	**$33,090,174**	**100%**

[1] Impacted structures are those structures with finished floor elevations below the Hazus-estimated 10-year modeled water surface elevation. These structures are the most likely to receive damage in a 10-year modeled flood event.
[2] The values within the modeled floodplain cannot be compared to the 100-year effective floodplain. See Section 7.1.
Notes: Values in this table are only for purposes of comparison among results. See Section 5 for a discussion of data limitations. Sources of data used in Hazus modeling are described in Section 5.

8.2.2 National Flood Insurance Program

Table 8-5 lists flood insurance statistics that help identify vulnerability in the planning area. Five planning area communities participate in the NFIP, with 1,636 flood insurance policies providing over $432.6 million in coverage (this includes portions of the unincorporated county outside of the Chehalis River Basin). According to FEMA statistics, within the planning area 1,872 flood insurance claims were paid between January 1, 1978, and May 24, 2021, for a total of almost $77 million, averaging over $41,000 per claim. Not all structures within the special flood hazard area (SFHA, also known as the 100-year floodplain) are covered by flood insurance.

Properties constructed after a FIRM has been adopted are eligible for reduced flood insurance rates. Such structures are less vulnerable to flooding because they were constructed after regulations and codes were adopted to decrease vulnerability. Structures built before a FIRM is adopted are more vulnerable to flooding because they do not meet current codes or are located in hazardous areas. The first FIRMs in the planning area were available in 1980.

The following information related to flood insurance statistics is relevant for understanding and reducing flood risk in the planning area:

- The uptake of flood insurance within Lewis County (county-wide) is below average. According to FEMA, only 22 percent of residential structures within the 100-year floodplain have a flood insurance policy. According to FEMA, as of July 31, 2019 about 28 percent of single-family homes in special flood hazard areas are covered by flood insurance nationwide (FEMA, 2021c). This rate is referred to as the penetration rate. See Table 8-5 for city estimates.
- In Centralia, the amount of insurance coverage in force represents approximately 20 percent of the total value of the assets exposed within the SFHA (estimated buildings and contents). In Chehalis, the amount of insurance coverage represents approximately 9 percent of the total value.

- The percentage of policies and claims outside a mapped floodplain confirms that not all of the flood risk in the planning area is reflected in current mapping. Based on information from FEMA (FEMA, 2021c), 33 percent of policies are for structures outside the SFHA. In Chehalis, 14 percent of policies are for structures outside the SFHA. In the unincorporated county, 46 percent of policies are for structures outside the SFHA (county-wide). Table 8-6 details the location of paid flood claims per jurisdiction.

Table 8-4. Flood Insurance Statistics for Lewis County.

	Date of Entry Initial FIRM Effective Date	# of Flood Insurance Policies as of 5/21/2021	Total Coverage	Total Annual Premium	Claims, 11/1978 to 5/21/2021	Value of Claims paid, 11/1978 to 5/21/2021
Centralia	6/1/1982	574	$149,682,900	$580,347	672	$26,053,865
Chehalis	5/1/1980	205	$64,844,800	$364,114	448	$28,216,898
Napavine	5/19/2017	2	$850,000	$1,363	0	$0
Pe Ell	3/4/1980	5	$1,137,100	$3,511	1	$37,771
Unincorporated County[1]	12/15/1981	850	$216,132,100	$703,068	660	$22,642,061
Total		**1,636**	**$432,646,900**	**$1,652,403**	**1,781**	**$76,950,595**

[1] Values reflect all of Lewis County, including areas outside of the Chehalis River Basin.
Source: FEMA, 2021c

Table 8-5. Estimated Residential Penetration Rate within Cities.

	Number of Residential Structures in 100-Year Effective Floodplain[1]	Number of Residential Policies in 100-Year Effective Floodplain	Penetration Rate	Number of Residential Policies outside 100-Year Effective Floodplain	Total Number of Residential Policies
Centralia	818	331	40%	170	501
Chehalis	238	117	49%	26	143
Napavine	4	0	0%	1	1
Pe Ell	17	2	12%	3	5

[1] Number of structures in floodplain is an estimate provided by Hazus.
Source: FEMA, 2021c.

Table 8-6. Flood Insurance Claims with Payment beginning 11/1978.

	A Zones (without BFE)	A Zones (with BFE or depths)	B, C, X Zones (outside of floodplain)	Unknown	Jurisdiction Total	Percentage of Claims outside the 100-Year Effective Floodplain
Centralia	13	545	114	0	672	17%
Chehalis	2	408	29	9	448	6.5%
Napavine	0	0	0	0	0	0%
Pe Ell	1	0	0	0	1	0%
Unincorporated County[1]	44	449	120	47	660	18%
Zone Total	**72**	**1,402**	**263**	**16**	**1,176**	**22%**

[1]Values reflect all of unincorporated Lewis County, including areas outside of the Chehalis River Basin.
Source: FEMA, 2021c.

8.2.4 Repetitive Loss

A repetitive loss property is defined by FEMA as an NFIP-insured property that has experienced two paid losses in excess of $1,000 within any rolling 10-year period.

A severe repetitive loss property is defined by FEMA as an NFIP-insured property has experienced either:

- Four or more paid losses in excess of $5,000
- Two to three or more paid losses that equal or exceed the current value of the insured property.

Repetitive loss properties make up only one to percent of flood insurance policies in force nationally, yet they account for 30 percent of the nation's flood insurance claim payments. In 2004, FEMA reported that the NFIP's 112,540 repetitive loss structures had made 314,640 claims costing $5.17 billion in flood insurance payments and that numerous other flood-prone structures remain in the floodplain at high risk. The government has instituted programs encouraging communities to identify and mitigate the causes of repetitive losses. A report on repetitive losses by the National Wildlife Federation found that 20 percent of these properties are located outside of the mapped 100-year floodplain. The key identifiers for repetitive loss properties are the existence of flood insurance policies and claims paid by the policies (King, 2005).

FEMA-sponsored programs, such as the CRS, require participating communities to identify repetitive loss areas. A repetitive loss area is the portion of a floodplain holding structures that FEMA has identified as meeting the definition of repetitive loss. Identifying repetitive loss areas helps to identify structures that are at risk but are not on FEMA's list of repetitive loss structures because no flood insurance policy was in force at the time of loss. Repetitive loss area maps are included in Figures 8-1 and 8-2. The information shown on the maps is limited due to federal privacy laws.

This analysis uses information from the 2014 Repetitive Loss Strategy (French and Associates, 2014). Due to privacy laws, the FEMA provided information does not include location data and was not able to be reviewed for accuracy. The breakdown of the properties by jurisdiction is shown in Table 8-7.

Table 8-7. Repetitive Loss Properties as of May 21, 2021.

	Total Repetitive Loss Properties	Severe Repetitive Loss Properties	Unmitigated Properties	Areas	Buildings
Centralia	64	6	31	8	760
Chehalis	65	9	47	8	130
Napavine	0	0	0	0	0
Pe Ell	0	0	0	0	0
Unincorporated County	54	3	27	15	165
Total	**183**	**18**	**105**	**31**	**1055**

Source: French and Associates, 2014

Figure 8-1. Lewis County Repetitive Loss Areas.

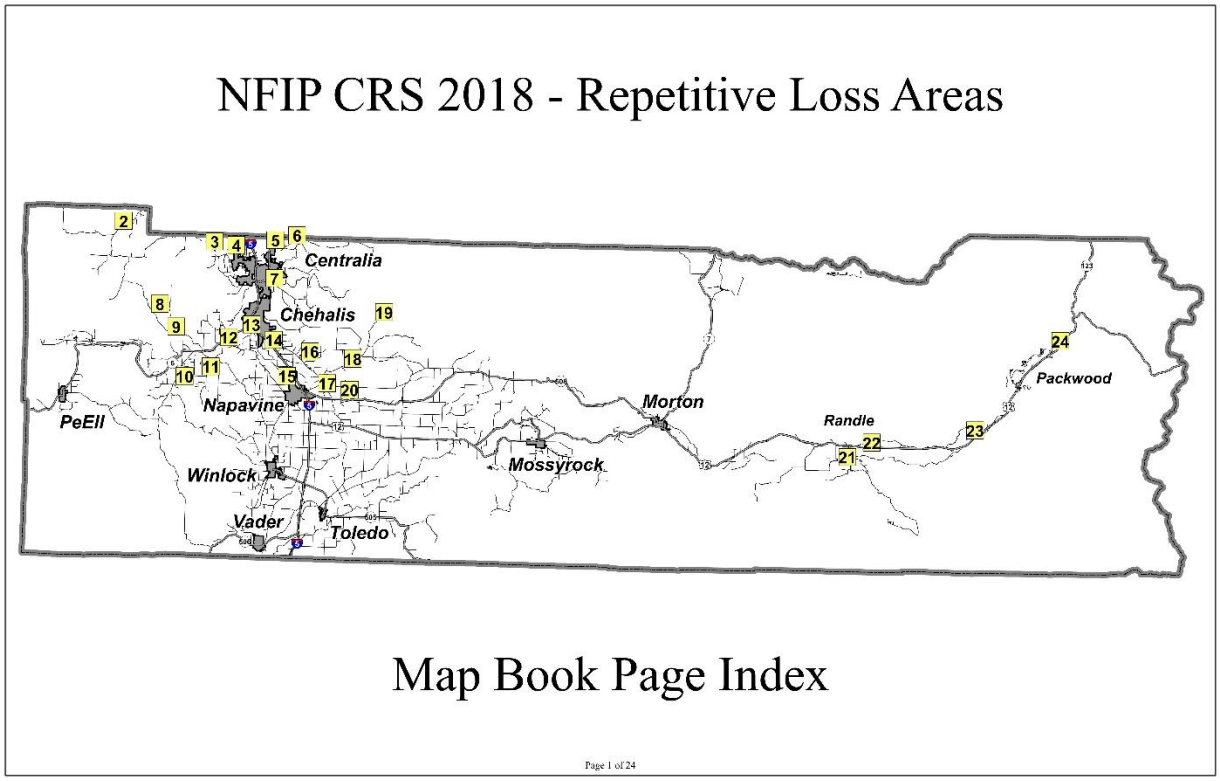
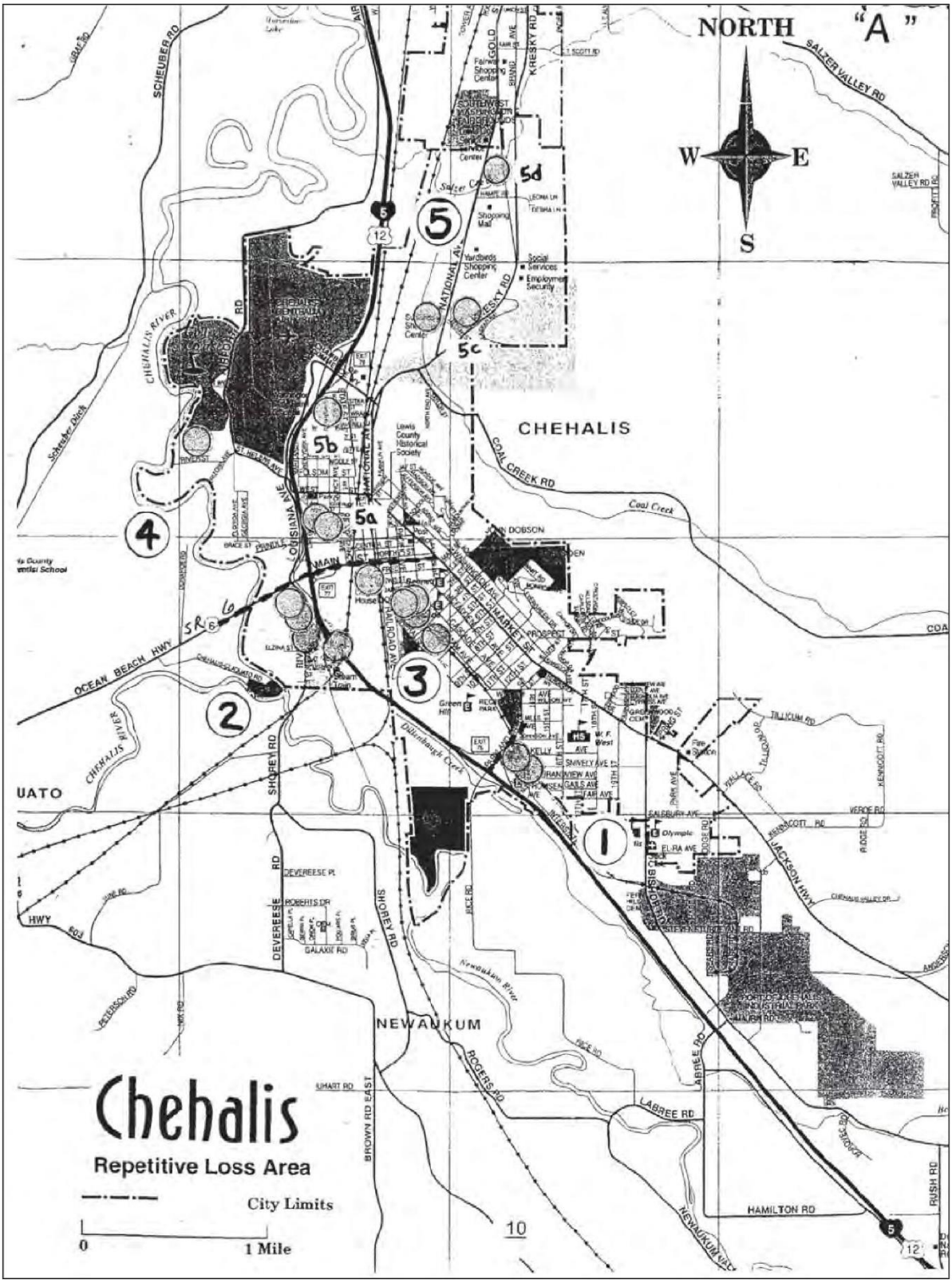


Figure 8-2. Chehalis Repetitive Loss Areas.



8.3 Environment

The environment vulnerable to the flood hazard is the same as the environment exposed to the hazard. The principle environmental impact from flood is the loss of aquatic habitat. One possible measure of environmental impacts from flooding is the amount of debris that that would be generated by each scenario flood event. Hazus includes a debris estimation component. These estimates can provide local governments information on the potential exposure to debris carried by flood water as well as estimates useful for planning for recovery. The Hazus debris estimates for each of the scenario flood events are shown in Table 8-8.

Table 8-8. Estimated Flood-Caused Debris.

	Debris to Be Removed (tons)[1]			
	100-Year Effective Flood	100-Year Modeled Flood	100-Year Climate Change	10-Year Modeled Flood
Centralia	5,550	7,611	16,063	1,609
Chehalis	2,277	2,029	3,165	665
Napavine	0	0	0	0
Pe Ell[2]	123	147	207	70
Unincorporated County[2]	6,141	10,178	13,855	3,491
Total	**14,091**	**19,965**	**33,290**	**5,835**

[1] The Hazus flood debris model focuses on building-related debris and does not address contents removal or additional debris loads such as vegetation and sediment.

[2] The values within the modeled floodplain cannot be compared to the 100-year effective floodplain. See Section 7.1.

9.0 CLIMATE CHANGE CONSIDERATIONS FOR FLOOD HAZARD MANAGEMENT

This chapter presents an overview of current understandings of how climate change will affect Lewis County and implications for flood hazard management. Information on climate change is continually updated, and the information presented here is a snapshot of the best available information at the time this document was written.

9.1 What Is Climate Change?

Climate, consisting of patterns of temperature, precipitation, humidity, wind, and seasons, plays a fundamental role in shaping natural ecosystems and the human economies and cultures that depend on them. “Climate change” refers to changes in these patterns over a long period of time. Worldwide, average temperatures have increased 2.1ºF since 1880 (NASA, 2021). Although this change may seem small, it can lead to large changes in climate and weather.

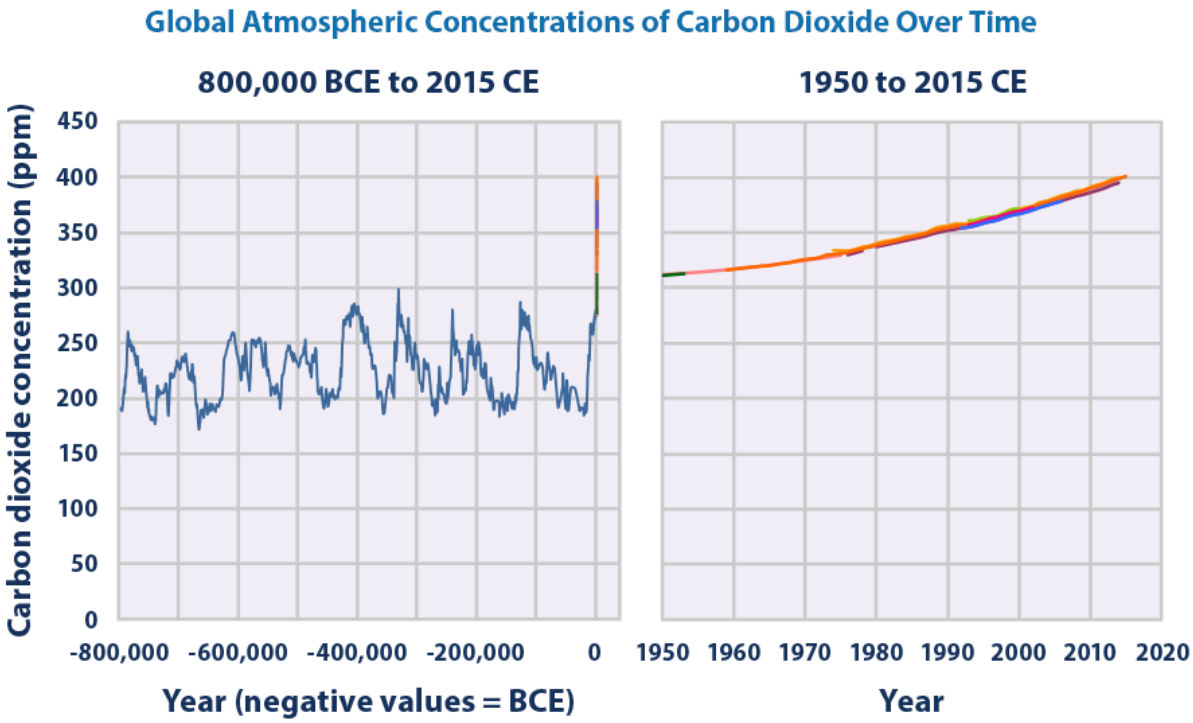
The warming trend and its related impacts are caused by increasing concentrations of carbon dioxide and other greenhouse gases in the earth’s atmosphere. Greenhouse gases are gases that trap heat in the atmosphere, resulting in a warming effect. Carbon dioxide is the most commonly known greenhouse gas; however, methane, nitrous oxide and fluorinated gases also contribute to warming. Emissions of these gases come from a variety of sources, such as the combustion of fossil fuels, agricultural production, changes in land use, and volcanic eruptions.

According to the U.S. Environmental Protection Agency (EPA), carbon dioxide concentrations measured about 280 parts per million (ppm) before the industrial era began in the late 1700s and have risen 43 percent since then, reaching 416 ppm in 2021 (US EPA, 2021) (see Figure 9-1). In addition, the concentration of methane has almost doubled, and nitrous oxide is being measured at a record high of 328 parts per billion (ppb) (US EPA, 2021).

Scientists are able to place this rise in carbon dioxide in a longer historical context through the measurement of carbon dioxide in ice cores. According to these records, carbon dioxide concentrations in the atmosphere are the highest that they have been in 650,000 years (NASA, 2021). There is broad scientific consensus (95 percent probability) that climate-warming trends are very likely due to human activities (NASA, 2021). Unless emissions of greenhouse gases are substantially reduced, this warming trend and its associated impacts are expected to continue.

Climate change will affect the people, property, economy, and ecosystems of Lewis County in a variety of ways. Its impacts are most frequently associated with negative consequences and increased risk, such as increased flooding or increased heat-related public health concerns. The most important effect for the development of this plan is that climate change is expected to have a measurable impact on the occurrence and severity of flooding and flood-related hazards. This chapter summarizes current understandings about climate change in order to provide a context for the recommendation and implementation of flood hazard mitigation measures in Lewis County.

Figure 9-1. Carbon Dioxide Concentrations Over Time.



Data source: Compilation of 10 underlying datasets. See www.epa.gov/climate-indicators for specific information.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

9.2 How Climate Change Affects Flood Hazard Management

An essential aspect of flood hazard management is predicting the likelihood of flooding in a planning area. Typically, predictions are based on statistical projections from records of past events. This approach assumes that the likelihood of flood events remains essentially unchanged over time. Thus, averages based on the past frequencies of floods are used to estimate future frequencies: if a river has flooded an average of once every five years for the past 100 years, then it can be expected to continue to flood an average of once every five years. But the assumption that future flooding behavior will be equivalent to past behavior is not valid if climate conditions are changing.

Climate involves not only average temperature and precipitation but also the frequency and intensity of extreme weather events. The frequency of flooding will not remain constant if broad precipitation patterns change over time. While predicting changes in flood events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment. For this reason, an understanding of climate change is pertinent to flood hazard management activities. Information about how climate patterns are changing provides insight on the reliability of future flooding projections used in mitigation analysis.

9.3 Current Indications and Observed Changes

9.3.1 Observed Global Changes

The major scientific agencies of the United States and the world—including the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA) and the Intergovernmental Panel on Climate Change (IPCC)—agree that climate change is occurring. Multiple temperature records from all over the world have shown a warming trend, and the IPCC has stated that the warming of the climate system is unequivocal (IPCC, 2014). Of the 19 warmest years since 1880, all but one (1998) occurred since 2000, and 2016 and 2020 tied for the warmest years on record (NASA, 2021). Worldwide, average temperatures have increased 2.1ºF since 1880 (NASA, 2021).

Rising global temperatures have been accompanied by other changes in weather and climate. Many places have experienced changes in rainfall resulting in more intense rain, as well as more frequent and severe heat waves (IPCC, 2014). The planet's oceans and glaciers have also experienced changes: oceans are warming and becoming more acidic, ice caps are melting, and sea levels are rising (NASA, 2021). Global sea level has risen nearly seven inches in the last 100 years (NASA, 2021). This has already put some coastal homes, beaches, roads, bridges, and wildlife at risk.

NASA currently maintains information on the vital signs of the planet. At the time of the development of this plan, the following trends and status of these signs are as follows (NASA, 2021):

- Carbon Dioxide – Increasing trend, currently at 416 parts per million
- Global Temperature – Increasing trend, increase of 2.1 degrees Fahrenheit since 1880
- Arctic Ice Minimum – Decreasing trend, 13.1 percent per decade
- Land Ice – Decreasing trend, 428 billion metric tons per year
- Sea Level – Increasing trend, 3.3 millimeters (0.04 inches) per year

9.3.2 Observed Changes in the Pacific Northwest

In the Pacific Northwest average annual temperatures increased approximately 1.3 degrees Fahrenheit between 1895 and 2011 (Mote et al., 2014). This has corresponded with a lengthening of the frost-free season and a higher incidence of nighttime high heat events (Dalton, Mote and Snover, 2013). In addition to these temperature related changes, several water-related impacts have been observed (Mote et al., 2014):

- Average snowpack – In the Cascade mountains area, average snowpack on April 1 has decreased about 20 percent since 1950.
- Snowmelt timing – Spring snowmelt is occurring as much as 30 days earlier in some locations.
- Streamflow timing – Streamflow levels and timing have shifted as late winter and early spring stream flows have increased and summer flows have decreased.

Like the rest of the western United States, the number and extent of wildfires in the Pacific Northwest have increased since the 1970s. This is believed to have been influenced by the onset of warmer and drier climatic conditions as well as the onslaught of pest infestations, such as mountain pine beetles, fueled at least in part by heat and drought stress (Mote et al., 2014).

9.4 Future Impacts

9.4.1 Global Projections

Scientists project that Earth's average surface temperature will continue to rise between 0.5ºF and 8.6ºF by 2100 (IPCC, 2014). Some research has concluded that every increase of 2ºF in average global average temperature can have the following impacts (NRC, 2011):

- 3 to 10 percent increases in the amount of rain falling during the heaviest precipitation events, which can increase flooding risks.
- 5 to 10 percent decreases in stream flow in some river basins.

Although not a concern in Lewis County, the amount of sea level rise expected to occur as a result of climate change will increase the risk of coastal flooding for millions to hundreds of millions of people around the world, many of whom would have to permanently leave their homes (IPCC, 2014). By 2100, sea level is expected to rise another 1 to 4 feet, with an uncertainty range of 0.66 to 6.6 feet (Melillo et al., 2014).

9.4.2 Projections and Potential Impacts for the Pacific Northwest

In the Pacific Northwest average annual temperatures are expected to continue to rise by 3.3ºF to 9.7ºF by the end of the century (Mote et al., 2014). It is anticipated that these changes will be most dramatic in the summer months. Projected precipitation changes in the region are ambiguous. Some models indicate that an 11 percent decrease in annual average precipitation will occur by mid-century, while other models project an increase of 12 percent for the same time period (Mote et al., 2014). The distribution of precipitation over the seasons is also uncertain, although there is some agreement amongst the models that summer precipitation is likely to decrease (Mote et al., 2014). These changes can have wider implications for stream flow and the incidence of drought and wildfires.

Projections for water-related impacts in the region are as follows (Mote et al., 2014):

- Snowmelt timing – By 2050, snowmelt is projected to shift three to four weeks earlier than the 20th century average.
- Stream flow levels – Summer stream flows are expected to be substantially diminished.
- Flood risk – Flood risk is expected to increase most in mixed basin watersheds (those with both rainfall and snowmelt related runoffs) and remain largely unchanged in snow dominated systems.
- Heavy precipitation events – It is unclear if there will be an overall increase in heavy precipitation events, but when averaged over the region models indicate that the number of days with more than one inch of precipitation is likely to increase by approximately 13 percent by mid-century. If such increases do occur, they could impact flooding in both mixed and rain-dominant systems, as well as contribute to localized flooding due to overwhelmed storm water management systems.

Water-related impacts are expected to contribute to an increased risk of wildfire in the region as water deficits stress trees and increase vulnerability to both insect infestation and combustion (Mote et al.,

2014). The average annual area burned by wildfire in the region may quadruple from the last century to two million acres by 2080 (Mote et al., 2014).

9.4.3 Projections and Potential Impacts for the Chehalis River Basin

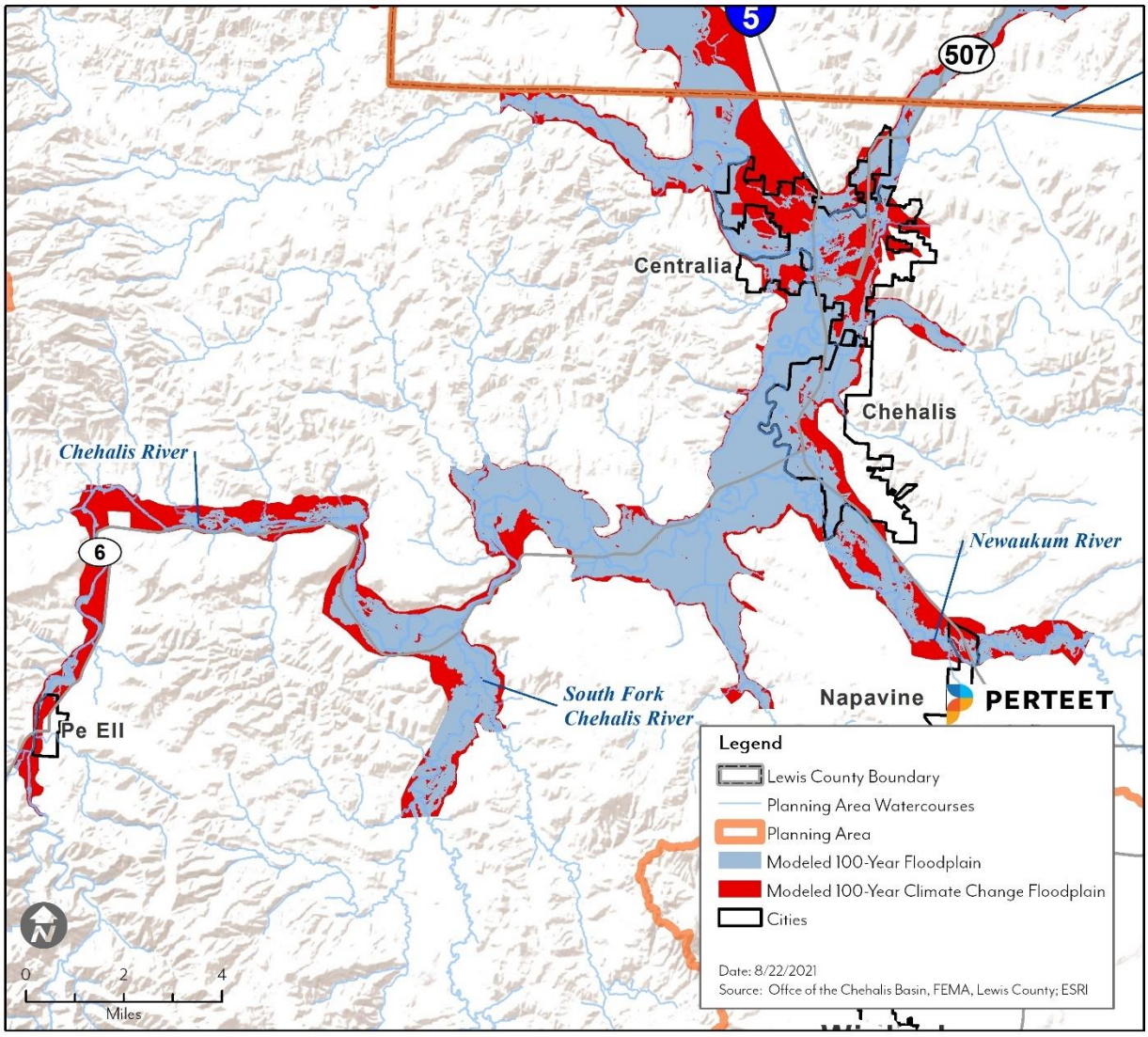
In 2014, the Climate Impact Group at the University of Washington released a report titled Effect of Climate Change on the Hydrology of the Chehalis Basin (Mauger, et. al, 2016). The report supports the ongoing work to reduce the risk and damage from flooding throughout the river basin. The report found that:

- Winter precipitation is projected to increase, while summer precipitation decreases.
- Peak streamflow is projected to increase.
- Annual temperature increases are projected to increase.
- Sea levels are projected to increase by another two feet along the Pacific coastline.

In 2019, the Office of the Chehalis Basin developed a climate change 100-year flood model using information from the University of Washington Climate Impacts Group. The data estimated a 26 percent increase in flood discharge for a late century flood (approximately the year 2080). The depth grid and boundary from the 2019 model was used for the analysis of this plan. In 2020, the model was updated using new data from the Climate Impacts Group. This data showed a substantial increase of 40-65 percent in flood discharge, averaging at about 50% basin-wide (Mauger, 2021). Currently, the 2019 model is being considered the “mid-range” projections and the updated 2020 data is considered the “high-end” projections.

Figure 9-2 illustrates the forecast changes in flooding for the mid-range climate change projection. The red areas show the increase in area compared to the modeled 100-year floodplain. In some areas, the boundaries for the two floodplains are in the same location. In these areas, the floodwaters have reached the extent they can spread and instead of spreading farther the floodwaters get deeper. The high-end projection will cause an even greater area to be subject to flooding and other areas to be much deeper.

Figure 9-2. Mid-Range Climate Change Projections.



9.5 Impacts on Flood-Related Hazards

9.5.1 Flood

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example, historical data are used for flood forecasting models and to forecast snowmelt runoff for water supply. This method of forecasting assumes that the climate of the future will be similar to that of the period of historical record. However, the hydrologic record cannot be used to predict changes in frequency and severity of extreme climate events such as floods. Going forward, model calibration or statistical relation development must happen more frequently, new forecast-based tools must be developed, and a standard of practice that explicitly considers climate change must be adopted. Climate change is already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast future conditions.

- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness and emergency response.

As hydrology changes, what is currently considered a 100-year flood (one-percent annual chance) may strike more often, leaving many communities at greater risk. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams, bypass channels and levees, as well as the design of local sewers and storm drains.

9.5.2 Dam Failure

Dams are designed partly based on assumptions about a river's hydrograph and the region's weather known at the time of construction. In the United States, the average age of a dam is almost 60 years (Fountain, 2020). In Lewis County, the average age of dams 44 years (WA Ecology, 2020). Changes in weather patterns have significant effects on hydrographs, such as early snow pack melt or heavier and more frequent rainfall, which can overwhelm dams' emergency spillways or cause structural damage. Of the ten dams on average that fail each year in the United States, the primary cause is due to excess rainfall. The most recent major dam failure on the west coast of the United States, the Oroville Dam in California in February 2017, has been attributed to warming conditions that increased snowpack melt and rainfall above the assumptions that were used to construct the dam (Huang, 2018). With these types of condition anticipated to increase in the future, more dam failure is a potential impact.

9.5.3 Wildfire

Climate change can affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. Climate change also may increase winds that spread fires and, potentially, thunderstorms producing lightning that ignites fires. Forest response to increased atmospheric carbon dioxide could contribute to more tree growth and, thus, more fuel for fires, although the effects of carbon dioxide on mature forests are still largely unknown. In turn, increased wildfires could release stores of carbon and further contribute to the buildup of greenhouse gases.

9.6 Responses to Climate Change

Communities and governments worldwide are working to address, evaluate and prepare for climate changes that are likely to impact communities in coming decades. Generally, climate change discussions encompass two separate but inter-related considerations: mitigation and adaptation. The term "mitigation" can be confusing, because it's meaning changes across disciplines:

- Mitigation in restoration ecology and related fields generally refers to policies, programs or actions that are intended to reduce or to offset the negative impacts of human activities on natural systems. Generally, mitigation can be understood as avoiding, minimizing, rectifying, reducing or eliminating, or compensating for known impacts (40 CFR 1508.20).

- Mitigation in climate change discussions is defined as human intervention to reduce the impact on the climate system. It includes strategies to reduce greenhouse gas sources and emissions and enhance greenhouse gas sinks.
- Mitigation in emergency management is typically defined as the effort to reduce loss of life and property by lessening the impact of disasters (FEMA, 2013).

In this section, mitigation is used as defined by the climate change community. In the other chapters of this plan, mitigation is primarily used in an emergency management context.
Adaptation is defined by the IPCC as "the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects" (IPCC, 2014).

Mitigation and adaptation are related, as the world's ability to reduce greenhouse gas emissions will affect the degree of adaptation that will be necessary. Some actions can both reduce greenhouse gas emissions and support adaptation to likely future conditions. One subset of this type of strategy is known as ecosystem-based adaptation. Ecosystem-based adaptation is the use of biodiversity and ecosystem services as part of an overall strategy to help people adapt to the adverse effects of climate change. This includes the sustainable management, conservation and restoration of specific ecosystems that provide key services. In terms of flood hazard management, many such actions are related to preserving or enhancing the natural beneficial functions of floodplain systems. Riparian forests can bind soils and hold large volumes of water during periods of significant precipitation, releasing it through the year. Floodplains can absorb large volumes of water during peak flows. Coastal ecosystems can hold out against storms, attenuating waves and reducing erosion.

PART 3 – MITIGATION STRATEGY

10.0 GOALS AND OBJECTIVES

This chapter identifies the goals and objectives for reducing long-term vulnerabilities to flooding in the planning area (CRS Step 6). These vital planning components were developed by the Stakeholders through a facilitated process that addressed flooding issues, public support, political support, and existing capabilities within the planning area. They were developed to establish a vision for reducing risk to flood hazards in Lewis County. The goals and objectives are linear planning components, meaning that they all directly support one another. The Stakeholders selected objectives that met multiple goals, and identified actions (identified in Table 12-1) that were prioritized based on the action meeting multiple objectives. Achievement of these goals and objectives will be pursued through an action plan that identifies the programs, projects and technical studies that will be implemented as resources are identified and allocated.

10.1 Goals

The effectiveness of a mitigation strategy is assessed by determining how well its goals are achieved. The Stakeholder Committee established the following goals for the 2021 Comprehensive Flood Hazard Management Plan:

Goal #1 – Reduce and minimize flood related hazards to the public and emergency responders.

Goal #2 – Reduce and minimize flood damage and financial impacts to the community.

Goal #3 – Avoid impacts that cause flooding of downstream neighbors.

Goal #4 – Avoid, minimize, or mitigate environmental impacts of flood hazard reduction activities.

Goal #5 – Increase public awareness and understanding of flooding.

10.2 Objectives

The Stakeholder Committee established the following objectives that meet multiple goals:

1. Utilizing the best available data and science, continually improve and annually review plans for mitigating and minimizing flood damage impacts.
2. Identify and support flood damage mitigation projects that provide the highest cost benefit and greatest protection, and avoid, minimize or mitigate impacts on the environment.
3. Communicate flood damage risk to the public, including increased risk due to climate change, and encourage that future development recognize and minimize this risk.
4. Consider floodplain management policies that promote resiliency and sustainable operations of identified critical facilities.
5. Support the current Chehalis Basin Strategy and the Lewis County Shoreline Master Program to enhance aquatic species and restore habitat in the floodplain.
6. Promote and maintain partnerships among all levels of government, including tribal governments, and the business community to coordinate mutually beneficial mitigation strategies.
7. Continue to improve systems that provide warning and emergency communications.
8. Enhance all facets of partnership emergency response capabilities, including flood damage mitigation of vulnerable critical facilities and infrastructure.

11.0 POLICIES

The Comprehensive Flood Hazard Management Plan policies, which are adopted by the Board of County Commissioners, provide the framework for making decisions about flood hazard management in the Chehalis River Basin within Lewis County. These policies also provide guidance for decision-making at the program and project level and define the level of discretion Lewis County has available in flood management decisions. When a policy uses the term “shall” or “will,” it is intended that such terms be interpreted as mandatory, and that the associated action or decision is nondiscretionary. The use of “should” or “may” in a policy means that the associated action or decision is provided as guidance and indicates that there is discretion in making decisions based on such policies.
The policies in this chapter are divided into four categories:

- General
- Flood Hazard Area Land Use
- Flood Risk Reduction
- Funding and Financing

The policies are intended to be consistent with any and all water resource policies in the Lewis County Comprehensive Plan (2018) and Lewis County Shoreline Master Program (2017), which directs land use and growth. These policies do not outline policy, code or program requirements for individual jurisdictions but do call on jurisdictions to enforce policies, codes, and programs they choose to adopt.

Chapter 12 of this Plan contains recommendations for flood hazard mitigation actions. These actions differ from policies in that they describe specific program and project actions that implement the Flood Plan. These actions are not mandatory. They are desirable actions that may be completed within staffing and budgetary limitations.

11.1 General Policies

The general policies listed below will provide a vision for Lewis County, and provide general guidance for all its activities.

11.1.1 Flood Hazard Management

Watersheds do not follow jurisdictional boundaries. Actions taken by a city or county in one part of a drainage watershed, whether it be a land-use plan, development permit, or capital improvement project, can affect flood hazard problems experienced by other jurisdictions in the watershed, and can impact valuable ecological resources. Actions taken by a city or county can also have positive effects on neighboring jurisdictions.

Cooperative flood hazard management between counties is supported by Chapter 86.13 RCW. Multi-jurisdictional approaches to watershed management can produce a multitude of public and private benefits, including flood risk reduction and improved ecosystem functions and values.
Flood hazard management includes a range of services at both the regional and local level to reduce the risk of flood hazards. The following policies have been identified to guide the FCZD in the management of the flood hazard within the planning area.

Policy G-1: Flood Hazard Management Actions
The FCZD should provide flood hazard management services to reduce the risk of flood hazards, including but not limited to:

a. Prepare technical studies to further identify flood hazard areas,
b. Provide technical information and assistance to other agencies, jurisdictions and individuals,
c. Construct, monitor, maintain, repair, retrofit, or remove flood protection facilities,
d. When feasible, preserve open space in flood hazard areas,
e. Monitor conditions in the river channels and take actions, such as developing mitigation projects or supporting the County, cities, or town taking emergency actions during flood events, to reduce risks,
f. Participate in flood preparedness activities
g. Collaborate with other jurisdictions to implement flood risk reduction actions, and
h. Take any other action deemed necessary to reduce flood related risks and the environmental impacts of flood hazard management on a regional scale.

Policy G-2: Inter-Governmental Coordination and Cooperation
The FCZD's flood hazard management activities should be planned and implemented in close cooperation and coordination with Lewis County, the cities and town within the Chehalis River Basin, neighboring counties, Office of the Chehalis Basin, Chehalis River Basin Flood Authority, tribes, Water Resource Inventory Area (WRIA) forums, and other agencies sharing jurisdiction in each basin. This intergovernmental coordination shall also include federal agencies, including but not limited to: the U.S. Forest Service, the U.S. Army Corps of Engineers, FEMA, the Bureau of Land Management, the National Park Service, the Bureau of Reclamation, the National Resource Conservation Service, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. This policy assumes that all federal agencies will coordinate in good faith as directed under Presidential Executive Order 11988.

Policy G-3: Intra-Governmental Coordination and Cooperation
In addition to the District itself, this Plan should be implemented by multiple Lewis County departments and the cities and town that have a role in flood hazard management including, but not limited to, public works departments, community development departments, and emergency managers.

Policy G-4: Multi-Objective Management
Lewis County's rivers and major tributaries and their associated flood hazard areas should be managed for multiple uses and objectives. Flood hazard management actions and land uses should be encouraged that support long-term flood risk reduction outcomes.

Policy G-5: Flood Hazard Management on Private Property
With the exception of flood emergency response functions, flood hazard management obligations of the FCZD shall be limited to public education and awareness outreach and grant funding where the FCZD, County, or other agency may act as an eligible applicant agent for identified feasible and cost-effective flood hazard mitigation projects. District funds shall not be used for the betterment of private property outside of these parameters.

11.1.2 Policies for Regional Consistency

This Flood Plan is a comprehensive flood control management plan as defined under RCW 86.12. Though state law suggests that such plans are binding on jurisdictions within the planning area, the FCZD acknowledges that municipalities within the county have different levels of existing development, flood hazard management resources, and staff for enforcing regulations. Complete adoption by all cities of all policies in this Flood Plan may not be appropriate and is considered optional. Local flood hazard regulations and programmatic recommendations should strive for consistency, but they may be adapted to suit each city's needs and resources.

The policies below are intended to provide guidance on how consistency as defined for this plan will be supported during the performance period of this plan.

Policy G-6: Technical and Planning Assistance
Upon request, the FCZD should assist the County, cities or town within the Chehalis River Basin in developing and adopting flood hazard management policies, regulations, and standards that are consistent with Policy G-2.

Policy G-7: NFIP Compliance and Good Standing
It should be the policy of Lewis County and all cities within the County that participate in the National Flood Insurance Program (NFIP) to maintain compliance and good standing by implementing programs that meet or exceed the minimum NFIP requirements. Such programs include but are not limited to: enforcement of an adopted flood damage prevention ordinance, limiting adverse downstream impacts from floodplain management policy, participating in floodplain mapping updates, and providing public assistance and information on floodplain requirements and impacts. The evaluation of compliance for this policy is managed by the Washington State Department of Ecology as the Washington State NFIP Coordinating Agency, and/or FEMA Region X.

Policy G-8: National Flood Insurance Program
When feasible, Lewis County and cities should strive to not only meet, but also exceed the federal minimum standards stipulated by the NFIP utilizing the CRS as a guide to better protect public safety, reduce the risk of flood hazards to existing public and private property, and achieve flood insurance premium discounts.

11.2 Flood Hazard Area Land Use Policies

Development in flood hazard areas can create two types of challenges:

- Because of its location in a hazardous area, the development may be at risk from inundation.
- The development can increase risks to neighboring properties by creating a barrier to the conveyance of floodwaters, thus causing backwater flooding upstream, and by reducing the area available to store and slowly release floodwaters, thus increasing flow velocities and erosion downstream.

This subsection contains policies to guide land-use planning and development regulations in flood hazard areas. The goal of these policies is to reduce flood risks to future developments and prevent increased risks to surrounding properties.

11.2.1 Changes to Flood Hazard Areas Based on Future Conditions

Historically, Lewis County flood hazard management regulations have been applied within the special flood hazard area as mapped by FEMA. FEMA maps are based on current or historical land use in the watershed. As watersheds develop, however, the rate and volume of runoff reaching rivers and streams can increase. In addition, changes in climate patterns can affect hydrologic conditions in flood hazard areas. The boundaries of the 100-year floodplain may change over time, creating inconsistencies between actual flood hazard conditions and those portrayed on FEMA maps. In addition, some rivers in Lewis County can migrate laterally, endangering properties along their banks. Areas that are at risk due to channel migration are sometimes outside mapped flood hazard areas, so that residents may not be aware of the risk.

Policy FLU-1: Future Conditions
The FCZD should strive to incorporate the best available data and science that utilize future condition projections for technical studies within the watersheds and basins that contribute to the flood hazards areas within Lewis County. When feasible, land use policies and flood hazard regulations should apply to flood hazard areas that utilize future conditions hydrology.

Policy FLU-2: Channel Migration Zone Hazard Areas
The FCZD could identify channel migration zone (CMZ) hazard areas through geomorphologic analyses, review of historical channel migration patterns and rates, and existing documentation. Any information gathered by the FZCD about CMZ hazard areas will be provided to participating municipalities to help them plan land-use regulations to restrict unsafe development in identified channel migration hazard areas.

11.3 Flood Risk Reduction Policies

The policies in this section guide a comprehensive program that can implement a range of flood hazard management projects, including both structural and non-structural projects. Structural projects often involve retrofitting existing facilities, including sediment management and bank stabilization facilities. Non-structural projects could include voluntary relocation, acquisition, and elevation of flood-prone homes and the removal of existing flood hazard management structures that are no longer needed.

Policy FRR-1: Selecting Flood Risk Reduction Actions
Flood risk reduction actions should be selected based on consideration of the following criteria:

a. Action effectively meets site- and reach-specific flood risk reduction objectives,
b. Action results in a benefit that exceeds the initial cost as well as the long-term maintenance costs,
c. Action does not create new unmitigated flood hazard or other problems,
d. Action recognizes riparian habitat and supports adopted Water Resource Inventory Area Plan objectives where applicable,
e. Action achieves public benefits, and
f. Action builds upon funding and partnering opportunities.

Policy FRR-2: Property Acquisition

The FCZD may acquire property interests in land necessary to meet flood hazard management objectives. Except under very limited circumstances, FZCD acquisition of structures and property should be voluntary on the part of the property owner. Condemnation should be considered only under the following circumstances:

a. Federal, state or local regulations prohibit reconstruction of the building,
b. The property in question is causing significant flood damage to other properties,
c. A property owner refuses to sell a portion of an area in which the majority of property owners have agreed to sell to the FCZD, or
d. A property owner refuses to sell an area needed to complete a proposed flood risk reduction project.

Policy FRR-3: Easements
Prior to participating in the construction of a new flood protection facility or maintaining, repairing, or reconstructing an existing flood protection facility, the FCZD should obtain all easements necessary to construct, maintain, repair, or retrofit the flood protection facility consistent with applicable Lewis County design and construction standards and federal and state engineering guidelines.

Policy FRR-4: Management of Lewis County Properties
The FCZD shall manage its public lands and easements within flood hazard areas in accordance with the policies within this Plan. Public access to flood hazard management properties will be evaluated on a case-by-case basis to determine the impact the public may have on the facility, as well as overall public safety issues.

Policy FRR-5: Flood Facility Design and Maintenance Objectives
The FCZD should construct new flood protection facilities and maintain, repair, or replace existing flood protection facilities in such a way as to:

a. Require minimal maintenance over the long term,
b. Ensure that flood hazard problems are not transferred to other sites,
c. Maintain or enhance aquatic, riparian, and other critical area habitat where feasible, and
d. Minimize impacts on flood hazard areas within areas that provide fish and wildlife habitat, recreational opportunities, and productive agricultural soils.

Policy FRR-6: Monitoring and Adaptive Management
Flood hazard management projects shall be monitored to assess their function relative to established performance measures. Adaptive management shall be used to modify the project in order to improve the effectiveness of the project and to inform the design and implementation of future projects.

11.4 Funding and Financing Policies

The recently formed FCZD requires the establishment of policies to govern when it will spend money on capital projects, maintenance of facilities, repairs, and emergency work throughout the county and the incorporated cities. The District has limited funds and cannot meet all the drainage or flood hazard reduction needs of all the communities within the county and is designed primarily to deal with public infrastructure and safety, not small local drainage issues. The policies in this section provide a framework for making decisions about how these funding sources are used for flood hazard management in Lewis County.

Policy FF-1: Management of the District
The District Administrator will exercise best professional judgment in conjunction with the direction of the Board of Supervisors to determine the appropriate courses of action for all circumstances or events within the province of the FCZD, whether or not such events or circumstances are anticipated and addressed in this document.

Policy FF-2: Regional Funding
New or expanded regional funding sources should be identified to meet the need for enhanced or expanded flood hazard management projects and programs to address flood impacts.

Policy FF-3: Grant Funding
The participating municipalities with the boundaries of the Chehalis River Basin FCZD and other local government agencies should identify, evaluate, and coordinate grant funding sources to determine their suitability and assess consistency with the goals and objectives of this Plan, and apply for grants to leverage local sources of funding for flood risk reduction projects.

12.0 MITIGATION ACTIONS

12.1 Alternatives Analysis

Prior to selecting mitigation actions, the stakeholder committee identified a comprehensive range of alternatives that Lewis County could consider to mitigate the flood issues identified by the Flood Plan. The alternatives provided a wide range of activities to ensure that all possible measures are explored, beyond the traditional approaches of flood control, acquisition, and regulation of land use. Presenting a complete range of possible alternatives diversifies the Comprehensive Flood Hazard Management Plan and positions it to be able to respond to changing conditions affecting the flood hazard. An action that might not be feasible today could become feasible in the future due to a change in programs, capabilities, or available resources. The items in this section provide options for the County to consider as it implements and maintains this Plan, to address changing conditions in mapped flood hazard areas.

The stakeholders held a meeting on June 23, 2020, to assess local strengths, weaknesses, obstacles, and opportunities related to flood hazard management. This meeting was the basis for considering and selecting mitigation actions for the flood hazard management plan. The planning team prepared a catalog of mitigation alternatives based on the findings of this meeting (CRS Step 7). The Stakeholder Committee reviewed and updated the catalog based on findings of public outreach efforts, the risk assessment results, and standard flood hazard management “best management practices.” The resulting catalog included alternatives that are categorized in three ways:

- Responsibility for implementation:
  - Public sector (citizens of Lewis County)
    - Private sector (non-governmental parties)
    - Government sector (federal, state and local)
- Flood mitigation alternatives that:
  - Manipulate the flooding hazard
  - Reduce exposure to the flooding hazard
  - Reduce vulnerability to the flooding hazard
  - Increase the ability to respond to or be prepared for the flooding hazard

The catalog provided the stakeholders a baseline of mitigation alternatives that are backed by a planning process, are consistent with the goals and objectives, and are within the capabilities of Lewis County to implement. However, not all the alternatives met all the selection criteria considered by the stakeholders. The enhanced catalog was used by the planning team to select flood hazard mitigation actions. The action catalog is provided in Appendix D.

12.2 Selected Mitigation Actions

The Planning Team and Stakeholder Committee determined that the actions from 2008 Lewis County CFHMP could be used as a starting point for developing actions for this plan. Due to the time that has passed between planning efforts, the changes that have occurred to processes and regulations, and new information available, no actions were carried forward without revisions. Several actions were not carried forward at all due to being outdated, completed, or unnecessary to list as an action.

The flood hazard mitigation catalog was also referenced to identify additional actions that should be added to the action plan to provide flood hazard mitigation benefits. Table 12-1 lists the identified actions and the following information:

- Whether the action applies to new or existing assets
- The types of flood hazards mitigated:
  - All flooding
  - Riverine flooding and erosion
  - FEMA floodplains
- The objectives met (Section 10.2)
- The lead agency responsible for implementing the action. Mitigation actions may be implemented by one or more of the agencies that participated in this planning effort. Not all mitigation actions apply to all agencies.
- The estimated cost:
  - **High** – Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).
  - **Medium** –The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
  - **Low** – The project could be funded under the existing budget. The project is part of or can be part of an ongoing, existing program.
- Potential sources of funding to implement the action.
- Timeline for implementation:
  - **Short-term**—Action to be completed in 1 to 5 years
  - **Long-term**—Action to be completed in greater than 5 years
  - **Ongoing**—Action currently being funded and implemented under existing programs.

Table 12-1. Flood Mitigation Action Plan Matrix.

Applies to New or Existing Assets	Flood Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
Action #1 – Continue participation and implementation of the flood damage reduction projects that are part of the Chehalis Basin Strategy sponsored by the Office of the Chehalis Basin. (See Section 12.6 for more details on this action)						
New and existing	All flood hazards	All	FCZD	High	OCB, Flood Authority FCZD, grants	Short-term, Ongoing
Action #2 – Develop a technical assistance program to support landowners with bank stabilization and/or post-disaster debris removal.						
New and existing	Riverine flooding and erosion	2	FCZD	Medium	County, possible grant funding	Short-term
Action #3 – Develop a Newaukum Unit Drainage Basin Plan for Dillenbaugh, Dilly, and Berwick Creeks. Develop a comprehensive drainage basin plan to identify cost effective and feasible structural and non-structural actions that will minimize future peak flow increases. The study should include the area between Armstrong Road and Jackson Highway adjacent to Logan Hill Road.						

Applies to New or Existing Assets	Flood Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
New and existing	All flooding	1, 2, 6, 8	FCZD, FCD, City of Chehalis, Port of Chehalis, and Lewis County Public Works	High	County, Cities, Districts, possible grant funding	Short- or long-term
Action # 4 – Identify sources of local funding for the FCZD to fund FCZD administration and leverage alternative funding sources.						
New and existing	All flooding	1, 2, 3, 5	FCZD	Low	County	Short-term
Action #5 – Identify alternative sources of funding to leverage FCZD funding to perform new flood studies in identified areas of need based on risk.						
New	All flooding	1, 2, 6	FCZD	Low	OCB, Flood Authority, possible grants	Short-term
Action #6 – As FCZD projects are constructed, monitor projects using identified performance measures and adaptive management to track the effectiveness of completed projects to inform the design and implementation of future projects.						
New	All flooding	1, 2	FCZD	Low	County	Long-term
Action #7 – When requested, FCZD may act as the applicant agent for mitigation grant opportunities for private property requesting to participate in the grant program.						
Existing	All flooding	1, 2, 3	FCZD	Medium	County	Ongoing
Action #8 – Maximize federal, state, and local funding opportunities through grant application submittals in support of capital improvement projects, technical studies, and other flood hazard management activities.						
Existing	All flooding	1, 2, 6	FCZD	Medium	County, Cities	Ongoing
Action #9 – Mitigate flood related risk to publicly owned County and City bridges.						
Existing	All flooding	1, 2, 4, 6, 8	Public Works	High	County, Cities, possible grant funding	Long-term, Ongoing
Action #10 – Maintain database of flood control needs within the planning area as needs become identified for incorporation into future updates and progress reporting to this plan.						
Existing	All flooding	1, 2, 4, 5, 6, 7, 8	FCZD, Public Works, Planning, Emergency Management	Low	County, Cities	Ongoing
Action #11 – Inform future mapping, grant applications, studies, and other activities by maintaining a database on known flood risk that tracks historical flood conditions to include, but not be limited to: high water marks, recorded damages, photos, observed flood conditions, etc.						
New and existing	All flooding	1, 3, 7	FCZD, Public Works, Planning, Emergency Management	Low	County, Cities	Ongoing
Action #12 – Utilizing the best available data, science, and technology, maintain and enhance, as data becomes available, the Level 2, user-defined Hazus-MH model that was constructed to support this planning effort.						
New and existing	All flooding	1, 2, 3, 8	GIS	Medium	County	Ongoing
Action #13 – Offer the Chehalis River Basin Comprehensive Flood Hazard Management Plan as information available for integration into other appropriate plans and programs that can support or enhance the participating jurisdictions efforts to reduce flood risk as these plans and programs are updated. Examples of such plans/programs would						

Applies to New or Existing Assets	Flood Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
include but are not limited to: Lewis County Hazard Mitigation Plan, Lewis County Comprehensive Plan, and Lewis County Shoreline Master Program.						
New and existing	All flooding	1, 3	FCZD, Public Works, Planning, Cities	Low	County	ongoing
Action #14 —Lewis County and the Cities of Centralia and Chehalis will continue participating in the Community Rating System (CRS) process.						
Existing	All flooding	1, 2, 3, 4, 5, 6, 7, 8	Planning, Cities	Low	County, Cities	Ongoing
Action #15 – Deploy public information and outreach program targeting at-risk properties within the planning area.						
Existing	All flooding	3	FCZD, Emergency Management, Cities	Low	County, Cities	Ongoing
Action #16 – Coordinate with FEMA Region X on deploying flood insurance workshops for agents, lenders, and citizens within the performance period for this plan.						
Existing	All flooding	6	FCZD, Planning, Emergency Management	Low	FEMA	Ongoing
Action #17 – Participate and coordinate with the Office of the Chehalis Basin, the Chehalis River Basin Flood Authority, and other pertinent Chehalis Basin organizations to ensure projects and programs are consistent with larger basin-wide objectives.						
New and existing	All flooding	1, 2, 4, 5, 6, 7, 8	FCZD	Low	County, Cities	Ongoing
Action #18 – Participate in updates to the County's Flood Insurance Rate Maps to ensure the maps accurately reflect local conditions.						
New and Existing	All FEMA floodplains	1, 3	Planning, Public Works, Cities, FCZD, Cities	Medium	County, Cities, FEMA	Short-term
Action #19 – Include CMZs, dam and levee breach inundation areas, and other critical areas as informational layers in the County's online public web map.						
New and Existing	All flooding	1, 3, 4, 6, 7, 8	GIS, Planning	Low	County	Ongoing
Action #20 – Encourage FEMA and NFIP training for County and City staff that administer floodplain regulations and FEMA grant programs.						
New and Existing	All FEMA floodplains	3	Emergency Management, Planning, FCZD, Cities	Medium	County, Cities	Ongoing
Action #21 – Provide outreach and educational materials for the public on flood hazards, risks of development in floodplains, NFIP regulations, and flood mitigation programs, including annual mailings to flood prone properties and placing flood information at local libraries.						
New and Existing	All FEMA floodplains	3	Planning, Cities	Low	County, Cities	Ongoing
Action #22 – Maintain the flood information website on the FCZD web page to provide Chehalis River Basin information and links to the flood warning system and all other related websites and information.						
New and Existing		3, 7	FCZD	Low	County	Ongoing
Action #23 – Maintain an inventory of properties located in the floodplain.						
New and Existing	All FEMA floodplains	1, 2, 6	Planning, Cities	Low	County, Cities	Ongoing

Applies to New or Existing Assets	Flood Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
Action #24 – Continue to support projects that evaluate the feasibility of regional stormwater detention facilities to address increased stormwater runoff for development in the basins that occurred prior to implementation of site-specific stormwater management measures.						
Existing	Surface water flooding	1, 2, 6	FCZD, Public Works	Medium	County, possible grant funding	Ongoing
Action #25 – Maintain a database of properties that experience repetitive flooding, to include properties identified as Repetitive Loss (RL) properties. The County will establish a procedure for updating the list annually or following a flood event as necessary. The database will be used to establish a prioritized list of properties that would benefit from mitigation or acquisition, and to provide the owners of the properties information about available funding.						
Existing	All FEMA floodplains	1, 2	Planning, Cities	Low	County, Cities	Ongoing
Action #26 – Participate in developing flood control projects with other entities such as the Chehalis River Basin Flood Authority, Office of the Chehalis Basin, USACE, and the Washington State Department of Transportation (WSDOT).						
New and Existing	All flooding	2, 4, 6, 8	FCZD, Public Works, Cities	Medium	County, OCB, Flood Authority	Ongoing
Action #27 – Perform a field examination of all flood control structures and create a database of the information, including ownership and maintenance responsibilities. Determine the maintenance responsibility of each structure.						
Existing	All flooding	1, 6	FCZD, Public Works	Medium	County, possible grant funding	Long- or short-term
Action #28 – Support projects that would mitigate or relocate utilities and critical facilities which are subject to flooding.						
Existing	All flooding	2, 4, 6, 8		Medium-High	Grants, FEMA	Long-term
Action #29 – Encourage NIMS/ICS training for County and City staff that may work within or interact with the Emergency Operations Center (EOC).						
New and Existing	All flooding	7	Emergency Management	Low	County	Ongoing
Action #30 – Develop a flood response plans, such as debris management plans, to include response and recovery roles, responsibilities, and priorities, flood early warning system procedures, pre-identified detour routes, criteria to assist emergency response personnel in determining what actions are appropriate when providing assistance to private property during the response and recovery phases, and a list of not-for-profit essential service providers that provide community support during and after a flood event.						
New and Existing	All flooding	1, 8	Emergency Management, Public Works, FCZD, Planning	Medium	County, FEMA	Short-term
Action #31 – Develop and/or review adequacy of mutual aid agreements and procure on-call service contracts to assist with demand for human resources following a disaster.						
New and Existing	All flooding	8	FCZD, Public Works, Emergency Management, Cities	Low	County, Cities	Short-term
Action #32 – Maintain a database of all known past problem areas. This database should be linked to GIS for easy visual examination. The County should update the database after each flood event to ensure that the information is captured for future mitigation grant opportunities.						
Existing	All flooding	1, 2	County Planning, Public Works, GIS, Cities	Low	County, road fund	Short-term

Applies to New or Existing Assets	Flood Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
Action #33 – Assign a staff member to become familiar with the FEMA Stafford Act Section 406 mitigation assistance program and identify potential new mitigation funding opportunities.						
New and Existing	All flooding	8	FCZD, Emergency Management, Public Works	Medium	County	Short-term
Action #34 – Coordinate with WA EMD to ensure County staff attends annual preliminary damage assessment training.						
New and Existing	All flooding	8	FCZD, Emergency Management, Public Works	Low	Emergency Management	Short-term
Action #35 – Prevent adverse impacts to the floodplain by requiring all new commercial, industrial, multi-family, and subdivisions to demonstrate no adverse impact.						
New and Existing	All FEMA floodplains	1, 2	County Planning, Cities	Medium	County, Cities	Short-term
Action #36 – Continue to maintain good standing under the National Flood Insurance Program by implementing programs that meet or exceed the minimum NFIP requirements. Such programs include enforcing an adopted flood damage prevention ordinance, participating in floodplain mapping updates, and providing public assistance and information on flood hazard requirements and impacts.						
New and Existing	All FEMA floodplains	1, 2, 3	County Planning, Cities	Low	County, Cities	Short-term
Action #37 – Develop a communication protocol plan and provide training to all County and city responders on new protocol and system upgrades as funding becomes available.						
New and Existing	All flooding	7, 8	Emergency Management	Medium	Emergency Management	Short-term
Action #38 – Map detour routes and share routes with WSDOT to assist in efficient detour planning.						
New and Existing	All flooding	8	Emergency Management, Public Works	Medium	Road fund	Short-term
Action #39 – Support updates to the flood warning system to ensure it utilizes the best available data, science, and technology.						
New and Existing	All flooding	3, 7	FCZD, Emergency Management	High	OCB, Flood Authority	Short-term
Action #40 – Utilize the best available data, science, and technology in District led projects, programs, and outreach.						
New and Existing	All flooding	1, 2, 6	FCZD, Emergency Management	High	County	Short-term

12.3 Benefit/Cost Review

The action plan is prioritized according to a benefit/cost analysis of the proposed projects and their associated costs (CRS Step 8). The benefits of proposed projects were weighed against estimated costs as part of the project prioritization process. The benefit/cost analysis was not of the detailed variety required by FEMA for project grant eligibility under the Hazard Mitigation Grant Program (HMGP) and BRIC grant program. A less formal approach was used because some projects may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time. Therefore, a review of the apparent benefits versus the apparent cost of each project was performed. Parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these projects.

Benefit ratings were defined as follows:

- **High** – Project will provide an immediate reduction of risk exposure for life and property.
- **Medium** – Project will have a long-term impact on the reduction of risk exposure for life and property, or project will provide an immediate reduction in the risk exposure for property.
- **Low** – Long-term benefits of the project are difficult to quantify in the short term.

Cost ratings were defined as follows:

- **High** – Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).
- **Medium** –The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
- **Low** – The project could be funded under the existing budget. The project is part of or can be part of an ongoing, existing program.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly.
For many of the strategies identified in this action plan, Lewis County agencies may seek financial assistance under the FEMA HMGP or Hazard Mitigation Assistance programs, both of which require detailed benefit/cost analyses. These analyses will be performed on projects at the time of application using the FEMA benefit-cost model. For projects not seeking financial assistance from grant programs that require detailed analysis, Lewis County reserves the right to define “benefits” according to parameters that meet the goals and objectives of this Plan.

12.4 Action Plan Prioritization

Table 12-2 lists the priority of each action as assigned by the Planning Team, using the same parameters used in selecting the actions.

A qualitative benefit-cost review was performed for each of these actions. The priorities are defined as follows:

- **High Priority** – A project that meets multiple objectives, has benefits that exceed cost, has funding secured or is an ongoing project and meets eligibility requirements for a grant program. High priority projects can be completed in the short term (one to five years). The key factors for high priority projects are that they have funding secured and can be completed in the short term.
- **Medium Priority** – A project that meets goals and objectives, that has benefits that exceed costs, and for which funding has not been secured but that is grant eligible. Project can be completed in the short term once funding is secured. Medium priority projects will become high priority projects once funding is secured. The key factors for medium priority projects are that they are eligible for funding, but do not yet have funding secured, and they can be completed within the short-term.
- **Low Priority** – A project that will mitigate the risk of a hazard, that has benefits that do not exceed the costs or are difficult to quantify, for which funding has not been secured, that is not eligible for FEMA grant funding, and for which the timeline for completion is long term (one to 10 years). Low priority projects may be eligible for grant funding from other programs. Low

priority projects are “blue-sky” projects. How they will be financed is unknown, and they can be completed over the long-term.

Table 12-2. Prioritization of Mitigation Actions.

Action	Number of objectives met	Benefits	Costs	Do benefits equal or exceed costs?	Is project grant eligible?	Can project be funded using existing programs/ budgets?	Priority (high, med., low)
#1	All	Medium	High	Yes	No	Yes	High
#2	4	Medium	Low	Yes	Yes	No	High
#3	4	Medium	High	Yes	Yes	No	Medium
#4	4	High	Low	Yes	No	Yes	High
#5	3	High	Low	Yes	Yes	No	Low
#6	2	Medium	Low	Yes	No	Yes	Medium
#7	3	High	Low	Yes	No	Yes	Medium
#8	3	High	Medium	No	Yes	No	Low
#9	5	High	High	No	Yes	No	Low
#10	7	High	Low	Yes	No	Yes	High
#11	3	High	Low	Yes	No	Yes	High
#12	4	High	Low	Yes	No	Yes	High
#13	2	High	Low	Yes	No	Yes	High
#14	8	High	Low	Yes	No	Yes	High
#15	1	High	Low	Yes	Yes	Yes	High
#16	1	High	Low	Yes	No	Yes	High
#17	7	High	Low	Yes	No	Yes	High
#18	2	High	Medium	Yes	No	No	Medium
#19	6	High	Low	Yes	No	No	Medium
#20	1	Medium	Medium	Yes	No	Yes	High
#21	1	High	Low	Yes	No	Yes	High
#22	2	High	Low	Yes	Yes	Yes	High
#23	3	Medium	Low	Yes	No	Yes	High
#24	3	Medium	Medium	No	Yes	Yes	High
#25	2	High	Low	Yes	No	Yes	High
#26	4	High	Medium	N/A	Yes	No	Low
#27	2	High	Medium	Yes	No	No	Medium
#28	4	High	High	N/A	Yes	No	Low
#29	7	High	Low	Yes	No	Yes	High
#30	2	High	Medium	Yes	Yes	No	Medium
#31	1	Medium	Low	Yes	No	No	Medium
#32	2	Medium	Low	Yes	No	Yes	High
#33	1	High	Low	Yes	No	Yes	Medium
#34	1	High	Low	Yes	No	No	Medium
#35	2	High	Medium	Yes	No	Yes	High
#36	3	High	Low	Yes	No	No	Medium
#37	2	High	Medium	Yes	No	Yes	Medium
#38	8	High	Medium	Yes	No	Yes	High
#39	2	High	High	Yes	Yes	No	High

#40	3	High	High	Yes	Yes	No	Low

12.5 Analysis of Mitigation Actions

Each identified action was classified based on the type of mitigation it involves. Mitigation types used for this categorization are as follows:

- **Prevention** – Government, administrative or regulatory actions that influence the way land and buildings are developed to reduce hazard losses. Includes planning and zoning, flood hazard management laws, capital improvement programs, open space preservation, and stormwater management regulations.
- **Property Protection** – Modification of public buildings, roads, or structures to protect them from a hazard or removal of structures from a hazard area. Includes acquisition, elevation, relocation, structural retrofit, storm shutters, and shatter-resistant glass.
- **Public Education and Awareness** – Actions to inform citizens and elected officials about flood hazards and ways to mitigate them. Includes outreach projects, real estate disclosure, hazard information centers, and school-age and adult education.
- **Natural Resource Protection** – Actions that minimize hazard loss and preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.
- **Emergency Services** – Actions that protect people and property during and immediately after a hazard event. Includes warning systems, emergency response services, and the protection of essential facilities.
- **Structural Projects** – Actions that involve the construction of structures to reduce the impact of a hazard. Includes dams, setback levees, floodwalls, retaining walls, and safe rooms.

Table 12-3 presents the results of this analysis.

Table 12-3. Mitigation Actions Analysis.

Mitigation Type	Applicable Mitigation Actions
1. Prevention	1, 3, 4, 5, 8, 9, 10, 11, 12, 14, 17, 18, 19, 20, 23, 24, 25, 27, 28, 30, 31, 32, 33, 36, 39, 40
2. Property Protection	1, 2, 4, 7, 35, 40
3. Public Education and Awareness	1, 4, 13, 15, 16, 19, 21, 22, 39, 40
4. Natural Resource Protection	1, 2, 4, 35, 40
5. Emergency Services	1, 4, 22, 28, 29, 30, 31, 32, 34, 37, 38, 39
6. Structural Projects	1, 3, 4, 6, 24, 26, 27, 40

12.6 Action #1 - Chehalis Basin Strategy

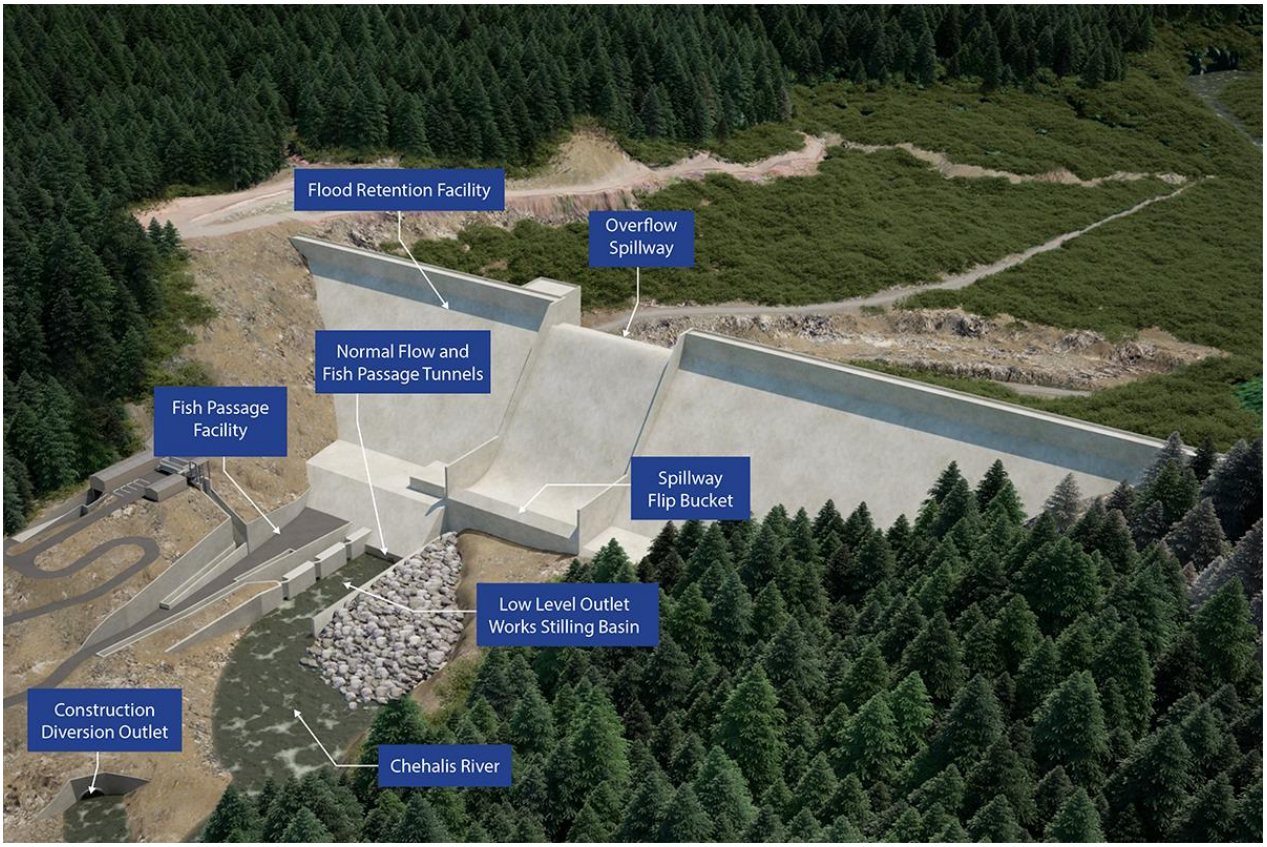
The goal of the Chehalis Basin Strategy is to reduce flooding and improve aquatic habitat throughout the Chehalis Basin, from the headwaters above Pe Ell, to the mouth of the Chehalis River in Gray's Harbor. For more background on the history of the Chehalis Basin Strategy, see Section 4.1.

The first major proposed action of the Chehalis Basin Strategy is the Chehalis River Basin Flood Damage Reduction Project. This project includes two major actions within Lewis County that will reduce flood damage within Lewis County and downstream: a flood retention facility near Pe Ell and improvements to the Chehalis-Centralia Airport Levee. At the time of this plan's adoption, the projects are under SEPA and NEPA EIS review. The FCZD is the project owner and applicant. These projects are included under Action #1 - Continue participation and implementation of the flood damage reduction projects that are part of the Chehalis Basin Strategy sponsored by the Office of the Chehalis Basin.

12.6.1 Flood Retention Facility

The FCZD proposes to construct a flood retention facility and associated temporary reservoir near Pe Ell to reduce damages during a major flood. It will not protect communities from all flooding, nor is it designed to stop regular annual flooding from the Chehalis River. The facility would only store floodwater during major floods and then slowly release retained floodwater when it is safe to do so and over a period of time. A major flood is defined as 38,800 CFS, or a flood with a 15% probability of occurring in most years (7-year recurrence interval). Most of the time, the Chehalis River would flow through the structure's low-level outlet works at its normal rate of flow and volume—and allow fish to pass both upstream and downstream. During a flood event similar to 2007 and 1996, a 6.2 mile long reservoir would form behind the facility holding 65,000 acre feet of flood water. The facility would be 1,220 feet wide and 254 feet tall. Figure 12-2 illustrates the proposed facility.

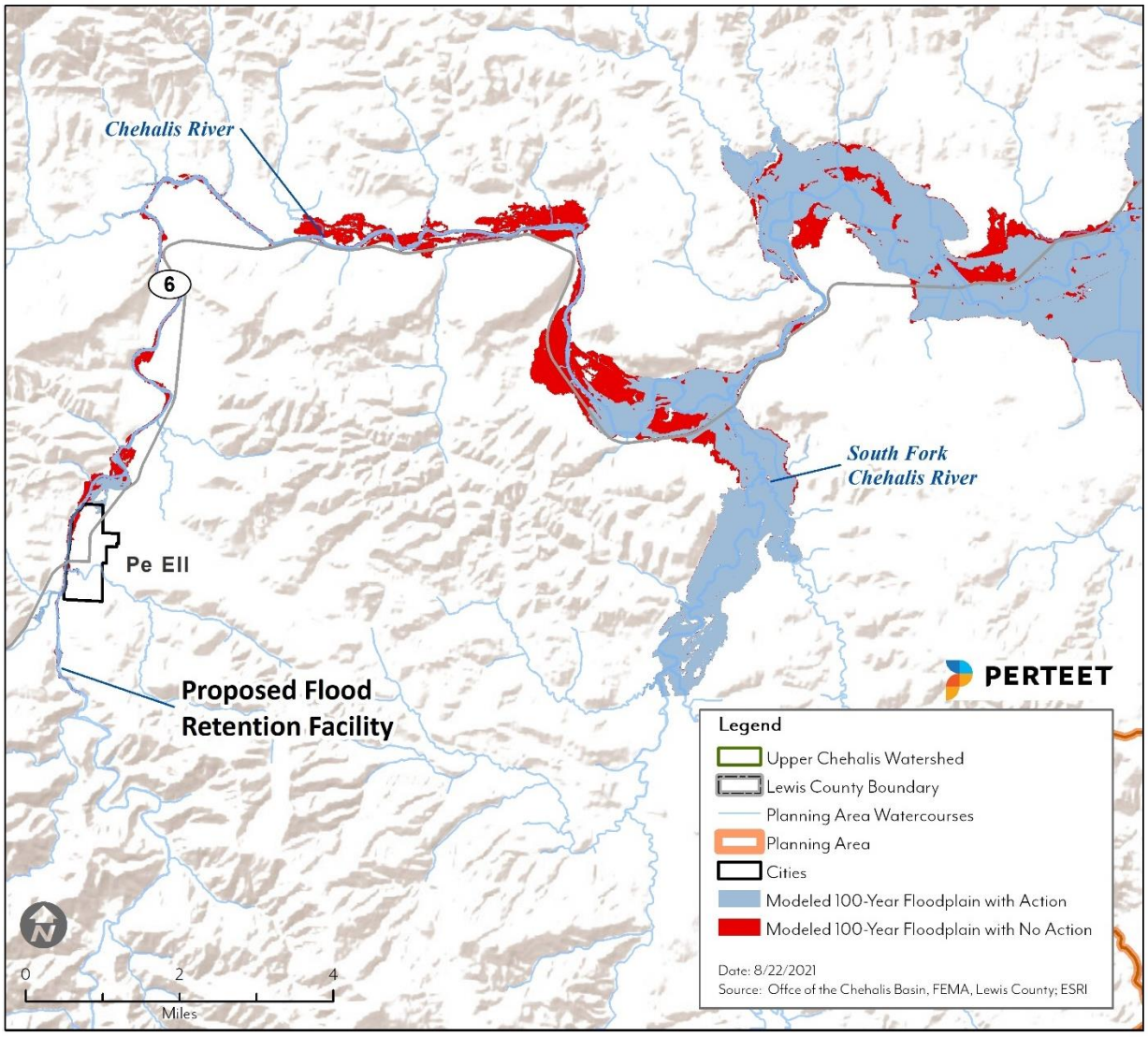
Figure 12-1. Flood Retention Facility Project.



Source: OCB

Figure 12-2 illustrates the reduction in flooding during a 100-year flood in the Pe Ell area as a result of the flood retention facility. The red areas show the modeled 100-year floodplain if there is no action taken. The blue areas are the modeled 100-year floodplain after the facility is constructed, demonstrating a significant reduction in flooding.

Figure 12-2. Flooding reduction as a result of Flood Retention Facility.



12.6.2 Airport Levee

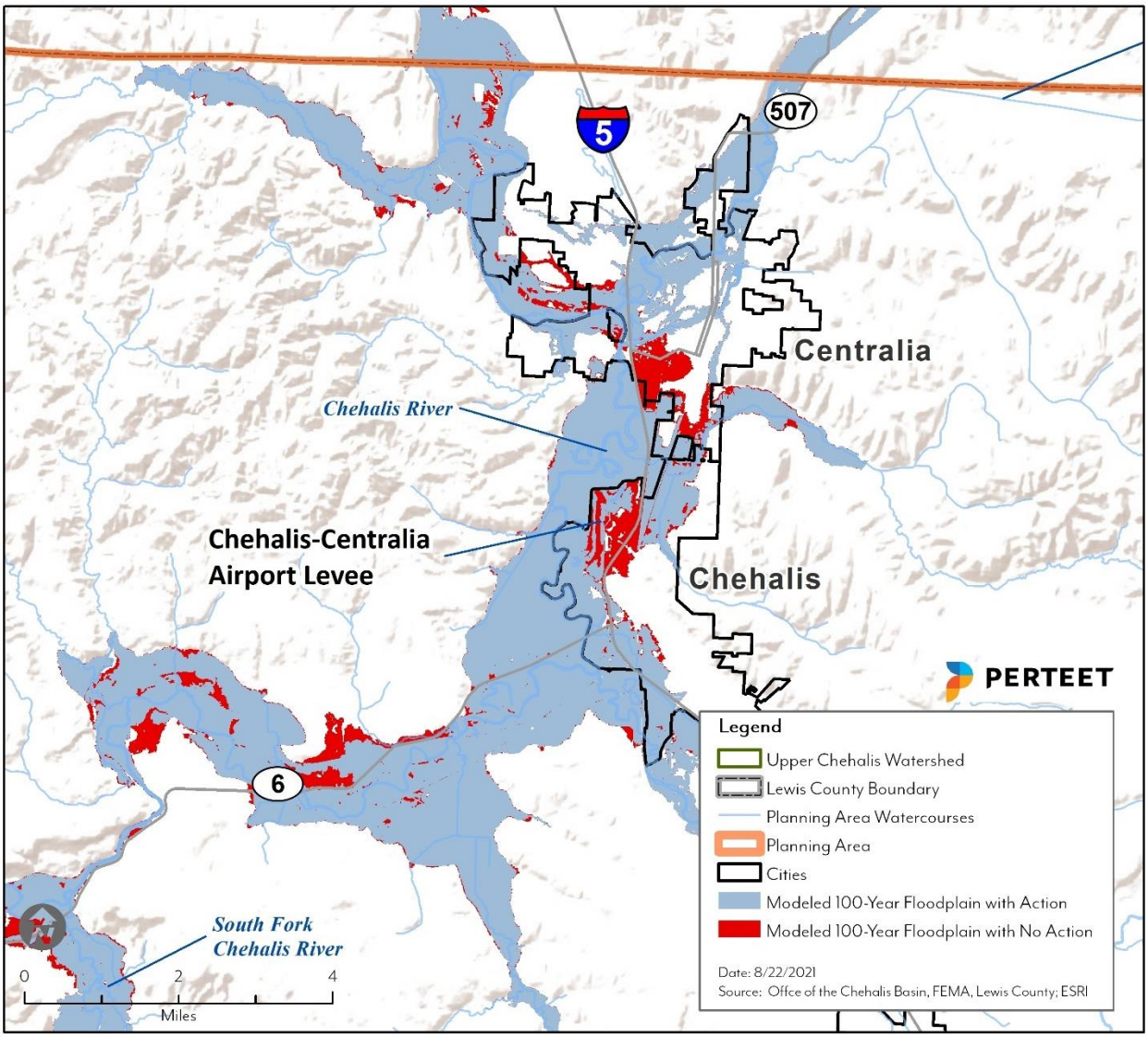
The FCZD proposes to construct levee improvements at the Chehalis-Centralia Airport. The levee improvements will protect the airport, local businesses, and area transportation from a 100-year flood. The existing levee height will be raised four- to seven-feet and a portion of Airport Road would be raised to meet the same height of the improved levee. Figure 12-3 shows the location of the levee improvements.

Figure 12-3. Airport Levee Project.

Source: OCB

Figure 12-4 illustrates the reduction in flooding during a 100-year flood in the Centralia and Chehalis area as a result of the flood retention facility and airport levee. The red areas show the modeled 100-year floodplain if there is no action taken. The blue areas are the modeled 100-year floodplain after the facility is constructed and the levee is improved, demonstrating a significant reduction in flooding.

Figure 12-4. Flooding reduction as a result of Flood Retention Facility and Airport Levee.



12.6.3 Economic Benefit of Flood Reduction Projects

The planning team was provided depth grids for the flood models that included the flood reduction projects and used the models to run Hazus analyses. The results of the Hazus analyses indicate a major reduction in damage after the projects are constructed. Table 12-4 describes the economic impacts as determined by the Hazus analyses. These estimates do not include damage to infrastructure like road, water, or sewer systems, or economic impact due to business or Interstate 5 closures.

The results indicate that during the modeled 100-year flood event, which is similar to both the 1996 and 2007 floods, the projects will reduce damages to structures and content by about $241 million, or 71 percent. In addition, after the project is constructed there will be about 6,600 less tons of debris to clean up and about 1,700 fewer people displaced.

During the 100-year climate change flood event, the project will reduce damage to structures and content by about $330 million, or almost 50 percent. In addition, after the project is constructed there will be 11,100 less tons of debris to clean up and about 1,800 fewer people displaced.

Damage reductions during the 10-year event are still significant with a 24 percent reduction in damages to structures and content, but lower than the 100-year event. This is due to the design of the facility, which will begin retaining flood waters during the 7-year flow, so a much smaller percentage of floodwaters will be retained in the 10-year even compared to a larger flood event.

Table 12-4. Economic Impacts of Flood Reduction Project.

100-Year Modeled Flood				
	Without Flood Reduction Project		With Flood Reduction Project	
	Impacted Structures	Structure and Content Value	Impacted Structures	Structure and Content Value
Centralia	1,573	$110,362,968	998	$42,271,698
Chehalis	300	$158,251,600	151	$23,425,813
Napavine	1	$53,096	1	$53,096
Pe Ell	7	$298,661	2	$37,283
Unincorporated County	629	$67,344,440	375	$29,510,092
Total	**2,510**	**$336,310,766**	**1,527**	**$95,297,983**

100-Year Climate Change Flood				
	Without Flood Reduction Project		With Flood Reduction Project	
	Impacted Structures	Structure and Content Value	Impacted Structures	Structure and Content Value
Centralia	2,501	$293,747,580	1,987	$128,905,547
Chehalis	390	$253,094,012	303	$140,450,699
Napavine	5	$831,338	5	$831,338
Pe Ell	9	$554,042	2	$66,612
Unincorporated County	985	$120,728,936	637	$68,568,219
Total	**3,900**	**$668,955,909**	**2,934**	**$338,822,416**

10-Year Modeled Flood				
	Without Flood Reduction Project		With Flood Reduction Project	
	Impacted Structures	Structure and Content Value	Impacted Structures	Structure and Content Value
Centralia	225	$9,840,106	220	$9,162,842
Chehalis	61	$8,073,920	28	$5,562,993
Napavine	0	$0	0	$0
Pe Ell	2	$44,114	2	$20,969
Unincorporated County	189	$15,132,033	141	$10,634,086
Total	**477**	**$33,090,174**	**391**	**$25,380,890**

[1] Impacted structures are those structures with finished floor elevations below the Hazus-estimated 100-year or 10-year water surface elevation for each flood event. These structures are the most likely to receive damage in a flood event.
Notes: Values in this table are only for purposes of comparison among results. See Section 5 for a discussion of data limitations. Sources of data used in Hazus modeling are described in Section 5.

PART 4 – PLAN MAINTENANCE

13.0 ADOPTION

This chapter documents formal adoption of the Chehalis River Basin Comprehensive Flood Hazard Management Plan by the Chehalis River Basin Flood Control Zone District Board of Supervisors and Lewis County's governing body (CRS Step 9). A copy of the resolutions are provided on the following pages.

Figure 13.1. FCZD Adoption Resolution.

Figure 13.2. Lewis County Commissioners Adoption Resolution.

Figure 13.3. Chehalis City Council Adoption Resolution.

14.0 PLAN MAINTENANCE STRATEGY

This chapter presents a plan maintenance process that includes the following (CRS Step 10):

- A section describing the method and schedule of monitoring, evaluating, and updating the flood hazard management plan over a five-year cycle.
- A process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate.
- A discussion on how the community will continue public participation in the Flood Plan maintenance process.

The plan maintenance strategy is the formal process that will ensure that the Comprehensive Flood Hazard Management Plan remains an active and relevant document. It includes a schedule for monitoring and evaluating the Flood Plan annually and producing an updated plan every five years. The strategy also describes how public participation will be integrated throughout the plan maintenance and implementation process. It explains how the mitigation strategy outlined in this plan will be incorporated into existing planning mechanisms and programs, such as comprehensive land-use planning processes, capital improvement planning, and building code enforcement and implementation. The Flood Plan's format allows sections to be reviewed and updated when new data become available, resulting in a plan that will remain current and relevant.

14.1 Plan Implementation

The effectiveness of the Comprehensive Flood Hazard Management Plan depends on its implementation and incorporation of its action items into existing local plans, policies, and programs. Together, the action items in the Flood Plan provide a framework for activities that Lewis County can implement over the next five years. The planning team and the Stakeholder Committee have established goals and objectives and have prioritized mitigation actions that will be implemented through existing plans, policies, and programs.

Lewis County's Chehalis River Basin Flood Control Zone District in cooperation with the County and other communities will have lead responsibility for overseeing the Flood Plan implementation and maintenance strategy. Plan implementation and evaluation will be a shared responsibility among all agencies identified as lead agencies in the mitigation action plan.

14.2 Stakeholder Committee

The Stakeholder Committee oversaw the development of the Flood Plan and made recommendations on key elements of the plan, including the maintenance strategy. It was the Stakeholder Committee's position that an oversight committee should have an active role in the plan maintenance strategy. Therefore, it is recommended that the Stakeholder Committee remain a viable body involved in key elements of the plan maintenance strategy.

The principal role of the Stakeholder Committee in this plan maintenance strategy will be to meet annually to review the annual progress report and to provide input to Lewis County's Flood Control Zone District on possible enhancements to be considered at the next update. Future updates will have

participation by a Stakeholder Committee similar to the one that participated in this plan development process, so keeping the stakeholder committee intact will provide a head start on future updates. It will be the Stakeholder Committee's role to review the progress report to identify issues needing to be addressed by future plan updates.

14.3 Annual Progress Report

The minimum task of the ongoing annual Stakeholder Committee meeting will be the evaluation of the progress of its individual action plan during a 12-month performance period. This review will include the following:

- Summary of any flood hazard events that occurred during the performance period and the impact these events had on the planning area.
- Review of mitigation success stories.
- Review of continuing public involvement.
- Brief discussion about why targeted strategies were not completed.
- Re-evaluation of the action plan to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term one because of new funding).
- Recommendations for new projects.
- Changes in or potential for new funding options (grant opportunities).
- Impact of any other planning programs that involve hazard mitigation.

The planning team has created a template for preparing a progress report (see Appendix C). The Stakeholder Committee and identified lead agencies will provide feedback to the planning team on items included in the template. The planning team will then prepare a formal annual report on the progress of the plan. This report should be used as follows:

- Posted on the Flood Control Zone District program website page dedicated to the Comprehensive Flood Hazard Management Plan.
- Provided to the local media through a press release.
- Annual flood meeting.
- Presented to the Lewis County Commissioners and City Council to inform them of the progress of mitigation actions implemented during the reporting period.
- Provided as part of the CRS annual re-certification package. The CRS requires an annual recertification to be submitted by October 15 of every calendar year for which the community has not received a formal audit. To meet this recertification timeline, the planning team will strive to complete progress reports between June and September each year.

Annual progress reporting is credited under CRS Step 10.

14.4 Plan Update

Lewis County intends to update the Comprehensive Flood Hazard Management Plan on a five-year cycle from the date of initial plan adoption (CRS Step 10). This cycle may be accelerated to less than five-years based on the following triggers:

- A Presidential Disaster Declaration that impacts the planning area.

- A flood hazard event that causes loss of life.
- An update of Lewis County comprehensive plan.

It will not be the intent of future updates to develop a completely new Comprehensive Flood Hazard Management Plan for the planning area. The update will, at a minimum, include the following elements:

- The update process will be convened through a Stakeholder Committee.
- The hazard risk assessment will be reviewed and, if necessary, updated using best available information and technologies.
- The action plan will be reviewed and revised to account for any actions completed, dropped, or changed and to account for changes in the risk assessment or new policies identified under other planning mechanisms (such as the comprehensive plan).
- The draft update will be sent to appropriate agencies and organizations for comment.
- The public will be given an opportunity to comment on the update prior to adoption.
- The Lewis County Board of County Commissioners will adopt the updated plan.

It is Lewis County's intention to fully integrate this Comprehensive Flood Hazard Management Plan into the Natural Hazards Mitigation Plan for Lewis County at some time. This will allow for a uniform update cycle for both plans and eliminate redundant planning.

14.5 Continuing Public Involvement

The public will continue to be apprised of the plan's progress through the Flood Control Zone District website and by providing copies of annual progress reports to the media. The website will not only house the final plan, it will become the one-stop shop for information regarding the Flood Plan and plan implementation. Upon initiation of future update processes, a new public involvement strategy will be initiated based on guidance from the Stakeholder Committee. This strategy will be based on the needs and capabilities of Lewis County at the time of the update. At a minimum, this strategy will include the use of local media outlets within the planning area.

14.6 Incorporation into Other Planning Mechanisms

The information on hazard, risk, vulnerability, and mitigation contained in this plan is based on the best science and technology available at the time this plan was prepared. The Lewis County Comprehensive Plan is an integral part of this plan. Lewis County, through adoption of a comprehensive plan and zoning ordinance, has planned for the impact of flooding. The Flood Plan development process provided the opportunity to review and expand on policies in these planning mechanisms. Lewis County's Comprehensive Plan and the Chehalis River Basin Comprehensive Flood Hazard Management Plan are complementary documents that work together to achieve the goal of reducing flood-risk exposure. An update to the county's comprehensive plan may trigger an update to the Comprehensive Flood Hazard Management Plan.

Lewis County has identified a priority action to link the Comprehensive Flood Hazard Management Plan and Lewis County Comprehensive Plan and City plans. Other planning processes and programs to be coordinated with the recommendations of the Comprehensive Flood Hazard Management Plan include the following:

- Lewis County Multi-jurisdictional Hazard Mitigation Plan
- Emergency response plans
- Capital improvement programs
- Municipal codes
- Community design guidelines
- Stormwater management programs
- Water system vulnerability assessments.

Some action items do not need to be implemented through regulation. Instead, these items can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation. As information becomes available from other planning mechanisms that can enhance this plan, that information will be incorporated via the update process.

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