# DRAFT

## Wahkiakum County Comprehensive Flood Hazard Mitigation Plan

## 2023

# TABLE OF CONTENTS

Introduction ..... 3
Goals and Objectives ..... 7
Inventory and Characterization ..... 8
Habitat ..... 21
Flooding Issues ..... 27
Past And Present Flood Hazard Management Practices And Facilities, Programs And Regulations ..... 32
State and Federal Flood Hazard Mitigation Guidance ..... 36
Recommendations ..... 43

# INTRODUCTION

## INTRODUCTION TO COMPREHENSIVE FLOOD HAZARD MANAGEMENT PLANNING

Comprehensive flood hazard management emphasizes non-structural flood hazard reduction methods and ecological restoration to reduce flood risks while achieving multiple community goals. Non-structural flood hazard reduction methods accommodate nature's flooding to reduce flood damages. Examples include property transactions, structure or infrastructure relocation and elevation, floodproofing, land use and zoning practices, flood risk studies and mapping, plans, and flood warning systems. Comprehensive flood hazard management is based on the following fourteen principles.

**Principle 1: Focus on Non-Structural Alternatives and Ecological Restoration**
Using non-structural flood risk reduction methods. ecological restoration, and in some cases traditional structural flood controls should result in more flood risk reduction and less impact to natural resources than relying on traditional structural flood control alone.

**Principle 2: Respect for Rivers' Natural Processes**
Comprehensive flood hazard management works with a river's natural processes to achieve better, more cost effective, and environmentally beneficial results. Structural flood protection is appropriate in some cases, and in others allowing the river to change its course with some limitations is more effective. Comprehensive flood hazard management minimizes impacts on natural processes in order to avoid unintended consequences in other parts of the river system.

**Principle 3: Focus on the Cause of Flood Damage**
Comprehensive flood hazard management attempts to alleviate the results of flooding, but also attempts to reduce flood risk by affecting the conditions that cause flooding in the first place.

**Principle 4: Integrated Floodplain Management**
Integrated Floodplain Management (IFM) is a collaborative approach to reduce flood damages, increase salmon runs, and preserve farms and open spaces. It brings together stakeholders to create local visions, strategies, and actions that deliver multiple benefits.

**Principle 5: Consideration of the Entire Watershed, Not Just Local Conditions**
Tides and streams and the complex natural systems that they are a part of cross jurisdictional boundaries. Comprehensive Flood Hazard Management considers the interrelated causes and effects of flooding throughout watersheds.

**Principle 6: Public Participation and Diversity, Equity, and Inclusion**
Flooding disproportionately affects vulnerable populations. For example, people with less income are more likely to live in floodplains and are less likely to have the resources needed to recover from flooding. Participation processes for Comprehensive Flood Hazard Management Plans proactively include vulnerable populations.

**Principle 7: Coordination among Public Works, Planning, and Building Departments and Other Department Activities**
Comprehensive Flood Hazard Management uses the expertise and input of multiple departments within county government that can affect flood risk and related community goals.

**Principle 8: Interagency and Stakeholder Coordination**
Outside of the county government, many agencies have expertise and resources that can help manage flood risk, and interests that can be impacted or benefit from flood risk mitigation projects or programs, so Comprehensive Flood Hazard Management includes these agencies in the planning process.

**Principle 9: Planning Process-oriented Examination of Issues**
Comprehensive Flood Hazard Management planning processes examine the causes of flooding and evaluate alternative solutions to achieve objectives and goals.

**Principle 10: Consideration of Future Conditions**
Floodplains change and are influenced by various factors. Future flood hazards depend on factors like climate change and development. Climate change will increase river flood risk and sediment transport, while development will lead to more flood damage. Ignoring future conditions in a flood plan leads to higher costs and flood hazard.

**Principle 11: Consideration of Tribal Rights**
Floodplain management impacts tribal rights, specifically salmon productivity and harvests. Floodplains are vital for salmon recovery and healthy habitat. Current regulatory frameworks inadequately protect tribal treaty resources, including salmon. Flood control infrastructure harms salmon populations. Better floodplain management is necessary to safeguard tribal resources. See Chapter 6 for more on tribal rights.

**Principle 12: Consideration of Environmental Justice**
For fair flood hazard management, environmental justice must be considered. Flooding has enduring impacts on communities, as seen post-Hurricane Harvey. Low-income and minority groups face greater post-flood difficulties. Including local communities and recognizing diversity can improve public engagement and accountability and help lift communities out of environmental justice vulnerabilities.

**Principle 13: Integration with Other Flood Hazard Management Programs and Grants**
Jurisdictions face a complex web of mitigation programs (e.g. NFIP, FEMA grants, Ecology's Floodplains by Design), so effective flood planning should fulfill multiple goals and funding requirements.

**Principle 14: Incorporation of Comprehensive Planning Solutions**
Flood management planning includes various tools to meet environmental, public, and private objectives such as land use planning, zoning, infrastructure development, acquisition of flood-sensitive areas, forestry management, and stormwater management planning. It also fulfills requirements for land use planning, critical area protection, and participation in the NFIP. Additionally, it supports lands acquisition, recreational planning, and stormwater management.

# AUTHORITY, PURPOSE, & SCOPE

This plan was prepared under the authority of Revised Code of Washington (RCW) Chapter 86.26 and Washington Administrative Code (WAC) Chapter 173-145, and it is an update to the 2005 Wahkiakum County Comprehensive Flood Hazard Management Plan.

The 2005 plan was created in response to increased frequency of floods and associated flood hazard risk in Wahkiakum County. The plan identified goals, objectives, and action items. It used a watershed approach, considering interrelated issues throughout the county's watersheds, The plan locally introduced concepts of non-structural flood control and erosion control methods, and multi-benefit projects to reduce flood risk while improving ecological functions.

The intended uses of the plan are to guide County investments, partnerships, or regulations related to flood risk reduction, and document flood risk reduction needs and priorities for project funders, such as state agencies.

The geographic scope of the plan is all of Wahkiakum County, including the sole incorporated community, the Town of Cathlamet[1]. The plan is intended to guide the County's flood risk reduction efforts for approximately ten years.

Flood hazards considered in this plan primarily include flooding resulting from rivers overtopping their banks, and riverbank erosion and channel migration.

# PLANNING PROCESS AND METHODOLOGY

This plan update included a review of flood risk data and other local conditions, a review of literature on best practices in comprehensive flood risk management, and new public and stakeholder input. The plan was updated to reflect the new information from this process.

The planning process occurred in 2022 and 2023. The process was led by the Wahkiakum County Building and Planning Department, and their consultant the Columbia River Estuary Study Taskforce.

[1] Wahkiakum County includes unincorporated communities such as Altoona, Dahlia, Deep River, Eagle Cliff, Eden, Family Camp, Grays River, Nassa, Oneida, Puget Island, Rosburg, Skarnokawa, and Waterford.

# Public and Stakeholder Involvement

Public and stakeholder input was obtained using the following tools and methods:

**Stakeholder Advisory Committee**

A diverse sample of stakeholders were invited to participate on the stakeholder advisory committee. Invited stakeholders included local residents, local government representatives, diking district representatives, port district representatives, conservation district representatives, a conservation land trust, subject matter experts, and an Indian nation representative. The committee was invited to convene for a kickoff meeting to provide guidance to the plan outline, goal formation, public involvement methods. Invited stakeholders were also encouraged to complete interviews with staff and consultants to understand their perspectives in more depth than the advisory committee meetings would allow for. The Stakeholder advisory committee will be invited to convene and provide feedback on this initial draft plan as well.

**Public Meetings**

In an initial public meeting was hosted in two county locations and online. The first public meetings offered information to the public on the scope of the planning effort and opportunities to provide input and aimed to obtain initial public input to inform plan goals and priority issues. The purpose of a second round of public meetings will be to share draft plan goals and objectives and obtain public feedback to inform draft plan revisions.

**Online Questionnaire**

An online questionnaire advertised to the public invited input on the same questions and issues posed at the initial public meetings. An online questionnaire will be used to obtain additional feedback on the draft plan to inform revisions.

**Planning Commission**

Before completing the planning process, the Planning Commission will be invited to review the plan, request improvements, and recommend its adoption by the County. This will take place through a public hearing process.

# GOALS AND OBJECTIVES

Identifying goals started by considering whether the goals from the prior plan still served the County's interests. The discussions resulted in one change to the goals. The change acknowledges that while managing flood hazards in a manner that is sensitive to or even beneficial to fish and wildlife habitat and ecological functions is valuable, there is an even broader range of potential values that can be complemented or supported by multi-benefit flood hazard management projects.

## GOALS

1. Reduce the Amount of Flood Hazard Risk to Public Infrastructure, Citizens and their Property.
2. Support opportunities for multi-benefit flood hazard mitigation projects.
3. Increase the Level of Coordination and Dialogue among Community Members and Interests of the State that Promotes Effective Floodplain Management Strategies.
4. Enhance Public Awareness about Activities that Increase Flood Risk to Existing and Future Development.
5. Protect and Enhance Productive Lands and the Rural Character of Wahkiakum County

## OBJECTIVES

1. Improve information for flood hazard management decisions. Flood insurance rate maps should be updated, other flood risk map products and flood risk studies should be created, channel migration zones should be identified and studied in more detail, and existing flood control infrastructure should be inventoried.

2. Update foundational plans and ordinances to reflect current conditions. The Shoreline Master Program and Floodplain Development Ordinance should be updated to reflect current conditions and state/federal requirements.

3. Maintain existing flood hazard management infrastructure and programs. Existing flood control infrastructure and culverts should be maintained until an informed decision is made to replace or relocate them. Diking districts should be supported with additional resources so that they can implement multi-benefit projects that are responsive to local values. Expand beneficial use of dredge material projects to protect Puget Island communities.

4. Make new flood hazard management investments to address the root causes of flood hazard risk. Pending the results of studies underway and initial projects by regional conservation partners, invest in upper watershed conservation projects that would reduce sediment supply and peak flows downstream.

# INVENTORY AND CHARACTERIZATION

## POPULATION AND DEVELOPMENT TRENDS

The number and distribution of residents, visitors, and structures is a determinant of flood risks to people and property.

Wahkiakum County is rural with an area of 287 square miles, approximately 4500 residents in 2020. The 2020 population grew from approximately 4000 residents in 2010. Ten to fifteen percent of the population lives in the Town of Cathlamet, and the majority of the remainder of the population is located in lower elevations of the County. The population has grown in the last several years, despite State of Washington in 2017 projecting a declining population. The most recent projections suggest that the County could reach a population of 5,000 by 2050.[2]

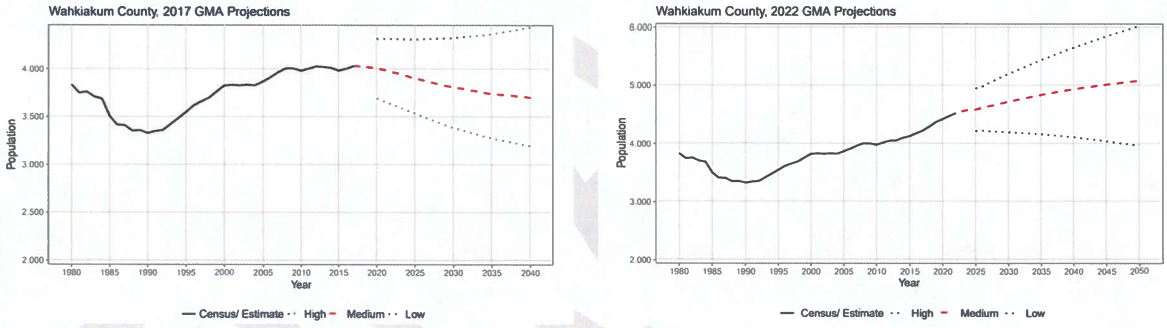


**FIGURE 1: WAHKIAKUM COUNTY POPULATION CHANGE ESTIMATE TO 2017, AND FORECAST FROM 2017 TO 2040**

Around 7% of the population primarily speaks a language other than English while at home. Over thirty percent of the County's population is over the age of 65, and nearly 20% of households do not have a broadband internet connection. About 12% of the population is in poverty, and the County's per capita income is about $30,000. Around 17% percent of the population under 65 has a disability[3]. Unique challenges in either understanding flood risks or preparing for and recovering from flooding events are associated with each of these populations[4]. For example, these figures imply that there are over 300 county residents who might have difficulty understanding flood risk warnings or post disaster recovery

[2] State of Washington Office of Financial Management. 2023. Growth Management Act population projections for counties: 2020 to 2050.
[3] U.S. Census Bureau. Quickfacts. https://www.census.gov/quickfacts/wahkiakumcountywashington
[4] US Census geographies in Wahkiakum County are too large to make valid estimates of the number of people residing in flood hazard areas who have any of the specific characteristics discussed above.

communications due to a language barrier, that around 900 residents lacking internet access to similar information.

Actively managed forests are the County's predominant land use. Agriculture is the second most predominant land use. Within this context, other land use types include the small-town urban land use patterns of the Town of Cathlamet, rural residential development interspersed amongst agriculture, water dependent and water related uses such as marinas adjacent to the Columbia River, and small groups of commercial/civic/industrial uses. The County's Comprehensive Plan[5] and Shoreline Master Program support the continuation of these overall development patterns, with marginal increases in residential densities in each of the contexts where residences are already found.

# CLIMATE

Climate is a determinant of flooding conditions. Climate in Wahkiakum County has been characterized as being a "mid latitude Marine West Coast Climate." Wahkiakum County's highest daily and monthly rainfall occurs between October and April, especially in November through January (National Weather Service, 2021). Heavy rainfall and extreme wind occur in large winter storm events called "atmospheric rivers", that cause flooding, landslides, and down trees. These storms sometimes melt snow at higher elevations, producing additional stormwater runoff. Within these wetter months precipitation has been known to exceed four (4") inches in some 24-hour periods (VTN, 1974).

## Climate Forecasts

Projections [6] [7] [8]suggest that extreme precipitation events will produce somewhat more precipitation in the future. For example, averages of available projections suggest that rain events with return intervals between 2 and 100 years will produce 6% to 9% more precipitation by the 2040's, with substantial variation among the projections that were averaged.

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[5] Wahkiakum County Comprehensive Plan.
https://co.wahkiakum.wa.us/DocumentCenter/View/295/Comprehensive-Plan-PDF

[6] University of Washington Climate Impacts Group. 2023. Heavy Precipitation Projections for use in Stormwater Planning. https://data.cig.uw.edu/picea/stormwater/pub/viz/

[7] Morgan, H., Mauger, G., Won, J., Gould, D. 2021 Projected Changes in Extreme Precipitation Web Tool. University of Washington Climate Impacts Group. https:/doi.org/10.6069/79CV-4233

[8] The projections assume a high greenhouse gas emissions scenario (RCP 8.5). Projections were not available for lower scenarios.


**FIGURE 2 EXAMPLE OF PRECIPITATION PROJECTIONS AVAILABLE THROUGH THE INTERACTIVE VIEWER AT HTTPS://DATA.CIG.UW.EDU/PICEA/STORMWATER/PUB/VIZ/**

Climate forecasts for atmospheric river events include increasing precipitation, increasing event frequency, and a shifting of atmospheric river events to occur more frequently earlier in the year, including October and November.

As a result of decreased snowpack and increasing participation, Bank full flows and widths are expected to increase in Wahkiakum County over the next 50 years, potentially on average in the range of 10% to 30%, although bank full flows for any given location on a steam will vary more widely based on a variety of factors. [9]

While less snowpack is forecasted for Washington studies were not found forecasting whether there would be less snow accumulation in Wahkiakum County, and how less snow could moderate flows that would otherwise result from the heavy rain on snow events. Studies forecasting climate changes specific to each of the County's watersheds were not found.

Generally speaking, these forecasts suggest that the climate factors contributing to flooding will contribute more to flooding in the future than they do now, with climate changes contributing to

[9] Mauger, G.S., M. Liu, J.C. Adam, J. Won, G. Wilhere, D. Dulan, J. Atha, L. Helbrecht, and T. Quinn (2021). New Culvert Projections for Washington State: Improved Modeling, Probabilistic Projections, and an Updated Web Tool. Report prepared for the Northwest Climate Adaptation Science Center. Climate Impacts Group, University of Washington. https://doi.org/10.6069/31T3-RE28

increasing flooded areas, flood depths, and flood flows, and more resulting impacts to residents, private property, roads, dikes, levees, culverts, and other infrastructure at risk of flooding.

## Sea Level Rise

Available forecasts suggest some sea level rise occurring in the future, for example, an 83% chance of a 1/10th of 1 foot increase in Columbia River Estuary elevations in Grays Bay by the 2040's under a low greenhouse gas emissions scenario (RCP4.5), or a 80% chance of a 1 foot increase in Columbia River Estuary Elevations by 2120.[10] Forecasts are available for other greenhouse gas scenarios, future dates, and locations. They all take into account the regional geologic trend of the land vertically rising at .4 feet per century. They do not account for local variations in vertical land movement. The projections generally suggest that sea level rise will occur to some extent in the coming decades[11], representing a factor contributing to more rather than less flood risk in and around today's tidally influenced flood-prone areas.



[10] University of Washington Climate Impacts Group. 2023. Interactive Sea Level Rise Visualizations. https://cig.uw.edu/projects/interactive-sea-level-rise-data-visualizations/

[11] Lavin, P., Roop, H.A., Neff, P.D., Morgan, H., Cory, D., Correll, M., Kosara, R., and Norheim, R., 2019. Interactive Washington State Sea Level Rise Data Visualizations. Prepared by the Climate Impacts Group, University of Washington, Seattle. Updated 7/20.

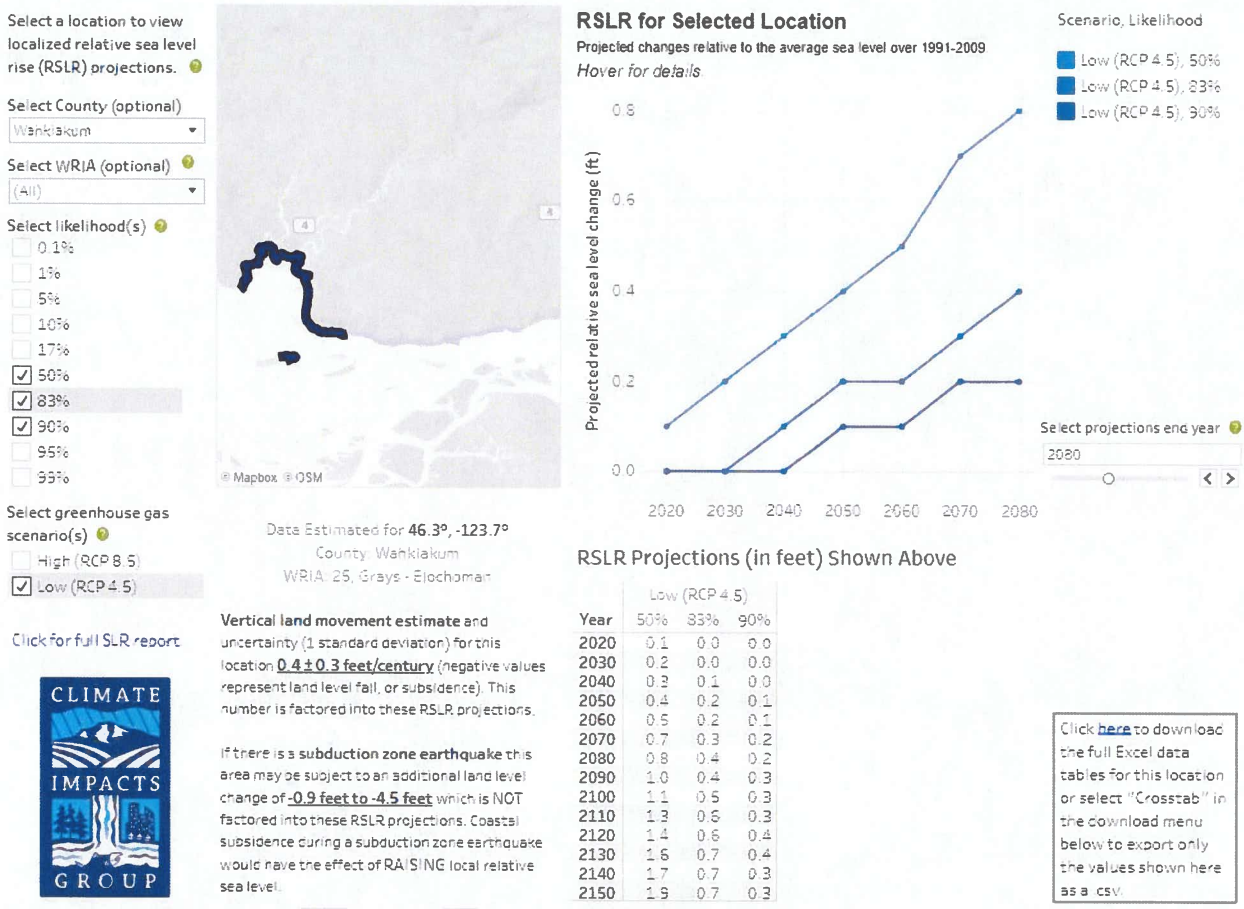



**FIGURE 3 EXAMPLE OF SEA LEVEL RISE PROJECTIONS AVAILABLE THROUGH THE INTERACTIVE VIEWER AT HTTPS://CIG.UW.EDU/PROJECTS/INTERACTIVE-SEA-LEVEL-RISE-DATA-VISUALIZATIONS/**

# TOPOGRAPHY

Topography influences the rate and timing of water travelling through watersheds and therefore is a determinant of flood risk. Wahkiakum County's streams flow from relatively steep higher elevation areas to less steep lower elevation areas, before discharging to the Columbia River. Flows from the upper watershed's slowdown in lower watershed areas as the topography flattens, contributing to flooding. Accumulated dredge spoils and sediment discharges from the upper watershed of Grays River have reduced its discharge capacity.

Larger flows transport earth material downstream and can create new channels as witnessed in avulsion events such as the one that occurred in 2001 at Gorley Springs. Lower gradient streams at the valley bottoms are more exposed to tidal and flow patterns in the Columbia River. These sections of Wahkiakum's watersheds experience lower rates of velocity and are therefore slower to drain and discharge material.

# SOILS

Soil characteristics influence flooding in a few different ways in different locations and contexts. Flat areas with soils having low infiltration rates may experience more surface water accumulation from direct precipitation, as is the case in some lower areas of the Grays Bay watershed. In upstream watershed areas, soil infiltration partly determines how much water infiltrates slowly through the ground versus flowing relatively quickly over the surface toward downstream flood prone areas.

Soil erodibility and landslide susceptibility determine how much soil erodes and is deposited downstream. Wahkiakum County includes large areas of highly erodible soils that are also prone to landslides in its actively managed upland forests. As described in later sections, these soils have eroded to downstream areas, causing changes to the shapes of stream channels, leading to further downstream bank erosion and channel migration and limiting the flow capacity of streams and their ability discharge flood flows into the Columbia River Estuary.

Sediment sources and their interaction with the rivers of Wahkiakum is a complex process. More information is needed to understand sediment patterns and trends in order to make better decisions about what are the best strategies for reducing sediment delivery to stream channels. Generally speaking, the erodibility and landslide susceptibility characteristics of Wahkiakum County's soils will not moderate the effects of increasing precipitation as much as less erodible and landslide prone soils would in other places.

# DRAINAGE PATTERNS

The county's upper watersheds typically have narrow steep channels (the upper zones). Surface water flows quickly and erodes sediment where erosive soils are vulnerable. Unpaved roads, degraded culverts, roads on steep slopes, and soils without stable vegetation, eroding channel banks, and landslides contribute sediment from the upper zone to downstream areas.

Downstream of the upper zones, somewhat flatter and wider channels allow coarser, heavier sediment particles to deposit in the transfer zones. A river's form and flow characteristics depend on the ratio of sediment transport capacity to sediment supply. Significant aggradation, channel widening, bed filling, pool filling, or braiding occurs where the amount of introduced sediment overwhelms transport capacity. These changes in channel shape and direction can cause land to erode and can cause flooding. This is especially true for sections of Grays River where sediment inputs are causing channel migration and erosion, and compounding the entrainment of more sediment to a system that is already sediment laden.

Downstream of transfer zones in flatter tidally influenced areas, lighter sediment settles and forms deltas. Dikes and tide gates have protected otherwise flood prone areas against overbank

flooding in tidal areas while at the same time preventing the same areas from serving as flood storage and receiving areas for eroded sediment. Depending on the timing of flooding events from seasonally high precipitation and storms, the tides can temporarily impede the ability of channels to convey water downstream, compounding flooding risk to private property and public infrastructure.

Columbia River and Willamette River Watershed dams have changed the timing and magnitude of Columbia River discharge and elevations reducing high flows that historically would re-configure drainage patterns near the mouths of the lower Columbia River's tributaries. Pile dikes, other in-stream structures, and Columbia River Federal Navigation Channel dredging and dredge material disposal have further modified lower Columbia River flow and channel patterns. Together, the upstream Columbia River dams, dredging activities, and local in stream structures have contributed to the accumulation of sediment in the Columbia River Estuary mouths of the Elochoman, Skamokawa, and Grays watersheds, which at least in the Gray's River is limiting the rivers' discharge capacity and contributing to flood risks.

Wahkiakum County flooding patterns are reflective of its dynamic location in the Coastal zone of Washington. The amount of precipitation during rainy season gives shape to high stream densities relative to the watersheds size. The geologic nature (as described elsewhere XX) of areas shared by the County's watersheds exposes significant sections of the area to mass failures events in the form of both shallow and deep-seated landslides. Less frequent debris flows have also been identified in the County's watersheds. These events occur naturally over the history of Willapa Hills province, legacy timber practices accelerate the frequency and intensity of these mass failures. Removing trees removes the canopy that would intercept precipitation events and the lack of root structure further destabilizes the soil structure. Associated activities such as road building and yarding also disrupt subsurface drainage patterns that contribute to additional erosion and sediment transport to the stream network.

The effects from upslope watershed processes described above have broad implications for flooding patterns downstream in Wahkiakum County's floodplains. The decrease of vegetation cover shift hydrology patterns to a "flashier" system as more surface water is moving into stream channel areas than it can accommodate. This results in water overtopping its banks and often eroding adjacent properties. Channel migration is a normal response to sediment inputs exceeding sediment discharges. Studies completed in the Grays (Figure 2.) provide some insight into channels migration patterns in lower gradient areas such as floodplains, where human infrastructure and dwellings are more common. While excessive sediment is still moving downstream through the watersheds from legacy land management practices, this is expected to decrease as the watershed responds to improved contemporary forest practices.

# GRAYS RIVER

Grays River is the largest watershed in the County, with steep headwater streams where elevations can vary up to 1,500 feet in one mile. The basin expands occupies parts of three counties with approximately 55% of the watershed outside/upstream of Wahkiakum County. From the confluence of the West and South Fork near the County's northern boundary, the Gray's River flows southwest as its floodplain

broadens and develops more meander-like channel patterns before meeting the tides. Grays River's major tributaries are the West Fork, Fossil, Klints, King, Thadbar, Nikka, Seal, Malone, and Hull Creeks.

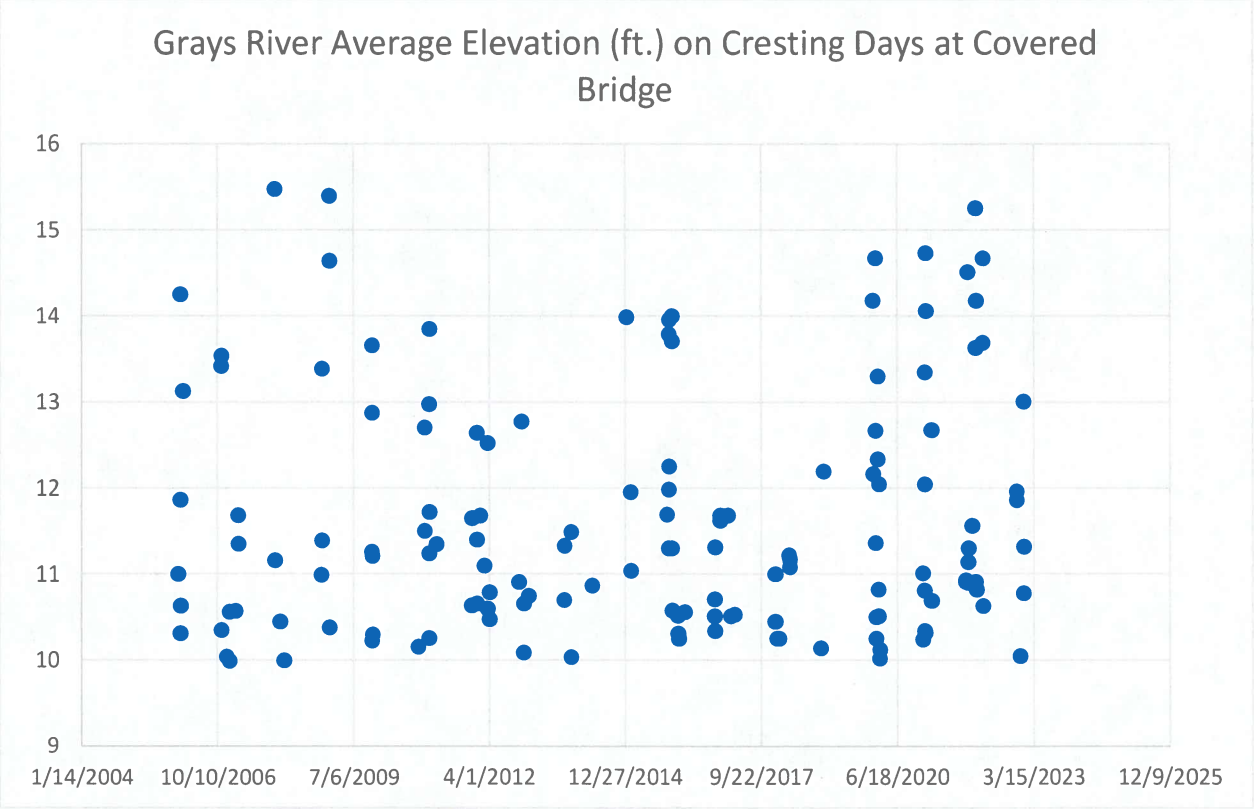



**FIGURE 4: GRAYS RIVER ELEVATIONS ON DAYS EXCEEDING 10 FT. THESE ARE THE AVERAGE ELEVATIONS FOR THOSE DAYS, AND THE ACTUAL CREST ELEVATIONS ON THESE DAYS WERE HIGHER. STATION ID 25B060[12]**

Flow data was collected on the Grays River in the middle part of the last century, and since 2005 stages have been recorded at the Covered Bridge. Wahkiakum County funds gage operation and the National Weather Service's Grays River flood forecast is based on this stage record. There is not a clear pattern over the last two decades of peak flood stages on the Grays River increasing in

[12] https://apps.ecology.wa.gov/continuousflowandwq/StationDetails?sta=25B060

height or becoming more frequent, although the last three years have had more high-water days than the prior several years did.

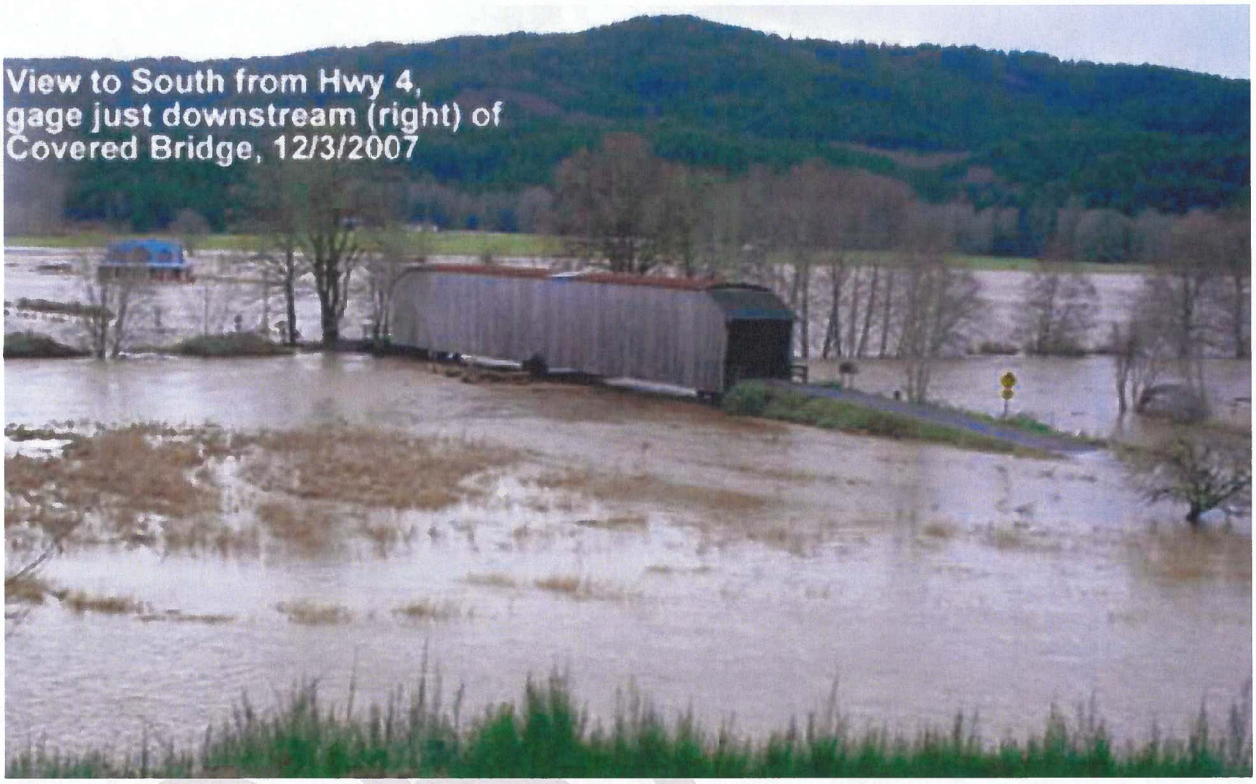



**FIGURE 5 GRAYS RIVER COVERED BRIDGE DURING THE HISTORIC 2007 FLOOD.**

A 2006 Grays River watershed study[i] found timber harvest impacts on bank-full flood return interval and mean duration were minor, although the effects of roads associated with timber harvest were not examined and roads are known to significantly affect peak flows. The upper watershed has erosive soils and is susceptible to mass wasting after vegetation is disturbed. Steep channels deliver sediment to the lower Grays River valley. Prior to the 2006 study, the watershed was producing around ten times more sediment than would be typical of forested watershed in the coastal region.

Sediment production from mass wasting and surface erosion lags behind forest road construction and timber harvest around 10 to 30 years. Watershed forest harvesting peaked in the late 1970's to early 1980' suggesting that going forward if all other factors such as climate were held constant the upper watershed should produce less sediment. Improving riparian forest health with modern forest practices should also increase the amount of instream large woody debris, improving the capacity of upper watershed reaches to store sediment. However, a contemporary comprehensive assessment or forecast of sediment production and distribution in the watershed has not been completed, and even if the

watershed were to produce less sediment in the future, there will be a substantial amount of previously eroded sediment working its way downstream through the watershed and affecting channels and flows.

Erosion Rates and Lateral Channel Migration Rates for the Mainstem, West Fork, and South Fork Grays River (Herrera 2005)

| Reach/Sub-Reach | Photographic Period | Erosion Rate ($m^2$/year) | Lateral Migration Rate (m/year) |
|---|---|---|---|
| SR 4 sub-reach | 1939–1966 | 394 | 0.17 |
| | 1966–1960 | 3.858 | 1.71 |
| | 1970–1982 | 3.488 | 1.46 |
| | 1982–1996 | 3.978 | 1.57 |
| | 1996–2003 | 8.684 | 3.43 |
| Gorley sub-reach | 1939–1966 | 1.709 | 0.72 |
| | 1966–1960 | 3.364 | 1.38 |
| | 1970–1982 | 3.291 | 1.29 |
| | 1982–1996 | 6.691 | 2.71 |
| | 1996–2003 | 11.292 | 5.13 |
| West Fork response reach | 1970–1996 | 1.595 | 1.06 |
| | 1996–2003 | 553 | 0.64 |
| South Fork response reach | 1970–1996 | 3.041 | 1.35 |
| | 1996–2003 | 1.253 | 1.01 |

**FIGURE 6 GRAYS RIVER EROSION RATES REPORTED IN 2005**

# SKAMOKAWA CREEK AREA

The Skamokawa Creek area includes about 14,100 acres, or about 20% of the County, in eleven subwatersheds. Major flood prone tributaries include: West Valley Creek, West Fork, Left Fork Skamokawa, Wilson, Falk and Pollard Creeks. The tidal influence on the mainstem of Skamokawa Creek extends approximately 2 miles from its mouth. Alger Creek and Risk Creek drain into Brooks Slough, a major tidal channel that flows through the Julia Butler Hansen Refuge. Jim Crow creek is considered part of the Skamokawa Creek Area in this plan, but it drains directly into the Columbia River and is not a tributary of Skamokawa Creek.

A 1992 Wahkiakum County Conservation District study and management plan assessed watershed factors contributing to flood hazards in the basin such as the condition of soils, vegetation, land use practices, road densities, and climate. The plan makes connections between vegetation changes and their effect on increasing peak flows which can consequently cause streambank erosion from increased lateral channel migration. Table 3 .20 shows an estimate of projected peak flows as a result of predicted forest harvests for a given flooding event. It also indicates what peak flows would be for a forest with 'Old Growth' Conditions.

| Flooding Event | Present Discharge (cfs) | Future Discharge (cfs) | Old Growth Conditions (cfs) |
|---|---|---|---|
| 10 Year | 1,832 | 1,918 | 1,347 |
| 50 Year | 3,074 | 3,205 | 2,422 |
| 100 Year | 3,562 | 3,681 | 2,844 |

**FIGURE 7 SKAMOKAWA CREEK ESTIMATED FLOW CHANGES FROM FOREST PRACTICES**

# ELOCHOMAN RIVER AREA

The Elochoman River originates in and just beyond the northeastern comer of Wahkiakum County and flows in a south-southwesterly direction for a large part of its drainage before it turns west and meanders into the Columbia. The Elochoman watershed covers approximately 27% of the County, draining approximately 42,000 acres. Following a pattern similar to the other basins in the County, the upper portion flows through a narrow valley with steep slopes draining major tributaries such as Otter Creek, Nelson Creek, North, West, and East Fork. In its middle reaches, the river flows through a series of less steep valleys turning into broader floodplains draining Duck Creek from the west and Beaver Creek from the east. The lower reaches are in a tidally influenced delta featuring a network of slough channels and midchannel islands like Hunters Island at its mouth.

Birnie Creek is also included in the Elochoman River Area in this plan, although technically it is its own watershed and has its own distinct issues because of its proximity to the urban area of Cathlamet.

Areas of Special Flood Hazard include lower portions of Nelson, Beaver, and Alger Creek, and a significant portion of the Elochoman Creek mainstem.

Washington Department of Ecology publishes river flow and height data from a gauge located at Monroe Drive at River Mile 3.26. The data goes back to December 2014. Previously a gauge on the Elochoman River collected flow data from 1941 to 1979. Over the last several years, it appears that there is a pattern of more high flow events and higher high flow events occurring more recently.

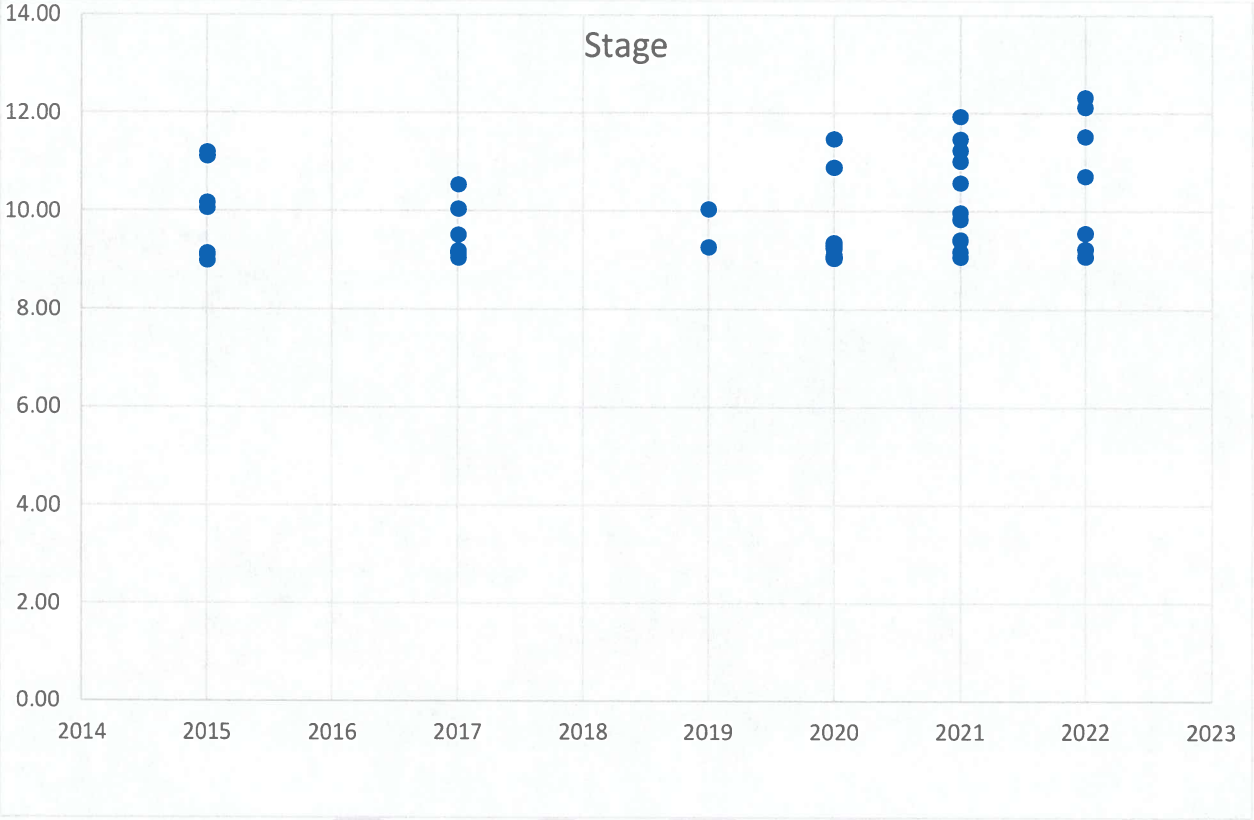



**FIGURE 8 ELOCHOMAN RIVER ELEVATIONS ON DAYS EXCEEDING 9 FT. THESE ARE THE AVERAGE ELEVATIONS FOR THOSE DAYS, AND THE ACTUAL CREST ELEVATIONS ON THESE DAYS WERE HIGHER.**

# PUGET ISLAND

Puget Island is in the Columbia River and experiences different drainage patterns and flooding issues than other areas. Columbia River dams and navigation channel dredging have changed the island's flooding context. Local diking, filling, installation of flood structures, and other activities associated with human development have partially disconnected the island from the Columbia River floodplain.

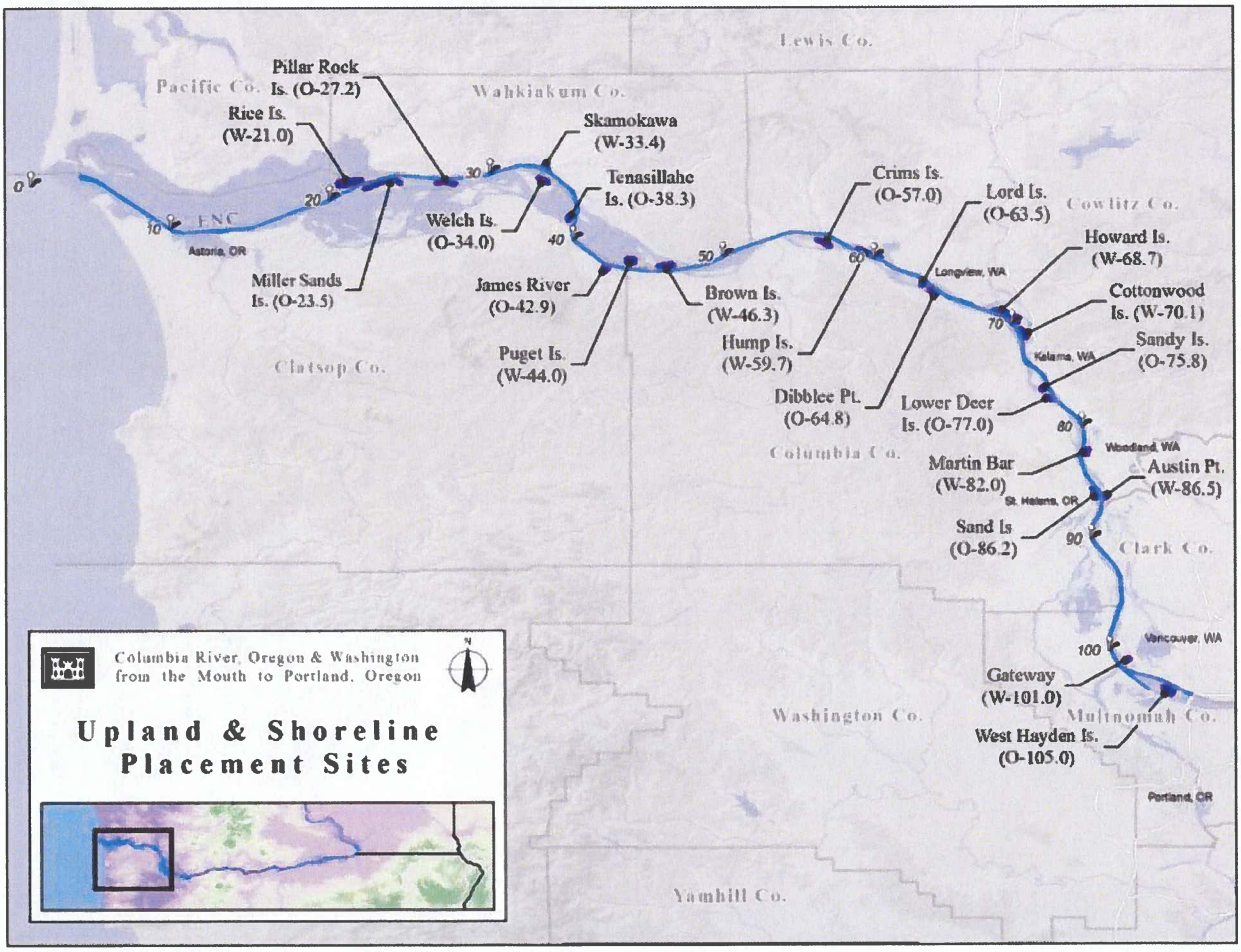
Flood control structures at Grove Slough have been installed to control tidal elevations. Pumps have also been installed at this location to maintain adequate water levels for properties along the Grove Slough channel network.

The channels around the island are products of both tidal and riverine forces. Surface water patterns maintaining the island landform have been manipulated by dredging and the construction of pile dikes. Pile dikes slow water at a channel's edges to direct flow energy through the channel center. They are used to aid navigation, prevent bank erosion, and provide stable areas for dredged

material. In some cases, pile dikes can lead to undesirable accumulation of sediment, and in some cases, they can create eddies that create undesirable erosion.

Cathlamet Channel on the island's northeast side accumulates sediment from the Elochoman watershed and from dredge spoil migration. The Columbia River Navigation Channel is located on the islands southeast side and is maintained by the Portland District Army Corps of Engineers. The Portland district also maintains the pile dikes that contributed to the erosional forces on shoreline areas adjacent to Sunny Sands road and Welcome Slough Road.

Some progress was made since the last plan was created organizing with property owners and working with the US Army Corps of Engineers to mitigate erosion around Cape Horn and Sunny Sands Road by depositing dredge spoils from the Columbia River Navigation Channel maintenance dredging program, however erosion is an ongoing problem along North Welcome Slough Road and Ostervold Road and reportedly a significant amount erosion has occurred at Sunny Sands Road in recent years, threatening progress that was made there previously to deposit dredge spoils.



# HABITAT

## PRIORITY HABITATS AND SPECIES

The dynamisms of emerging coastal weather patterns and watershed processes influence the shape and distribution of fish and wildlife habitats in the County. As described above forest practices in the watershed upper areas have indirect impacts to channel patterns, but also direct impacts to specific species. Development in the floodplain required conventional flood control practices in the form of dikes, revetments, and tide gates. The state maintains lists of priority habitat species for each County. State listed priority habitats related to floodplains include instream aquatic habitat, estuarine and freshwater wetlands, and riparian habitats.

**Riparian/Wetland Habitat**

Riparian areas and wetlands are the interface between terrestrial and aquatic habitats. Riparian areas are the zone of vegetation next to the stream corridor. Wetlands are defined by the unique oxygen-reduced or "hydric" soils created by extended saturation and/or inundation. These conditions promote unique plant communities valuable to the survival and reproduction of a variety of species. Wahkiakum County's floodplain riparian habitats tend to be in poor and sometimes fair condition. Some of the important functions that these habitats are supposed to provide include:

- Continuous patches of mature plant cover from these areas perform numerous functions that benefit the health of the watershed:
- Provides migration corridors, dispersal routes and habitat connectors for wildlife;
- Promotes shade and cover from direct radiation maintaining cool aquatic temperatures for
- salmonids, birds, and other animals;
- Serves to hold and trap sediment delivery from upland and riverine sources;
- Contributes organic matter to support food web dynamics;
- Slows the energy associated with velocity of stream discharge, thereby preventing erosive processes downstream;
- The root structure of some riparian/wetland plant species binds soil particles together, thereby enhancing the structural integrity of the soil and protecting it against erosive forces.

**Tidal Estuarine Habitat**

Tidal wetland habitat performs important functions for migrating juvenile salmonids in the Columbia River Estuary. They serve as low velocity refuge areas during the transition from freshwater to the estuary and ocean. An analysis conducted by CREST in the 1980s found that tidal marsh and swamp habitats were significantly diminished over the prior century due to diking, filling, and tide gate installation. The CREST study found there had been an 88% decrease in tidal swamp habitat while showing an increase in tidal marshes and flats due to siltation of the Bay. For the upper portion of the Estuary, which includes Puget Island, Skamokawa Creek, Brooks Slough, and parts of the Julia Butler Hansen Wildlife Refuge substantial losses of both tidal marsh and swamp habitat types were found.

***Grays Bay***

| Habitat Type | 1870 Acreage | Present Acreage | Pct. Change |
|---|---|---|---|
| Deep Water | 2,270 | 1,690 | -25.6% |
| Medium Depth | 2,230 | 2,040 | -8.5% |
| Shallows/Flats | 3,790 | 4,330 | 14.2% |
| Tidal Marshes | 310 | 760 | 145.2% |
| Tidal Swamps | 4,410 | 510 | -88.4% |

***Upper Estuary***

| Habitat Type | 1870 Acreage | Present Acreage | Pct. Change |
|---|---|---|---|
| Deep Water | 6,520 | 5,060 | -22.4% |
| Medium Depth | 2,710 | 2,790 | 3.0% |
| Shallows/Flats | 1,770 | 2,710 | 53.1% |
| Tidal Marshes | 1,430 | 510 | -64.3% |
| Tidal Swamps | 11,180 | 2,250 | -79.9% |

**FIGURE 8 ESTUARINE HABITAT CHANGES FROM 1870 TO 1980. REPRODUCED FROM THE CREST STUDY, WHERE 1980 WAS THE PRESENT.**

Fish that rely on the County's streams and wetlands and that are on the states priority species lists include:

| |
|---|
| Rainbow Trout |
| Resident Coastal Cutthroat |
| Summer Steelhead |
| Fall Chum |
| Winter Steelhead |
| Coho |
| Fall Chinook |
| Steelhead |
| Cutthroat |
| Coho |
| Chinook |

Salmonid presence has been well documented in the Limiting Factors Analysis and Lower Columbia Fish Recovery Board reports. The unique combination of upland spawning and tidal estuarine wetland habitat combine to play a vital role at various life cycle stages in the survival and productivity of these fish. Salmon life history patterns in the Lower Columbia River are highly varied and complex among anadromous fish species. The introduction of artificially produced fish has modified salmon behavior in the Lower Columbia River. Currently there are thirteen (13) stocks listed on the Federal Endangered Species List either as threatened or endangered. They all use the tidal, brackish areas of the Columbia River Estuary for at least a portion of their life cycle. During the spawning stage salmon use habitat in middle to upper portions of local watersheds.

Listed below are other species of concern that have been observed in Wahkiakum County and that have some relation to floodplain locations.

### Priority Habitat Species List

| Species | Location |
|---|---|
| Columbia White Tailed Deer | Puget Island, Elochoman lowlands |
| Dunn's Salamander | Abe Creek |
| Van Dyke Salamander | Elochoman |
| Sandhill Crane | Lower Skamokawa, Dead Slough |
| Northern Spotted Owl | Upper Skamokawa |
| Roosevelt Elk | Mid-Upper Skamokawa |
| Pacific Lamprey | West Fork, Grays River |

# HABITAT ISSUES AND OPPORTUNITIES RELATED TO FLOODING AND FLOOD CONTROL INFRASTRUCTURE

The primary set of issues at the intersection of flood risk management and habitat management in Wahkiakum County concerns state and federally listed fish species and their use of streams and connected wetlands. Within that broad topic, flooding, erosion, and our response to those hazards have created several different issues for salmon in different habitat contexts.

The State of Washington's Habitat Limiting Factors Analyses identified the following habitat limiting factors for salmon.

Access and Passage

- There are culverts that prevent fish passage. While many culverts have been upgraded or replaced with bridges for fish passage, there are remaining culverts that prevent fish from accessing habitat.

- Low flows in Deep River, Seal River, the lower West Fork Grays River, and the Grays River between the Covered Bridge and the Canyon, may be partially caused or exacerbated by accumulation of sediment.

Floodplain and Side Channel Connectivity

- Most streams in their lower reaches are separated from their floodplains and side channel habitat has been restricted by flood control structures, bank hardening, channelization and splash damming. Reconnecting historic floodplains and restoring riparian areas can include both habitat and flood risk reduction benefits.

Bank Erosion / Stability

- Increased peak flows, unstable soils and geology combined with forest practices, has led to substantial sediment loads and unstable, aggrading stream channels. Peak flows cause bank erosion in areas with alluvial deposits and limited woody vegetation. Both of these conditions lead to unstable stream substrates, which is a limiting factor for chum and chinook salmon.

Riparian Conditions and Large Woody Debris

- Degraded riparian habitats limit the recruitment of large woody debris into the stream, limit food production, and have diminished water quality functions, particularly in managing stream temperatures. Upper watershed forest practices and lower watershed land use patterns have left area streams with a limited supply of large woody debris.

Pool Habitat

- Pool habitat is limited due to a variety of practices that have simplified stream channels.

Water Quality and Water Quantity

- Water temperatures are elevated above recommended levels during parts of the year. Stream sections in each of the major watersheds, especially the Skamokawa, are on the state's 303(d) list for temperature.
- Low flows and elevated peak flows are limiting factors in many streams. Both issues are partly attributable to historic forest practices in the upper watersheds and historic flood control practices in the lower watersheds.

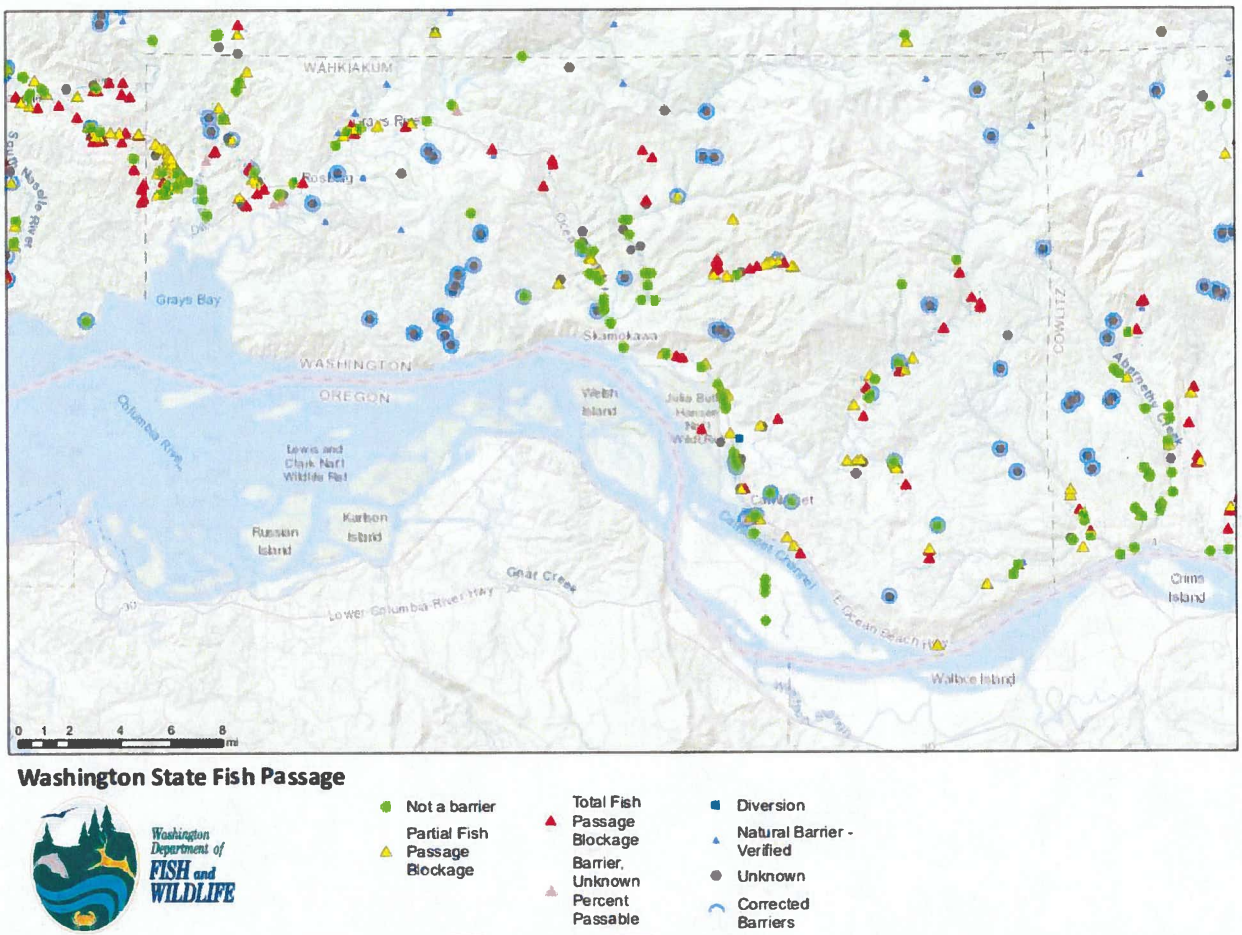
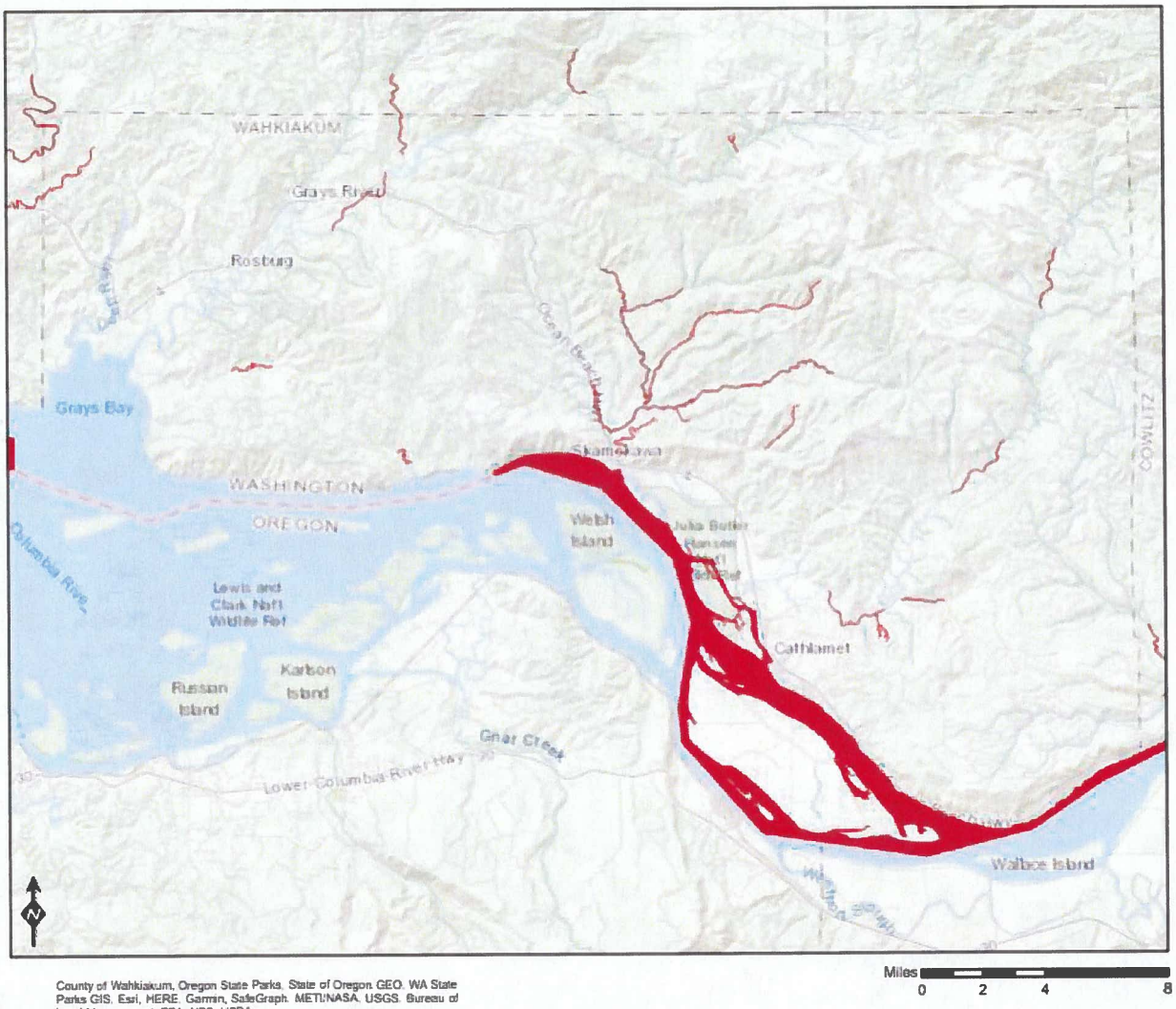



**FIGURE 9 STATE OF WASHINGTON FISH PASSAGE INVENTORY[13]**

[13] Washington Department of Fish and Wildlife. 2023. Fish Passage Inventory, Assessment and Prioritization.




County of Wahkiakum, Oregon State Parks, State of Oregon GEO, WA State Parks GIS, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA

**FIGURE 10 WATER QUALITY IMPAIRED STREAM REACHES**

# FLOODING ISSUES

Areas prone to flooding are found surrounding each of the County's major streams. The Wahkiakum County Flood Insurance Study [14]describes the Columbia River, Skamokawa River, Elochoman River, Grays River, and Wilson Creeks as the primary sources of flooding. Around 8% of the population resides in floodplains. Additionally, the value of agricultural land can be degraded by flooding, and flood control structures themselves can be impacted by flooding. (Wahkiakum County, 2019). Seasonal flood related closures of and damage to transportation infrastructure occurs nearly every year. Additionally, public comments to inform this plan suggest that flooding impacts residential structures every year, even if the damages are not substantial enough to be documented as the national flood insurance program claims. Finally agricultural uses are regularly impacted by flooding, for example when fields are too saturated to be used for livestock pasture.

Flooding in Wahkiakum County results from primarily from intense rainfall that causes rivers to overflow their channels, and from exceptional tidal events that cause the Columbia River to back up into local riverine floodplains. Both forms of flooding occur primarily between October and April, and they are interrelated in that exceptional tidal events impede the downstream flow of riverine flood waters.

While there is no historical record of flash flooding in Wahkiakum County, there is a risk of it occurring. Reports (Nelson, 2022) of prior winter storm events include instances of debris and slides blocking culverts. A sudden release of impounded water from a blocked culvert, or the sudden rerouting of river flow from a blocked culvert could cause a flash flood. Some of Wahkiakum County's population and structures are protected from flooding by dikes and levees. A sudden unplanned dike or levee breach could cause a flash flood as well.

Streambank erosion and channel migration are other flood related hazards occurring every year in Wahkiakum County. Active channel migration areas include Hull Creek (Grays River basin), West Fork Grays River and upper Fossil Creek (Grays River basin, Skamokawa Creek upstream of the West Fork of Skamokawa Creek, Skamokawa Creek between Standard Creek and Falk Creek, Wilson Creek, and the Elochoman River throughout the watershed as far downstream as below Beaver Creek.

# PRIOR FLOODING

The previous CFHMP documents a historical record of flood events from 1849 to 2003 based on information from stream gauges, previous assessments, and anecdotal local information. Wahkiakum County Eagle has documented many of the County's relatively large flood events, helping to illustrate some of the local flood issues. The prior CFHMP's record, and a collection of Wahkiakum Eagle references are provided in figures below.

[14] FEMA. (1990). *Flood Insurance Study, Wahkiakum County WA Inincorporated Areas*.

| Date | Flow Recorded/ Event |
|---|---|
| 1849 | 1,201,560 cubic feet/second on Columbia River Mainstem |
| 1859 | 869,364 cubic feet/second " " |
| 1862 | 950,646 cubic feet/second " " |
| 1864 | 749,208 cubic feet/second " " |
| 1866 | 749,208 cubic feet/second " " |
| 1871 | 862,296 cubic feet/second " " |
| 1876 | 961,248 cubic feet/second " " |
| 1880 | 961,998 cubic feet/second " " |
| 1894 | 876,432 cubic feet/second " " |
| 1933 | Flood Stage of 17.2 feet reported on the Elochoman |
| 1948 | 999,273 cubic feet/second on Columbia River Mainstem; Major Portions of Puget Island covered |
| 1949 | 12.66 feet flood elevation recorded on Elochoman |
| 1950 | 12.51 feet flood elevation reported on Elochoman |
| 1956 | 12.49 feet flood elevation recorded on Elochoman; 10.23 recorded on Grays River |
| 1962 | 12.86 feet elevation on Elochoman; 11.1 feet elevation recorded on Grays; Localized flooding reported throughout the County |
| 1966 | 10.94 feet flood elevation recorded on Grays River |
| 1972 | 11.29 feet flood elevation recorded on Grays River; 11.93 recorded on Elochoman |
| 1975 | 10.86 feet flood elevation recorded on Grays River; 11.74 reported on Elochoman |
| 1977 | 10.32 feet flood elevation on Grays River; 13.6 Feet on Elochoman; Localized Flooding in Towns of Grays River and its Floodplain |
| 1979 | USGS gages cease recording |
| 1990 | Significant flooding along Nelson Creek;Middle Valley;Seal River; Skamokawa; Closest recorded elevation @ Naselle exceeded 16 feet three (3) times during the year |
| 1994 | 17.62 and 16.16 feet flood elevation @ Naselle |
| 1997 | 19.26 feet flood elevation recorded @ Naselle; extensive flooding throughout the County and Pacific Northwest |
| 1998 | Dike fails near Gorley Springs requiring emergency evacuation and causing extensive damage to private property |
| 2003 | Erosion accelerates on Puget Island |

**FIGURE 11 HISTORIC FLOODING RECORDS IN COLUMBIA RIVER AND WAHKIAKUM COUNTY WATERSHEDS**

| Reference Date | Reference Title |
|---|---|
| April 14, 2022 | "Disaster assistance deadlines nearing" |
| January 13, 2022 | "Downriver Dispatches" by Karen Bertroch |

| | |
|---|---|
| January 20th, 2022 | "Valley residents share concerns of erosion threats" |
| | |
| January 7, 2021 | "Downriver Dispatches" by Darrell Alexander |
| January 30, 2020 | "County still divided by slide; ferry running" by Kay Chamberlain |
| January 3, 2008 | "2007, A Year in Review" |
| November 22, 2012 | "Storm wallops region" by Rick Nelson. |

**FIGURE 12 WAHKIAKUM COUNTY EAGLE ARTICLES REFERENCING FLOODING EVENTS SINCE THE LAST COMPREHENSIVE FLOOD HAZARD MITIGATION PLAN**

The NOAA Storm Events Database recorded 53 flood events between 1996 and January 11, 2022[15]. (NOAA, 2022). In those events, there were no reported injuries or deaths. A total of $6,579,000 of property damage was reported across all events, however a substantial portion of this damage may have occurred in other counties affected by coastal floods that were recorded in the database as a common event with Wahkiakum County's coastal flooding. Reported damages occurred in 10 of the reported flood events.

There have been 98 paid NFIP claims valued at $1,814,733.38. There have been nine substantial damage claims. (FEMA, 2021). There are two repetitive loss properties and two severe repetitive loss properties, in the Grays River and Skamokawa watersheds. (Wahkiakum County, 2019)

# PROBABILITY OF FUTURE FLOODING

Approximately 9% of Wahkiakum County's area is included in Wahkiakum County's 1% annual chance floodplains. These were primarily mapped nearly 40 years ago. Any given place included in that area may have at least a 1% chance of being flooded in any given year. Flooding that at least disrupts transportation routes, erodes stream banks and agricultural land occurs every year. Flooding that damages private property structures may be less frequent or there is a less complete record of it occurring, and flooding that causes loss of life is not included in the recent historical record.

Studies have not mapped the area, estimated the depth, or described other characteristics of flooding that can be estimated to have a greater than 1% chance of occurring in a given year. For example, there are no maps or studies describing the extent of flooding that can be expected to occur annually or every ten years.

Neither has future flooding under expected future conditions been specifically studied. For example, there is not a study describing the County's floodplains under any given climate change and upper watershed timber harvest scenario for future decades.

[15] Twelve of sixty-five events are recorded twice as both coastal flooding and riverine flooding.

Prior sections of this plan described climate and land use trends suggesting that in the future, flooding will be more frequent, more intense, and occur earlier in the year than it typically does now. Two factors that could moderate flooding in the future include the potential for there to be less snowpack, and the potential for rivers' sediment loads and channel migrations to stabilize as forest management practices improve with regards to erosion control, or as more time passes since the era of the County's most intensive timber harvests.

# VULNERABILITY

## Critical Facilities and Other Infrastructure

The locations of several critical facilities were reviewed for their location relative to the 1% annual chance floodplain. Other types of critical facilities and infrastructure such as natural gas, communications lines, and dikes and levees were not evaluated for flood risk vulnerability.

Puget Island Fire Department, Skamokawa Fire Department, and Grays River Fire Department do not appear to be located in the 1% annual chance floodplain. The Grays River Fire Department was previously damaged by flooding in the December 3, 2007 storm, and relocated to a safer location. District 4 Fire Department at 703 Elochoman Valley Rd, Cathlamet, appears at least very close to the 1% annual chance floodplain.

The Town of Cathlamet's drinking water system supply intake is located in the Elochoman River, however there were not reports of water quality issues or intake structure damage associated with flooding or erosion. Town of Cathlamet's Wastewater Treatment facilities were partially located within the 1% annual chance floodplain adjacent to the Columbia River, however they have been moved to a safer location. The Cathlamet Ferry Terminal is located on the Cathlamet Channel shoreline of the Columbia River in and adjacent to the 1% annual chance floodplain, however issues related to flooding were not identified.

## Transportation Facilities

Winter storms cause flooding and landslides that damage and obstruct transportation routes annually. Culverts vulnerable to collapsing also tend to fail during these high flow events. Newspaper and other reports from the last two decades following flood events focus largely on flood and landslide impacts to transportation routes and flooding impacts on transportation routes was a primary concern identified through public input. Participants identified impacts to workers and business owners accessing jobs and their business operation, impacts to patients needing emergency medical services, hazards to drivers, and general disruptions to daily life as issues related to flooded roads.

Inventories on existing infrastructure have been completed since the CFHMP plan was developed. These are available through the local conservation district, Washington Department of Fish and Wildlife, and Department of Transportation. These inventories describe the condition of the culvert and supporting

infrastructure. Depending on the condition of these structures, this information can provide insight into flooding processes and opportunities for future project development with local sponsors.

Given the public's interest in flooding impacts to transportation infrastructure, an informal inventory of transportation flooding issues was conducted for this plan. The goal was to identify sections of roads that flood on an approximately annual basis, as remembered by County Planning and Public Works Staff. Following is a summary of the results:

| Area | Location | Issue |
|---|---|---|
| Deep River | Intersection of SR 4 and West Deep River Road | Submerged road |
| | Multiple sections of East and West Deep River Roads in downtown Deep River and downstream | Submerged road |
| | Wainamo Road | Submerged road |
| | Wirkala Road at West Deep River Road. 700 feet. | Submerged Road |
| Eden Valley | Eden Valley Road near mile post 3 and the confluence of Crooked River and South Crooked River | Submerged road |
| | Multiple sections of Eden Valley Road and Upper Landing Road near their intersection | Submerged road |
| | Eden Valley Road near mile marker 2 | Submerged road |
| Elochoman | Foster Road from Elochoman Valley Road to Risk Road. 3500 feet. | Submerged Road |
| | Risk Road near SR 4. 200 feet. | Submerged Road |
| | Beaver Creek Road Bridge over Elochoman River | Submerged road |
| | Schraum Road intersection with Beaver Creek Road | Debris clogs culvert, Submerged Road, Culvert Washout |
| | Private driveway upstream of Schraum Road washed out | Debris clogs culvert, Submerged Road, Culvert Washout |
| Grays | Altoona Pillar Rock Road from SR to south of Barr Road. 3000 feet. | Submerged Road |
| | Barr Road near Altoona Pillar Rock Road. 1200 feet. | Submerged road |
| | Altoona Pillar Rock Road just south of Larson Road. 300 feet. | Submerged road |
| | East Malone Road approximately 300 feet north of SR 4. 400 feet. | Submerged Road |
| | SR 4 between Seal River Road and Waistaka Road. 400 feet. | Submerged Road |
| | SR 4 at Seal River. 800 feet. | Submerged Road |

**FIGURE 13: INITIAL INVENTORY OF REGULARLY OCCURRING FLOOD IMPACTS TO TRANSPORTATION ROUTES**

## Population

Approximately 8% of the county population resides in a floodplain.[ii] Wahkiakum County has a relatively small and dispersed population, so despite having a large proportion of its area in floodplains (9%) and moderate proportion of its population in the floodplain, the number of people residing in floodplains is less than in more populated counties. Similarly, although Wahkiakum County's population is growing, its growth in real numbers is small compared to more populated counties. There are no reported deaths resulting from flooding in the last two decades.

# PAST AND PRESENT FLOOD HAZARD MANAGEMENT PRACTICES AND FACILITIES, PROGRAMS AND REGULATIONS

## Flood Control Structures

Dikes, levees and other structures to control river flow have been implemented historically in Wahkiakum County since European settlement. In the 1940's and 1950's, the US Army Corps of Engineers began implementing some diking projects, and diking districts were formed as well. (Washkiakum County, 1995). The prior Flood Mitigation Plan noted that many dikes were deteriorating, and that many tide gates were inoperable. Figure [insert] represents the most recent effort to map the County's flood control structures. (Wahkiakum County, 2015).There is currently not a complete inventory of flood control structures, including all dikes, levees, and tide gates.

Specifically on the Grays River in 1940s and 50s, the Army Corps, in partnership with the County Conservation District investigated and implemented a variety of opportunities for stream bank protection that included the placement of riprap, stone revetments, gravel dikes, gravel removal, etc. The Grays River Habitat District currently maintains these structures formerly the Upper Grays River Diking District. In addition, tide gates were installed in the lower areas of the Grays River area. More than 20 of these structures were constructed in both the Grays and Deep River area.

On Skamokawa Creek, in addition to diking, a canal was constructed to divert flow away from the historic channel. The tide gates which were installed effectively created a manmade artificial cut off meander. Additional types of flood control actions also included the installation of pump stations to control channel elevations on Nelson Creek and Puget Island. Pump stations were also installed in 1977 on Brooks Slough on the National Wildlife Refuge managed by US Fish and Wildlife.

## Emergency Infrastructure Repairs

The County is accustomed to responding to flood damage to roadways and culverts within their regular budget and staff resources. Each year the County's public works department clears debris from roads and culverts and occasionally must restore roadway shoulders and complete emergency culvert replacements.

## Dredge Material Management

The County, landowners and the U.S. Army Corps of Engineers have deposited dredge spoils at Puget Island locations that were experiencing erosion. Beneficial use dredge material disposal projects at Cape Horn and Sunny Sand Road have had some success in reducing erosion, however recent lessons suggest that beneficial use disposal areas subject to erosion need to be replenished with more dredge spoils, otherwise these areas will continue eroding.

## Special Purpose Districts

Grays River Habitat Enhancement District (Formerly called Upper Grays River Flood Control District), Consolidated Diking District No. 1 of Wahkiakum County, Wahkiakum County Dike District No. 5, and Wahkiakum County Dike Improvement District No. 4 maintain dikes in Wahkiakum County, and in some cases participate in multi-benefit erosion control and flood risk reduction projects that have habitat and ecological benefits. (Wahkiakum County, 2012) (MSRC, 2022). The County has also established four Flood Control Zone districts. The Cowltiz-Wahkiakum Soil and Water Conservation District is also active in planning and implementing multi-benefit projects that provide flood and erosion risk reduction.

## National Flood Insurance Program, Flood Hazard Ordinances, and Flood Insurance Rate Maps

Wahkiakum County and Town of Cathlamet's flood insurance studies were completed in 1990 and 1986 respectively (FEMA, 1986). Wahkiakum County and the Town of Cathlamet have adopted Flood Hazard Ordinances intended to be consistent with the standards of the National Flood Insurance Program[16] and the Washington Floodplain Management Standards[17]. There are approximately 133 NFIP policies in Wahkiakum County (FEMA, 2021).

## Public information

[16] 44 CFR 60.3
[17] RCW Chapter 86.16

Wahkiakum County maintains flood hazard information and its flood hazard ordinance on its webpage. The County also published flood hazard warnings on its Facebook page, which has over 1,800 followers, a number equivalent to over one third of the county population.

## Shoreline Master Program and Critical Areas Ordinances

Wahkiakum County's Shoreline Master Program (SMP) and Critical Areas Ordinance references and reinforces the County's flood hazard ordinance. They also support flood risk reduction by protecting the ecological and hydrologic functions of wetlands and shorelines, and limiting the amount of development that is allowed in and adjacent to wetlands and shorelines. The County is currently in the process of updating its SMP.

## Tidal Wetland Habitat Conservation and Restoration Projects

Many projects have occurred in recent decades to conserve and restore tidal wetland habitat and have typically been aimed at improving salmon habitat. These projects also typically employ voluntary conservation easements with willing private landowners, helping them achieve their goals. Because these projects are in places where water elevations are primarily determined by Columbia River flows and tides, they typically do not provide a significant flood storage or discharge benefit. However, any project that uses a conservation easement to permanently protect a flood hazard area from being occupied by dwellings, roads, and other structures can be said to have some flood hazard mitigation benefit. The following is a partial list of restoration projects that had some flood risk reduction benefit.

### Grays/Deep River Areas

1. CREST, Gorley Springs
2. LFEG, Fossil Creek
3. CLT, Crazy Johnson
4. Deep river tide gate retrofit project
5. Deep river Oneida Landing
6. Cowlitz Indian Tribe, Grays Headwater Project (early phases)

### Elochoman River Area

1. CLT-Lower Elochoman
2. Tidal area near SR 4- Nelson Creek project
3. Wahkiakum-Cowlitz Conservation District Project
4. Streambank erosion/LW placement
5. Culvert Improvements (i.e., Duck Creek)

### Skamokawa Creek Area

1. Dead Slough, Tide gate retrofit
2. Streambank protection, Wilson Creek
3. Riparian projects, numerous

## Upper Watershed Conservation and Restoration Projects

The planning process did not create any inventory of upper watershed conservation and restoration projects that have a flood risk reduction benefit; however, an inventory and analysis of upper watershed actions could inform future flood risk reduction efforts.

## State and Federal Programs

Washington State's Guidebook on Comprehensive Planning for Flood Hazard Management[18] provides an overview of state and federal regulations relating to flood hazard management.



[18] Comprehensive Planning for Flood Hazard Management: A Guidebook (wa.gov)

# ESTABLISHED STATE AND FEDERAL FLOOD HAZARD MITIGATION GUIDANCE

The State of Washington and Federal Government provide guidance on flood hazard mitigation that complements their regulations and investment programs. While there is a large body of guidance from each of these sources and other sources, some of the highest-level resources relating to this plan's recommendations from these most established sources is provided below.

## Washington State Guidebook

Washington Department of Ecology published an updated guidebook on comprehensive planning for flood hazard management in 2021. Since the prior version was published, and since Wahkiakum County's last Comprehensive Flood Hazard Management Plan was completed, several new conditions have developed. These include:

- Endangered Species Act (ESA) listing of Salmon species.
- Increased understanding of tribal rights, including treaty rights.
- Increased understanding of the projected impacts of climate change on flood hazards
- Increased focus on environmental justice, diversity, equity, and inclusion, inscribed into state law with the passage of the Healthy Environment for All (HEAL) Act as Senate Bill 5141 in 2021.
- The failure of traditional structural flood control approaches, which have degraded habitat and disrupted natural processes while failing to curb ever-increasing flood damages.
- The broader application of the Integrated Floodplain Management approach.

The Washington State guidebook promotes comprehensive flood hazard management based on the following 12 principles:

1. Focus on Non-Structural Alternatives and Ecological Restoration
2. Respect for Rivers' Natural Processes
3. Focus on the Cause of Flood Damage
4. Integrated Floodplain Management
5. Consideration of the Entire Watershed, Not Just Local Conditions
6. Public Participation and Diversity, Equity, and Inclusion
7. Coordination among Public Works, Planning, and Building Departments and Other Department Activities

8. Interagency and Stakeholder Coordination
9. Planning Process-oriented Examination of Issues
10. Consideration of Future Conditions
11. Consideration of Tribal Rights
12. Consideration of Environmental Justice

## Washington Model Floodplain Ordinance

The Washington Model Floodplain Ordinance includes the minimum state and federal required regulations that must be contained in the local floodplain ordinance. It also includes recommended regulations to improve flood hazard mitigation beyond the minimum requirements. The model ordinance identifies which parts are required, and which parts are recommended. Implementing the minimum and/or recommended provisions of the Washington Model Floodplain Ordinance does not on its own result in integrated floodplain management or comprehensive floodplain management.

## 44 CFR Part 60C

44 CFR Part 60 contains the federal regulations that local governments must follow when creating and implementing their floodplain development ordinances. A subsection of this part, 44 CFR Part 60C[iii] provides non-mandatory best practices for local communities to consider implementing, including but not limited to:

- Requiring that structures be elevated or floodproofed to elevations higher than the base flood elevation, to account for floating debris, land subsidence, and higher than expected floods.
- Acquisition of frequently flood-damaged structures;
- Preservation of the flood-prone and erosion prone areas for open space purposes;
- Disclosure of flood and erosion risk to prospective buyers and renters.
- Requiring new floodway delineations for subdivisions in flood prone areas.
- Requiring pilings instead of fill for structures that are to be elevated above the base flood elevation.

## Channel Migration Zones

Channel Migration Zones (CMZ's) are areas along a river within which the channel(s) can be reasonably predicted to migrate over time as a result of natural and normally occurring hydrological and related processes when considered with the characteristics of the river and its surroundings. Washington Department of Ecology has published guidance on how to complete studies of and manage hazards in CMZ's[iv], including the following overview guidance for managing hazards in CMZ's: "The safest flood protection, and usually the least expensive option, is to limit development to areas not susceptible to either flood inundation or channel migration, thus eliminating exposure to channel migration hazards. For existing communities, it is important to know whether they have areas within a CMZ so they can plan accordingly. Where defenses are needed, the most effective measures will accommodate some channel migration (e.g., levee setbacks) and dissipate the river's erosive energy (e.g., rough versus smooth revetments)."

# ALTERNATIVE FLOOD HAZARD MANAGEMENT SOLUTIONS

Below is a preliminary list of alternative flood hazard management solution types that may be used to respond to flooding issues.

**Dikes**
Dikes are structures that flow to the stream channel. They protect areas adjacent to the dike from flooding when flood levels are lower than the top of the dike. When maintained, dikes can provide effective flood risk reduction for the flood events that they were designed to protect against. Dikes may limit the channel's capacity to convey a stream's flood flows, and disconnect wetlands and floodplain areas from the stream, that would otherwise provide additional flood storage capacity, fish habitat, and other ecological functions. In this regard, despite their effectiveness, dikes can increase flood risks in areas they don't protect, create the illusion that they protect adjacent areas from all flooding, and impair ecological functions. The prior CFHMP did not consider new dikes to be an appropriate solution in Wahkiakum County, however maintaining existing dikes is appropriate and essential to managing flood risk, unless or until the community decides to replace the dike's flood risk management functions with other solutions.

**Setback Levees**
Compared with dikes levees are located further from the stream channel, leaving areas closer to the stream channel vulnerable to flooding, and connected to the stream to provide ecological functions and to store and convey flood flows. Setback levees may be designed to leave aquatic/ wetland/ riparian habitats intact, provide for recreational use of the floodplain, and accommodate channel migration. In some cases, it may be appropriate to replace dikes with setback levees to achieve community goals for floodplain areas closest to the stream, while maintaining protection for areas further away. The prior CFHMP considered levee setback projects potentially appropriate in the Lower Grays River.

**Riprap**
Riprap is rocks placed over an area of shoreline to protect it against erosion from stream flows or waves, and it can be an effective tool for this purpose. Riprap can also increase erosion on nearby shorelines by redirecting the flow energies back into the channel and to adjacent shorelines. Riprap eliminates most ecological functions in the actual area that it covers and impacts ecological functions in adjacent areas as well. Riprap is appropriate in some situations such as emergencies in which there is an imminent erosion threat to something that is very important. However, in many situations alternative solutions are as effective at controlling erosion while having fewer negative impacts. Riprap is not recommended in any particular location.

**Gabions**
Gabions are wire mesh baskets filled with concrete or rocks that are used as a structural toe or sidewall on streambanks. Like riprap, these structures are effective in an emergency and for localized flooding.

Combined with vegetation plantings, gabions can reduce downstream erosion. The prior CFHMP considered gabions potentially appropriate in the Lower Grays River (RM 14-Mouth).

**Deflector Structures**
Deflector structures are typically placed partially across a channel to deflect stream flow away from an eroding stream bank. Rock groins on the Grays River are an example of deflector structures. Similar to other hard shoreline protection methods, deflector structures direct the water's energy in a direction it would otherwise not be directed, potentially increasing the potential for erosion or other damage in nearby areas. Figure 5.5 shows a combination of deflector material and woody material that combines the benefits of flood control while providing additional benefits such as trapping sediment and important functions for aquatic habitat. The prior CFHMP considered deflector structures potentially appropriate around Puget Island, Lower Grays River (RM 14-Mouth), Middle Valley Skamokawa, and the Lower Elochoman River.

**Channel Capacity Enhancement**
Channel capacity enhancements are made to convey larger flood flows. Channel capacity enhancement design requires analysis of channel configuration, surface discharge patterns, sediment trends, and impacted habitats, often relying on new data collection to inform the analyses. Channel capacity enhancement should be responsive to upstream sources of sediment and undertaken in concert with upstream measures to lessen sediment deposition. The prior CFHMP considered this practice potentially appropriate in Lower Grays River (RM 14-Mouth), Middle Valley Skamokawa, Lower Elochoman River.

**Flood Control Structure Maintenance**
Diking districts are not sufficiently funded to maintain the area's flood control infrastructure, and attracting and retaining volunteer board members is a challenge to sustaining maintenance efforts. (Zimmerman, 2022) (Bertroch, 2022). Diking Districts may consider attempting to levy additional tax revenue to carry out their missions. Alternately diking district organizers and the County may consider forming Flood Zone Control Districts authorized under RCW 86.15.020. Flood Zone Control Districts have a variety of authorities at their disposal to fund flood control projects.
It does not appear that there is a systematic inventory of dikes and tide gates, their condition, and maintenance or replacement needs for the whole County or for any of its watersheds. Formally inventorying maintenance needs can provide a foundation for allocating scarce resources to flood control structure maintenance.

**Beneficial Use of Dredge Material**
The beneficial use of dredge material includes using dredge material to manage erosion and flood risks, by depositing it on shore where erosion is occurring, or strategically placing it in aquatic areas where the river's flow patterns will distribute the dredged material to beneficial locations. XXXXX reference requires the Army Corps of Engineers to use xxx percent of dredge material for beneficial purposes. Beneficial use of dredge material is sometimes undertaken in concert with other new flood or erosion control measures such as revegetation, and dynamic revetments.

Section 125 Water Resources Development Act 2020 establishes national policy to increase the beneficial use of dredge material, increase the number of beneficial use demonstration projects, and support Corps' districts such as the Portland District to create beneficial use planning documents that will be added to the 20 -year Columbia River Navigation Channel Maintenance Dredging Plan. While

WRDA does not authorize new funding to support the beneficial use of dredge material, it represents a positive change in policy that guides how the Corps plans for dredge material disposal. Beneficial use of dredge material is recommended to continue around Puget Island in all locations where more detailed analysis demonstrates that it is appropriate.

**Riparian Plantings**
Riparian areas provide a variety of ecological functions. The roots of vegetation in riparian areas bind soil particles together making vegetated riparian areas more resilient to erosion and less likely to contribute to stream aggradation. Maturely vegetated riparian areas can absorb and redirect stream flow energy that would otherwise cause more erosion. Riparian planting is appropriate is appropriate in a variety of contexts. While existing and regularly updated regulations should result in healthier riparian areas over time, intentional riparian plantings should follow projects that disturb riparian vegetation and should accompany more structural flood control measures described above.

**Tide Gate Upgrades**
Many tide gates need repair, replacement, or removal. Older tide gates typically disconnected stream channels from their floodplains, confining flows to a smaller area of the channel, and increasing flow volumes and velocities. Newer tide gate designs provide more connection between channels and their floodplains, allowing for some positive floodplain functions while still protecting upstream areas from tidal flooding. The last CFHMP recommended tide gate upgrades in the tidally influenced areas of Grays River, Deep River, Rangila Slough, Skamokawa Creek, and Groves Slough on Puget Island.

**Large Wood Placement**
The Cowlitz Indian tribe is in completing Upper Grays River Watershed projects to repair hillslope processes, reduce sediment input, and provide habitat benefit for local fish populations using large wood structure placements and native plantings, this large-scale project is an attempt to rehabilitate sections the stream corridor to trap sediment and re-establish a healthy riparian zone for the future. Evaluation of this project effectiveness for trapping sediment would be useful for informing project development elsewhere in the County.

**Road Inventories and Maintenance/Decommissioning Programs**
Private and public timber holdings are required to keep road inventories for their existing logging operations. Road inventories are an excellent platform for demonstrating effectiveness of project types completed to reduce erosion such as culvert replacement and road rehabilitation activities. Road inventories can also be used as a platform for collaborating with local partners to leverage resources for road decommissioning in areas that are vulnerable to landslides that are sources of sediment.

**Culvert Replacement Program**
There is not a program for proactively replacing aging culverts before they fail. The State's required culvert sizes for ESA listed salmon bearing streams are seen locally as cost prohibitive. Emergency culvert replacements following a failure involve less costly regulatory procedures, and may employ smaller culverts, so even though emergency replacements are required to be brought up to normal standard within several years, there are short term regulatory incentives to approach culvert replacements reactively. Creating an inventory of culverts and a system for maintaining the inventory can provide a basis for good decision-making regarding culvert replacements.

**Use of County Owned Land for Restoration**
The County owns land that may be used as functioning floodplain, for in-stream large woody debris projects, and sustainable forest practices.

**Community Forestry**
In community forestry, forest management decisions are made with local community input, opening the potential for decisions that are partially aimed at reducing downstream flood risk. This could include expanded stream buffers, diverse aged stands, and stream corridor projects. The State of Washington's Urban and Community Forestry program[19] is a resource for exploring this idea further.

**Watershed Modelling**
Columbia Land Trust is applying the Visualizing Ecosystem Land Management Assessments (VELMA) Model in the Grays River watershed. The model establishes linkages across watershed process and their effect on variables such as stream flow. Output from the model show a variety of management scenarios during high flow and low flow events that may serve as useful conversation piece related to the Community Forest concept described above and tool for community engagement with landowners in Wahkiakum's upper watersheds.

**Channel Migration Zones**
Channel migration zones are areas in a floodplain where a stream or river channel can be expected to move naturally over time. Guiding development away from channel migration zones reduces the future costs of repairing or replacing damaged infrastructure and property, lessens impacts on habitat. The Inventory and Characterization Report to inform the County's pending Shoreline Master Program Update included a planning level identification of Channel Migration Zones. The analysis however did not identify rates of channel migration, and ultimately mapped relatively wide Channel Migration Zones that while valid within the scope and context of that analysis, included areas so large that they do not serve as well for prioritizing actions to reduce channel migration zone risks. The County may consider completing more detailed Channel Migration Zone analyses for selected areas where channel migration is evidently occurring. After considering the results of those analyses, the community would have more complete information to help decide what methods to use to reduce channel migration zone hazard risk.

**Flood Risk Mapping**
The County's 1990 Flood Insurance Study included analysis of flood risks using standard methods of the time for the Elochoman River up to River mile 4.5, and for much of the Columbia river. For these areas, base flood elevations were determined. Other limited extents of streams were analyzed using more approximate methods, and for these areas base flood elevations were not determined. These study areas do not encompass all of the areas where property and infrastructure are at risk of damage from flooding. The study was initiated nearly 40 years ago with a meeting between FEMA, the U.S. Army Corps of Engineers, and local officials at the County courthouse on July 25th, 1983. Completing a new flood insurance study represents an opportunity for the community to understand current flood risks using current methods and data.

[19] Urban and community Forestry in Washington State – Let's Get Growing! (wordpress.com)

| River | Begin Study Area | End Study Area | Decade Studied | Methods |
|---|---|---|---|---|
| Elochoman River | Mouth | 4.5 | 1980's | Standard |
| Elochoman River | 7.1 | 11.6 | 1980's | Approximate |
| Skamokawa Creek | Mouth | 4.9 | 1980's | Approximate |
| Wilson Creek | Mouth | 5.4 | 1980's | Approximate |
| Birnie Creek | Mouth | .05 | 1980's | Approximate |

**FIGURE 14 SCOPE OF WAHKIAKUM COUNTY FLOOD INSURANCE STUDY**

**Floodplain Management Ordinance**

The most recent FEMA Community Assistance Visit (CAV) resulted in feedback to improve the floodplain ordinance and its administration. The CAV emphasized improvement to ensure that accessory structures such as outbuildings will obtain floodplain permits and have elevation certificates obtained at the required development milestones. (Rosen, 2001) (Wahkiakum County, 2006) Department of Ecology's review of the floodplain ordinance produced a variety of other proposed changes that are either recommended by Ecology, required for compliance with state law[v] and the National Flood Insurance Program[vi].

An adopted floodplain management ordinance meeting minimum state and federal requirements provides flood risk reduction benefits to Wahkiakum County and ensures that property owners remain eligible for flood insurance associated with the National Flood Insurance Program. Local governments commonly adopt floodplain management ordinances that provide an extra level of flood risk reduction beyond what is required by the state and federal government. Some examples of options to reduce flood risk by going beyond the minimum standards include:

**Community Rating System**

Wahkiakum County can further reduce flood risk and reduce flood insurance premiums in the county by participating in the Community Rating System (CRS). CRS is a voluntary incentive program that recognizes and encourages community floodplain management practices that exceed the minimum requirements of the National Flood Insurance Program (NFIP). Participation in the Community Rating System requires some extra administrative resources. A 2018 FEMA publication[vii] titled "Small Communities in the CRS" states that of the 1,486 communities in the CRS as of May 2018, fully 150 have populations of 5,000 or less. Of those, 18 have reached Class 5, earning a 25% discount for the policyholders in their communities' Special Flood Hazard Areas." This and other FEMA publications include useful information for small communities such as Wahkiakum County if they consider participating in the CRS.

**Shoreline Master Program and Critical Areas Regulations**

The Shoreline Master Program is over 20 years old. Updating Shoreline Master Program and Critical Areas Regulations to reflect current conditions and best available science will ensure that floodplain management activities are undertaken in consideration of values such as ecological functions, public access, hazard mitigation, and economic opportunity.

**Property Acquisitions and Purchase of Development Rights**

Acquisitions and purchases of development rights can have flood risk reduction benefits to the extent that they prevent future development from locating in areas of risk, remove existing development that is at risk of flooding, or are needed to implement other activities that reduce risk.

**Property Acquisitions and Purchase of Development Rights**
Acquisitions and purchases of development rights can have flood risk reduction benefits to the extent that they prevent future development from locating in areas of risk, remove existing development that is at risk of flooding, or are needed to implement other activities that reduce risk.

# RECOMMENDATIONS

The CFHMP places an emphasis on non-structural solutions to flood hazard management, and particularly a renewed emphasis on creating and organizing information to inform flood hazard management decisions.

## 1. Update the Floodplain Development Ordinance

The County should update the floodplain development ordinance to at least meet the minimum standards of Washington State and the National Flood Insurance Program. While updating the ordinance, the County should evaluate opportunities to enhance flood risk protections beyond the minimum standards.

## 2. Finish Updating the Shoreline Master Program

The County's draft shoreline master program includes regulations that will help ensure that structural flood hazard management solutions are consistent with the goals of preserving ecological functions, promoting, and protecting public access to shorelines, and prioritizing water-dependent and other preferred uses near local shorelines.

## 3. Update Flood Hazard Area Maps and Information

Advocate for the State of Washington to conduct a RiskMAP project in collaboration with the County, to create up to date information on flood risks and other hazard risks for the County. The RiskMAP process would produce an updated flood risk map, and a variety of other risk information that individuals and the community can use to protect themselves and each other from hazards. This information is a pre-requisite for making informed decisions that are responsive to residents' interests. The County should attempt to customize the RiskMAP project to respond to the community's interest in making the transportation network more resilient to flooding.

## 4. Channel Migration Zone Analyses

Complete Channel Migration Zone Analyses for some of the active channel migration areas identified in the Shoreline Master Program Inventory and Characterization Report. These include Hull Creek (Grays River basin), West Fork Grays River and upper Fossil Creek (Grays River basin, Skamokawa Creek upstream of the West Fork of Skamokawa Creek, Skamokawa Creek between Standard Creek and Falk Creek, Wilson Creek, and the Elochoman River throughout the watershed as far downstream as below Beaver Creek.

## 5. Maintain and Expand Flow and Stage Monitoring

Ensure that the existing Elochoman River and Grays River gauges are maintained so that long term trends in river flow and flood characteristics can be assessed. Consider adding and maintaining additional gauges as well.

## 6. Inventory Flood Control Infrastructure

Inventory flood control infrastructure, starting with areas locally known to have issues. While County residents and staff have deep knowledge of the area's flood control infrastructure, this knowledge needs to be documented and organized so that diking districts can prioritize resources and effectively communicate technical assistance and funding needs to partners.

## 7. Prioritize Culvert Replacements

Using existing culvert inventories, local knowledge of the most undersized and deteriorating culverts should be documented and organized, and the information should be used to identify priority culvert replacement projects and establish implementation goals. Initial goals may be modest, for example to proactively replace one specific culvert within the next three years, and proactively replace one additional culvert every two years thereafter. In any case, the selected culverts and schedule objectives should be determined by a review of the existing culvert inventory, supplemented by local knowledge and community priorities.

## 8. Diking District Support

Explore opportunities to expand support for local Diking Districts, including additional tax levies or sharing technical or management staff that can help plan and execute flood hazard management projects.

## 9. Grays Bay Dredging

Continue advocating with the County's congressional delegation to fund a feasibility study for dredging flow channels in Grays Bay. The US Army Corps of Engineers requires a 50% cost share from a local partner on a feasibility study, and 35% cost share on any actual dredging.

## 10. Puget Island Beneficial Use Dredge Material Disposal

Continue working with the US Army Corps of Engineers and participating in opportunities to comment on the Columbia River Dredge Material Management Plan, to identify beneficial near shore and shoreline dredge material disposal opportunities that mitigate erosion issues on Puget Island.

## 11. Voluntary Buyouts for Flood Impacted Properties

The County may consider taking a leadership role in offering owners of properties that are negatively impacted by flooding the opportunity to relocate. Depending on the circumstances, these projects can be largely funded by FEMA for properties with repetitive losses claimed under the National Flood Insurance Program, or by the US Department of Agriculture for farmland that is impacted or threatened by flooding or erosion.

## 12. Lower Watershed Multi-benefit Projects

Local and regional conservation partners are active in identifying opportunities to restore floodplain habitats. Other local values of interest may be a part of floodplain management projects as well. For example, local landowners may consider partnering with land trusts focusing on agricultural preservation to obtain incentives for preserving agricultural uses.

**Gorley Springs/Crazy Johnson, Grays River Strategy**

This is a large floodplain area that receives substantial sedimentation from upper watershed processes. A portion of this area is currently protected by Columbia land trust and serves as the last remaining spawning areas for Lower Columbia Chum salmon. Large wood has been placed in this area as a part of past conservation projects. Local and regional partners should explore opportunities to create a comprehensive multi-benefit flood and erosion mitigation strategy in this area.

**Large Woody Debris Installations for Streambank Protection**

Large Woody Debris installations to control erosion may be beneficial around the Grays River covered bridge, Sorenson beach, County Park, and East Valley Skamokawa. Local diking districts or the County should initiate conversations with local and regional conservation partners to further assess the feasibility and probably effectiveness of this kind of solution in these locations.

## 13. Upper Watershed Multi-benefit Projects

The Cowlitz Indian Tribe has demonstrated success in implementing multi-benefit projects in upland forest areas that improve salmon spawning habitat and that retain sediment. The results of Columbia Land Trust's Visualizing Ecosystem Land Management Assessments (VELMA) Model may highlight opportunities to reduce flood and erosion risk by focusing actions upstream in the watershed. If modelling suggests upper watershed conservation and restoration projects can meaningfully reduce peak flows and sediment supply downstream in the areas where more lives, property, and agricultural uses are at risk of flooding, the County and downstream diking districts may consider actively investing with conservation partners on upper watershed projects.

**FIGURE 15 EVALUATION OF RECOMMENDATIONS**

| | | | Short Term Objectives | | Long Term Objectives | |
|---|---|---|---|---|---|---|
| **Recommendation** | **Cost and Complexity** | **Term** | **Improve information for flood hazard management decisions.** | **Update foundational plans and ordinances to reflect current conditions.** | **Maintain existing flood hazard management infrastructure and programs.** | **Make new flood hazard management investments to address the root causes of flood hazard risk.** |
| Update the Floodplain Development Ordinance | Low | 1st Action | ■ | ■ | ■ | |
| Finish Updating the Shoreline Master Program | Low | 2 Years | | ■ | ■ | |
| Update Flood Hazard Area Maps and Information | Moderate | 5 Years | ■ | ■ | ■ | ■ |
| Channel Migration Zone Analyses | Moderate | 2 Years | ■ | | | ■ |
| Maintain and Expand Flow and Stage Monitoring | Moderate | 2 Years | ■ | | ■ | |
| Inventory Flood Control Infrastructure | Moderate | 2 Years | ■ | | ■ | |
| Prioritize Culvert Replacements | Low | 2 Years | ■ | | ■ | |
| Diking District Support | Low | 2 Years | | | ■ | |
| Diking District Support<br>Explore opportunities to expand support for local Diking Districts, including additional tax levies or sharing technical or management staff that can | High | 5 Years | | | | ■ |

| | | | | | | |
|---|---|---|---|---|---|---|
| help plan and execute flood hazard management projects. Grays Bay Dredging | | | | | | |
| Puget Island Beneficial Use Dredge Material Disposal | Moderate | 2 Years | | | | |
| Voluntary Buyouts for Flood Impacted Properties | High | 5 Years | | | | |
| Lower Watershed Multi-benefit Projects | Moderate | 5 Years | | | | |
| Upper Watershed Multi-benefit Projects | Moderate | 5 Years | | | | |

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