CHAPTER 6 FLOOD PROBLEM AREAS

Problem Identification

Flood problem areas are located throughout the Chehalis River basin. As discussed in previous chapters, flooding occurs to some extent in most years and can be dramatically different in the upper or lower basins. To frame a discussion of flood problem areas, general flooding problems are presented, followed by a partial listing of specific flood problem areas throughout the Flood Authority's study area. The specific flood problem areas were developed by reviewing existing Comprehensive Flood Hazard Management Plans for jurisdictions in the area, soliciting comments from the public at the Flood Authority's public meetings in February 2009, reviewing recent detailed hydraulic modeling, and analyzing Geographic Information System (GIS) data.

This discussion is intended to support the development of solutions to these known flooding problems. In the Flood Authority's previous deliberations, several overarching problems have been identified, and initial steps (known as "ripe and ready" projects) have been identified and targeted for support. These projects are identified throughout this chapter as appropriate.

General Flooding Issues

General flooding issues in the Chehalis River basin include understanding the sources, potential extent, and potential consequences of flooding; communicating flood hazard information; responding to flood events; and impacts of flood waters. These general flooding issues are described in the following sections.

Understanding the Sources, Potential Extent, and Potential Consequences of Flooding

Initial scientific and engineering hydrologic and hydraulic investigations are an essential element of planning for flood events. These studies can help show the potential extent of flooding, and can suggest the consequences of flooding outside the inundated area. For the Chehalis River basin, initial flood studies have been completed along most of the major channels. The resolution of these studies varies significantly throughout the study area, with more detailed models available in the upper basin (generally upstream of Grand Mound) and less detailed models available for the lower basin.

The Flood Authority is addressing the variable level of detail of the studies through the authorization, in April 2009, of funding for several ripe and ready projects. Those projects include:

- Extending LiDAR[1] coverage throughout the entire study area to establish a consistent, high quality representation of floodplain surface topography;

[1] LIDAR = Light Detection and Ranging – a remote sensing technology that measures properties of scattered light to find range and/or other information of a distant target.

- Developing an unsteady HEC-RAS[2] model for the lower basin, to match the resolution of the existing model in the upper basin; and
- Augmenting the existing precipitation and stream gauge network.

Communicating Flood Hazard Information

Information about flood hazards needs to be conveyed to all residents of the Chehalis River basin. Flood hazard information is available in three phases: prior to flood events, during flood events, and post-event. Prior to flood events, it is important that the public understand that floods can and will occur, both to support decisions about property acquisition, insurance, and development, and to prepare for future events. Challenges with communicating flood hazards include:

- Lack of public understanding of river system behavior and flood hazards;
- The real-time nature of these events; and
- Highly variable levels of understanding of, and tolerance for, risk.

Communication is vital during flood events to ensure that information is disseminated to all affected residents in a way that provides adequate warning. Post-event communication focuses on informing and reminding people of proper cleanup and sanitary measures.

A flood warning system exists for the Chehalis River basin, based primarily on the National Weather Service's Advanced Hydrologic Prediction System. This system is available on the web and provides measured and predicted hydrographs at established USGS stream gauges. This system provided advance warning of flooding in both 2007 and 2009, and provided a reasonable level of accuracy for both events.

Public comments at public workshops suggest that this system may not provide the level of detail necessary to achieve the overall goal of providing clear warning to residents throughout the basin. The National Weather Service information is often interpreted through media outlets, which can influence the impact of the information.

To address this potential gap, the Flood Authority authorized funding for an Early Warning System project to evaluate the adequacy of the existing warning system and make recommendations for augmenting existing systems and improving communication tools. The needs assessment portion of that project will be presented to the Flood Authority at its March 2010 meeting.

[2] HEC-RAS = Hydrologic Engineering Centers River Analysis System – a hydraulic model of water flow through rivers and other channels developed by the Corps of Engineers.

Responding to Flood Events - Emergency Management

The quality of response to flood events is tied to advance planning, preparation of materials, and broad understanding of plan implementation. Key factors for emergency management include:

- Adequate warning of flood events;
- Established circulation/access routes;
- Established coordination protocols;
- Access to flood fighting materials; and
- Access to hospitals and emergency headquarters.

Specific emergency response issues have included the lack of access from one side of the flooded valley to the other, loss of local radio stations, and impaired access to a major hospital. The Early Warning System project authorized by the Flood Authority will include recommendations for improvements for emergency management.

Impacts of Flood Waters

The direct impacts of flood waters extend across the floodplain, and include temporary and long-term impacts. These impacts include:

- Inundation during the flood event;
- Risk to human safety;
- Loss of property due to bank erosion and channel migration;
- Sedimentation;
- Water quality impacts, including domestic well contamination;
- Damage to buildings, machinery, or roads;
- Risks to livestock and crops; and
- Compromised vital infrastructure, including wastewater treatment plants.

Summary

Table 6-1 summarizes the flooding issues in the basin and identifies ripe and ready projects that the Flood Authority has authorized to further evaluate the issues.

Table 6-1. General Flooding Issues

Issue	Ripe and Ready Project(s)
Understanding the Sources, Potential Extent, and Potential Consequences of Flooding	• LiDAR • Unsteady HEC-RAS model • Stream and rain gauge program • Study of ecosystem services
Communicating Flood Hazards • Lack of public understanding of river system behavior and flood hazards • The real-time nature of these events • Highly variable levels of understanding of, and tolerance for, risk	• Early Warning System
Response to Flood Events – Emergency Management • Adequate warning of flood events • Established circulation/access routes • Established coordination protocols • Access to flood fighting materials • Access to hospitals and emergency headquarters	• Early Warning System
Impacts of Flood Waters • Inundation during the event • Loss of property due to bank erosion and channel migration • Sedimentation • Water quality impacts, including domestic well contamination • Damage to buildings, machinery, or roads • Compromised vital infrastructure, including wastewater treatment plants	• Early Warning System • Unsteady HEC-RAS model • PUD Storage Study

Site-Specific Flood Issues

The following sources were used to develop a list of site-specific flooding issues:

- Existing Comprehensive Flood Hazard Management Plans for jurisdictions in the Chehalis River basin;
- Public comments solicited at public meetings held on February 11, 2009, in Chehalis and February 12, 2009, in Montesano;
- Contacts with floodplain and emergency managers at member communities; and
- A general mapping analysis of the basin comparing major transportation infrastructure to mapped special flood hazard zones.

The existing CFHMPs are described in Chapter 4. These plans provided the basis for identifying flood problem areas in the basin.

The Flood Authority conducted public meetings in Chehalis on February 11, 2009, and Montesano on February 12, 2009. At the meetings, the Flood Authority solicited public input on flood-related problems, potential solutions, and recommended goals for the Authority. The problems identified by members of the public are listed below. The

problems are presented as a list of actual comments made by the public, and no attempt has been made to edit or categorize them.

Problems identified by the public at the public meeting in Chehalis on February 11:

- Restricted flow of the Chehalis River at Galvin Road
- Water built up at Mellen Street, goes into Chehalis and Centralia
- Water backing up over Highway 6 / Closure of Highway 6
- Residential flooding along Highway 6
- Flooding in West Adna
- Residential flooding 3 to 4 miles up Salzer Creek
- Bridges washed out
    - Dryad
    - Meskill
    - Rainbow Falls State Park
- Extensive flooding on Bunker Creek – loss of livestock and feed, major property damage, river changed course
- Flooding on Scheuber Road – across from Airport
- Flood on Newaukum, Rice Road area
- Flooding on Sylvenus Street – across from Riverside
- Lack of forest duff causes faster runoff
- Flooding in homes near Veteran's Memorial Museum in Chehalis
- Lack of flood prediction and gauges near Veteran's Memorial Museum
- South Street area of Chehalis, by Salzer Valley Creek, floods between the landfill and the tracks
- Emotional trauma related to flooding of homes
- Flooding along River Street in Chehalis
- Long Road dike area
- Long Road dike breach (2007), impact on houses
- Residential flooding in Curtis
- Flooding in China Creek
- Retail business losses due to flooding
- Debris and mud flow contributing to property damage
- Inability to travel

- Inability to develop
- Stalled process
- Lack of responsiveness from Corps
- Levees push water into houses
- Consequences of filling runoff spots (wetlands)
- Communications break down in 2007 flood
- Not enough stormwater drains, or they back up (near Veteran's Memorial Museum)
- Poor predictions
- "Best" practices that are not
- River does not have enough capacity
- Roads acting as a dike or levee, particularly as a result of road repairs
- Projects that contribute to what they are supposed to fix
- Bureaucracy
- Waiting too long for solutions
- Steep-slope clear-cutting / logging practice - rotation lengths that are too short
- Unclear rules on rebuilding permits
- State sales tax on rebuilding
- Impacts on business/commerce
- Need better flood notification to neighborhoods
- Need for better flood cleanup, should involve community
- Environmentalists in the way
- Some folks are trapped
- Difficulty with government processes – billing, requirements, permitting
- Corps cannot be trusted
- Inadequate flood fighting
- Water super tunnels
- Levee failure / levees get overtopped often
- Inadequate levee repair
- Levees displace people

Problems identified by the public at the public meeting in Montesano on February 12:

- Mismanagement of the lake level on the Wynoochee Dam
- Log jams in the rivers
- Erosion of farm lands – mile long stretches
- Flooding of Oakville
- Water from Capital Forest
- Loggers and property owners cut down trees before they get to 30 inches and that causes more water runoff and more soil erosion in a flood
- Lost livestock
- Loss of three dairies – each dairy loses $1 million a year during floods
- Bank erosion on the lower Satsop – there are 250,000 cubic yards of dirt that went into the river
- Barometric pressure of water coming out of the ground
- Difficulty for citizens to predict flooding on their property from available information
- Anderson Road (Chehalis Reservation) acts as dam
- Black River Bridge acts as a dam
- Highway 12 acts as a dam
- Moon Road (Chehalis Reservation) gets closed every flood
- Levees just cause someone else to get flooded
- 100-year floods happen more often than every 100 years
- Dams only work during unique situations planned for by hydrologists
- Erosion in Boistfort – soils end up downstream

A general GIS analysis was performed to identify other potential flood problem areas not identified in existing CFHMPs or by public comment. The analysis used the Washington State Department of Transportation (WSDOT) "major roads" layer and the mapped 1 percent annual chance flood. The 1 percent annual chance flood mapping used was the FEMA Q3 data for Lewis and Grays Harbor Counties, and a data layer developed by Thurston County in that area. The major roads layer and the 1 percent annual chance flood area were overlayed to identify infrastructure at risk for flooding. The results were then evaluated to identify long stretches of major road that have the potential to be overtopped in a major flood. If these areas provided what appeared to be regionally-important access (e.g., connecting a more rural portion of the area to an urban center), they were included in the mapping. This analysis was a mapping exercise only and has not been verified through field work.

More recent flood mapping developed by Northwest Hydraulics Consultants (nhc) for the Lewis County prosecutor's office was also inspected to identify areas with significant flooding. This mapping is based on an unsteady HEC-RAS model that has been developed to show the approximate extent of the 2007 flood event. While the general flood mapping is similar to the FEMA Q3 mapping described above, the Northwest Hydraulics Consultants mapping is more detailed in many areas, and also is set up to depict the depth of flooding.

To simplify the discussion of site-specific flood issues, the issues were categorized into three areas:

- Major Infrastructure (MI),
- Human Health and Safety (HHS), or
- Emergency Response (ER).

Major Infrastructure issues include major items such as interstate highways and wastewater treatment plants that are threatened by flood events. Human Health and Safety includes flooding of private property, secondary roads, and other public infrastructure. The Emergency Response category is intended to capture key elements of the emergency response network that have been damaged or cut off during floods, when they are needed most. Table 6-2 lists the identified flood issues. All site-specific flood issues are mapped in Figures 6-1 (upper basin) and 6-2 (lower basin).

Table 6-2. Site-Specific Flood Issues

Location	Type[1]	Information Source	Flooding Source(s)
I-5 at Dillenbaugh Creek Confluence	MI	GIS	Mainstem Chehalis and Dillenbaugh Creek
Highway 6	MI	GIS and Public Comment	Mainstem Chehalis and Newuakum
I-5 at Chehalis	MI	GIS, nhc map	Mainstem Chehalis
Mellen Street Wastewater Treatment Plant	MI	Lewis County CFHMP	Mainstem Chehalis
Centralia Central Business District at China Creek	MI	Lewis County CFHMP	Mainstem Chehalis, China Creek, Skookumchuck River
Montesano Wastewater Treatment Plant Lagoons	MI	Montesano Hazard Plan	Mainstem Chehalis, Tidal Action
Highways 105 and 107 at Montesano	MI	GIS	Mainstem Chehalis
US Highway 12 at Elma	MI	GIS	Mainstem Chehalis
Chehalis River at Aberdeen	MI	GIS	Mainstem Chehalis, Tidal Action
Long Road	HHS	GIS and Public Comment	Mainstem Chehalis
Stearns Creek Confluence	HHS	nhc mapping	Stearns Creek, Mainstem Chehalis
SF – Mainstem Confluence	HHS	nhc mapping	South Fork, Mainstem Chehalis
Salzer Creek/Fairgrounds	HHS	Lewis County CFHMP	Salzer Creek,

Location	Type[1]	Information Source	Flooding Source(s)
Dillenbaugh Creek Industrial Area	HHS	Lewis County CFHMP	Dillenbaugh Creek, Mainstem Chehalis
Lower Coffee Creek	HHS	Lewis County CFHMP	Coffee Creek, Skookumchuck River
Galvin	HHS	Lewis County CFHMP	Mainstem Chehalis, Lincoln Creek
Bucoda	HHS	Bucoda CFHMP	Skookumchuck River
Adna	HHS	Public Comment	Mainstem Chehalis
Residential flooding on Salzer Creek	HHS	Public Comment	Salzer Creek
Newaukum at Rice Road	HHS	Public Comment	Newaukum River
Curtis	HHS	Public Comment	South Fork Chehalis
Bridge failures at Dryad and Rainbow Falls State Park	HHS	Public Comment	Mainstem Chehalis
Bridge failure at Meskill	HHS	Public Comment	Mainstem Chehalis
Highway 507	HHS	GIS	Skookumchuck, China Creek
Wakefield Road near Elma	HHS	GIS	Mainstem Chehalis
Oakville	HHS	Chehalis Tribe CFHMP	Mainstem Chehalis
Sickman Ford Bridge Approach	HHS	Chehalis Tribe CFHMP	Mainstem Chehalis
Upper Falls Creek	HHS	Grays Harbor CFHMP	Upper Falls Creek
Elma	HHS	Grays Harbor CFHMP	Mainstem Chehalis
Road near Satsop – Chehalis Confluence	HHS	Grays Harbor CFHMP	Mainstem Chehalis, Satsop River
Chehalis downstream of Satsop-Chehalis Confluence	HHS	Grays Harbor CFHMP	Mainstem Chehalis, Satsop River
Chehalis near Arland Road	HHS	Grays Harbor CFHMP	Mainstem Chehalis
Wynoochee River near Montesano	HHS	Grays Harbor CFHMP	Wynooche, Mainstem Chehalis
Hospital on Crooks Hill Road	ER	Lewis County CFHMP	Mainstem Chehalis
Moon Road at Chehalis Tribe	ER	Chehalis Tribe CFHMP	Mainstem Chehalis, Black River
Anderson Road at Chehalis Tribe	ER	Chehalis Tribe CFHMP	Mainstem Chehalis
Howanut Road	ER	Chehalis Tribe CFHMP	Mainstem Chehalis, Black River

1 MI = Major Infrastructure, HHS = Human Health and Safety, ER = Emergency Response

CHAPTER 7 DEVELOPMENT OF MITIGATION ALTERNATIVES

Options for addressing flooding concerns include infrastructure and capital projects, public information programs, regulations, planning measures, and environmental protection and enhancement measures. Comprehensive flood hazard management emphasizes selecting a mix of approaches to minimize flooding impacts. This chapter presents and defines the general types of alternatives commonly used in floodplain management.

General Categories of Solutions

Flood hazard management measures are commonly classified as structural or non-structural. Structural measures involve physical activities in or near the stream such as storage facilities, levees, placement of bank protection materials, and other engineering and construction activities. Non-structural measures include stormwater and land use regulations, flood preparedness programs, public awareness programs, floodproofing, and maintenance programs. The federal government encourages the use of cost-effective, long-term non-structural alternatives. Tables 7-1 and 7-2 summarize typical non-structural and structural solutions, respectively.

Table 7-1. Typical Non-structural Flood Hazard Management Solutions

Measure	Description	Typical Activities
Public Information	Public information activities to advise people of the risks associated with flood hazards, about flood insurance, and ways to reduce flood damage	• Public outreach projects • Flood protection library • Flood preparedness programs • Elevation certification • Hazard disclosure • Public workshops or meetings
Regulation	Regulatory measures to provide protection for existing structures and new development through land use regulation	• High regulatory standards • Low-density zoning • Open space preservation • Regulatory consistency • Building codes • Stormwater management
Planning and Data Collection	Activities to develop accurate floodplain information and flood data and increase the understanding of the river's flood characteristics	• Floodplain and channel meander zone (CMZ) mapping • Flood data maintenance (GIS, databases) • Engineering studies • Modeling
Reduce Damage to Existing Structures	Measures addressing flood damage to existing structures (buildings, roads, bridges, levees, etc.)	• Acquiring or relocating floodprone structures • Floodproofing • Developing repetitive loss plans • Elevating buildings and roadways • Flood insurance

Measure	Description	Typical Activities
Emergency Response and Preparedness	Actions to minimize the effects of flooding on people, property, and the contents of buildings	• Individual action plans • Comprehensive planning • Flood warning systems • Stream and precipitation gauge monitoring • Flood facility maintenance programs • Emergency response plans • Critical facilities protection • Post-distaster mitigation
Natural Resource Protection Projects	Measures to preserve or restore natural areas or the natural functions of floodplain and watershed areas	• Wetland protection • Habitat protection • Erosion and sediment control • Forestry practices

Table 7-2. Typical Structural Flood Hazard Management Solutions

Measure	Description	Typical Activities
Floodplain Protection	Measures that reduce flood hazards for property, structures and occupants in the floodplain. Protection from inundation, floating debris, sediments, and the force of water flowing in the floodplain	• Setback levees • Dikes • Elevating roads • Redesigning and replacing bridges • Constructing/expanding storage reservoirs
Bank Protection	Measures designed to produce a stable, durable streambank that can withstand flood waters	• Reestablishing riparian vegetation • Constructing approach dikes • Installing gabions (wire cages filled with rocks to stabilize the bank) • Constructing windrow revetments (a line of stone placed on the edge of a bank) • Reducing bank slope • Riprap
Conveyance Capacity	Increasing channel bed slope or cross-sectional area or decreasing channel roughness in order to increase the amount of flow that a stream can carry; increasing off-channel storage or floodplain storage	• Constructing overflow/secondary channels • Removing vegetation and debris • Widening or deepening the channel • Controlling growth of vegetation in the channel • Increasing floodplain storage by removing levees or moving roads

CHAPTER 9 RECOMMENDED ACTIONS AND ALTERNATIVE ANALYSIS

Introduction

The Chehalis River Basin Flood Authority has limited funding to implement flood mitigation projects. The majority of the funding appropriated by the Legislature for the Flood Authority is set aside as matching funds for the U.S. Army Corps of Engineers flood hazard mitigation projects for the Chehalis river basin area. The Flood Authority determined that the best use of its limited funds would be to fund projects they have called Ripe and Ready Projects and to gather project ideas that could be implemented in the future when a governance structure, such as a flood district, is in place and funding is available. In addition, the Flood Authority has funded and/or supported the study of two major capital projects for the basin—the Corps Twin Cities Project and Lewis County PUD's Upstream Storage Project. The Flood Authority also developed a selection criteria process for evaluating proposed projects.

This chapter describes the two major capital projects being evaluated for the basin, the Ripe and Ready Projects that the Flood Authority has undertaken, and the Regulatory Review Project. It also presents lists of project ideas that have been proposed by jurisdictions and individuals in the basin. At the end of the chapter is a description of selection criteria that can be used in the future.

Existing Flood Mitigation Actions

Major Regional Capital Projects

Major regional capital projects address flood issues on a broad or regional basis. These include projects such as levee construction, flood storage, and dam modifications. The Flood Authority is currently supporting two such projects.

The Twin Cities Project is being undertaken by the Corps of Engineers. It consists of a series of levees along the Chehalis River in Centralia and Chehalis. The project is intended to alleviate flooding of Interstate 5 near Chehalis and will also mitigate local flooding in the vicinity. The project also includes evaluation of modifications to Skookumchuck Dam to allow the reservoir to be used for flood storage. The design of the project is scheduled to be complete in May 2013 with construction extending from 2015 to 2020. The project is authorized by Congress through the Water Resource Development Act and requires a local match. The state authorization of the Flood Authority includes the matching funds.

Lewis County PUD is studying the feasibility of two upstream storage facilities, one on the Upper Chehalis River and one on the South Fork Chehalis. These facilities are intended to provide flood Mitigation, hydropower production, and instream flow benefits. The PUD is currently studying the feasibility of the facilities.

Neither of these projects is ready to be implemented. To support decision-making on these major regional projects, the Flood Authority decided to undertake the Ripe and Ready projects described below.

Ripe and Ready Projects

An early interest of the Flood Authority was to implement some flood risk reduction projects as soon as possible. These projects were identified as ones that could provide an immediate benefit, would not adversely affect others, and would not preclude any future actions. These have been referred to as "Ripe and Ready" projects. Under the category of Ripe and Ready studies, the Flood Authority has chosen to support a number of studies that would support decision-making on major capital projects in the basin. The Ripe and Ready projects also included two nonstructural projects—an evaluation of regulatory programs in the basin and the design of an early warning system for the basin.

The Flood Authority has funded or provided support for studies that will be useful in evaluating future flood mitigation projects.

- Seamless LiDAR. This project would acquire Light Detection and Ranging (LiDAR) data for the entire Chehalis River mainstem and major tributaries. The project would provide a consistent topographic dataset throughout the area that could be used with hydraulic models to improve the evaluating of flood impacts and the effectiveness of flood mitigation projects.

- Lower-basin Hydraulic Model. This project would produce a calibrated 1D hydraulic model for the lower basin, similar to the existing unsteady HEC-RAS model used by Northwest Hydraulic Consultants **(nhc**) and the Corps for the upper basin. This model would allow for evaluation of downstream impacts and benefits of potential flood mitigation projects.

- Ecosystem Services. This project includes an economic analysis to value flood protection and other ecosystem services in the basin. It can be used as a tool to select flood mitigation projects.

- Lewis County PUD Upstream Storage Phase 2 Studies. These studies are evaluating the feasibility of constructing the two storage facilities in the upper Chehalis basin proposed by the PUD.

- Coordinated Study. This project will develop timely, comparable data on the Twin Cities Project and an upstream storage facility designed solely for flood mitigation and to determine if there is an economically feasible combination of the two projects.

- Early Warning Program. This project is evaluating the need for improved flood warning and emergency management systems in the basin. An improved system will be designed and implemented.

- Evaluation of Regulatory Approaches. This project evaluated existing flood regulations of jurisdictions in the basin and made recommendations for improved regulations that could be adopted by those jurisdictions. Additional information on the recommendations is presented below.

In addition to the studies listed, the Flood Authority also considered involvement in the Skookumchuck Dam Modification Feasibility and Decision Support Tool projects. The Skookumchuck Dam feasibility study is evaluating alternatives for modifying the discharge system of the dam to allow more effective use for flood control. TransAlta has determined that the best approach to modification of the Skookumchuck Dam is to work with the Corps of Engineers as part of the Twin Cities project. The USGS Decision Support Tool is a rainfall-runoff model that could improve flood prediction. The USGS and Corps are developing a scope of work for the project and it appears the Flood Authority will not be involved at this time.

Regulatory Program Recommendations

In response to concerns and questions about development impacts on flooding and the adequacy of existing local regulations, the Flood Authority agreed to evaluate existing regulations in the basin. The Flood Authority authorized an approach to considering regulatory programs in June 2009.

The purpose of the project was to make recommendations for improvements to regulatory programs in the basin. The project consisted of an evaluation of existing flood regulations of member jurisdictions and development of recommendations for improved regulations. The evaluation and development of recommendations was conducted by a Regulatory Work Group consisting of Board Advisory Committee members and representatives from the basin jurisdictions planning and building departments.

The Work Group determined that all jurisdictions in the Flood Authority meet state flood regulations requirements as well as the minimum requirements of the National Flood Insurance Program. The Work Group developed recommendations to improve regulations beyond those standards using concepts presented in FEMA's Community Rating System (CRS). The CRS gives discounts on flood insurance to citizens of communities that implement regulations that go beyond the minimum National Flood Insurance Program (NFIP) requirements.

In addition to using the CRS guidelines, the Work Group evaluated regulatory approaches to development in the floodplain from the perspective of:

- Risk to proposed structures,
- Risk to existing structures and properties,
- Ecological risks (including habitat, water quality, and wetland impacts), and
- Emergency management costs.

The recommendations are listed below. Additional details on the recommendations are included in Appendix A.

Basic Recommendations

The Work Group decided to present its recommendations in two categories. Basic recommendations are those that the work group felt all jurisdictions in the basin should adopt.

Recommendation 1 - Require that all new residential structures in the floodplain (Special Flood Hazard Area) be built 2 feet above the base flood elevation (freeboard).

Recommendation 2 - Require that all new commercial or industrial structures in the floodplain be built 1 foot or more above the base flood elevation (BFE) or be floodproofed so that areas located 1 foot above the BFE or lower are watertight.

Recommendation 3 - Require that buildings in the floodplain have an approved foundation (per the requirements of NFIP Technical Bulletin 11-01).

Recommendation 4 - Adopt regulations that limit enclosures below the BFE to discourage finishing elevated areas.

Recommendation 5 - Require a lower threshold for substantial improvements.

Recommendation 6 - Require that substantial improvements be counted cumulatively within a specific time period such as 10 years.

Recommendation 7 – Place limitations on critical facilities in the floodplain.

Recommendation 8 - Adopt subdivision and development regulations that avoid or minimize development in floodplains.

Recommendation 9 - Adopt low density zoning in the floodplain.

Recommendation 10 - Adopt the current version of the Department of Ecology's Stormwater Manual.

Recommendation 11 - Include floodplain protection in the Critical Areas Regulations or adopt floodplain regulations as part of the Critical Areas Regulations.

Recommendation 12 - Adopt wetland and stream buffers that protect the natural and beneficial functions of wetlands and streams.

Recommendation 13 - Restrict activities allowed in wetland and stream buffers to those that do not increase impervious surfaces.

Recommendation 14 - When Shoreline Management Programs are updated, incorporate Shoreline Management Program guidelines for flood hazards.

Recommendation 15 - Include "associated wetlands" as part of the shoreline management zone.

In addition, at its January work session, the Flood Authority decided to add an additional recommendation:

Recommendation 16 – All jurisdictions should participate in the NFIP CRS program.

Ideal Recommendations

The Work Group also developed "ideal" recommendations. These are recommendations that the Work Group thinks all jurisdictions in the basin should consider and work towards if practical for the conditions in their jurisdictions

"Ideal" Recommendation 1 - Require compensatory storage for fill in the floodplain. Consider a 1:1 or 1.5:1 requirement for storage.

"Ideal" Recommendation 2 - Adopt a zero-rise policy in the floodplain.

"Ideal" Recommendation 3 - Restrict development in the floodplain, requiring all development proposals to acquire a special permit or reasonable use exception.

"Ideal" Recommendation 4 - Require new streets in the floodplain to be at or above base flood elevation

"Ideal" Recommendation 5 - Prohibit the storage of hazardous materials in the floodplain or require that such materials be stored above the flood protection elevation for residential structures.

Flood Mitigation Alternative Actions

The Flood Authority solicited input on structural and non-structural alternatives to reduce flooding impacts in the Chehalis River basin. The Flood Authority identified these mitigation alternatives in a number of ways. First, project lists were compiled from existing Comprehensive Flood Hazard Management Plans (CFHMPs) for jurisdictions within the Chehalis River basin. Second, the public was asked to recommend projects at the public workshops held in February 2009. The Flood Authority also requested project recommendations from member jurisdictions and the public.
These projects have not been developed or designed to a level adequate to evaluate their potential feasibility or effectiveness. The Flood Authority presents these projects as a list of identified projects that could be further evaluated in the future and possibly be implemented under a flood district.

The identified projects are presented in Table 9-1. The projects are classified using the categories described in Chapter 7. Both structural and nonstructural measures are presented. Many of the projects identified are Planning and Data Collection efforts to support the development of projects in the future.

Table 9-1. Identified Flood Mitigation Alternatives in the Chehalis River Basin

Project	Location
Floodplain Protection	
Salzer Creek backwater control	On Salzer Creek in Lewis County
Increased on-site detention and retention	Grays Harbor County
Overtopping levee on the north end of town	Bucoda
Twin culverts under Main Street at 11th	Bucoda
Relief culvert for north side runoff	Oakville
Harris Creek fish enhancement	Oakville
Sickman-Ford Bridge culvert	Oakville
Open old migration channels to allow river braiding	Wynoochee and Satsop Rivers
Culvert projects on Hiram Hill	Grays Harbor County
Montesano WWTP protection	Montesano
Adna levee improvement	Adna
Wastewater outfall protection	Basin-wide
Weelhead and water treatment protection	Montesano
Tilley Road culvert replacement	Thurston County
Bank Protection	
Bank stabilization and debris removal program	Basin-wide
Biostabilization	Basin-wide
Wynoochee River bank stabilization	Montesano
Streambank stabilization	Bucoda
Mary's River Lumber bank protection	Montesano
Independence Road bank protection	Thurston County
Conveyance Capacity	
Open migration zone of the Satsop	Satsop River
Dredge Lake Sylvia	Montesano
Open relic channel at Marys River oxbow	Grays Harbor County
Regulatory Programs	
Floodplain conservation easement program	Basin-wide
Improve floodplain regulations	Basin-wide
Tax breaks for removing structures from floodplain	Basin-wide
Penalization for building in the floodplain	Basin-wide
Planning and Data Collection	
Remap high groundwater areas	Thurston County
Channel migration zone mapping	Basin-wide
Channel migration analysis	City of Chehalis to Grays Harbor County
Augment Chehalis Tribe Flood Plan with 2-, 5-, and 10-year recurrence interval maps	Chehalis Reservation
Survey of river cross-sections	Basin-wide
Remap floodplains	Thurston County
Berwick Creek Drainage Plan	Chehalis and Lewis County
China Creek Drainage Plan	Lewis County and Chehalis
Rochester Stormwater Plan	Rochester
Reevaluate land uses and zoning based on new mapping	Thurston County
Study of woody debris and aggregates	Basin-wide
Evaluate channel response to sediment	Basin-wide
Study of failed riprap	Basin-wide
Conduct studies needed to design proposed mitigation strategies	Chehalis Reservation
Investigate conditions near Wickett levee	Chehalis Reservation
Determine cause of water backup over Highway 6	Highway 6

Project	Location
Study of fill adjacent to Harris Creek to determine if it should be removed	Harris Creek, Chehalis Reservation
Independence Road Bank Realignment Feasibility Study	Thurston County
Skookumchuck River scour potential study	Skookumchuck River
Develop dynamic model of middle basin to assess effects of future development	Middle basin
Construct a 2-D flow model	Chehalis Reservation specifically and basin-wide
Model effects of removing/modifying the Sickman-Ford Bridge Approach	Sickman-Ford Bridge
Cumulative downstream flood impact analysis	Lower basin
Monitoring program on channel conditions	Basin-wide
Study of impact of recent development of trucking and warehouse facilities	Basin-wide
Evaluate how groundwater impacts flooding events	Basin-wide
Riparian habitat inventory	Basin-wide
Develop a floodplain property acquisition program	Basin-wide
Education and Public Information	
Provide educational materials on flood hazard management	Basin-wide
Provide floodproofing guidance to residents	Basin-wide
Establish a Flood Awareness Week	Basin-wide
Governance and Management	
Form a flood district	Basin-wide
Emergency Response and Preparedness	
Evaluate opportunities for flood warning systems	Lewis County
Flood Hazard Warning Policies	Grays Harbor County
Improve gauge system in Grays Harbor County	Grays Harbor County
Acquire generator for City Hall	Montesano
Construct drinking water reservoir	Montesano
Improve flood notification and response program	Bucoda
Develop and maintain a specific flood warning program	Centralia
Manage Wynoochee and Skookumchuck dams for flood control	Skookumchuck and Wynoochee dams
Install generator at Grays Harbor Fairgrounds	Grays Harbor Fairgrounds
Address loss of power and cell phone coverage	Basin-wide
Establish critter pads to reduce livestock loss	Basin-wide
Reduction of Damage to Existing Structures	
Join the NFIP Community Rating System	Basin-wide
Develop a home elevation and buyout program	Basin-wide
Regrade Main Street	Bucoda
Raise elevation of Moon Road/Easton 188th Roadway	Thurston County
Lincoln Creek floodplain purchase	Lincoln Creek Road area in Lewis County
Protect access to Satsop Development Park	Grays Harbor County
Natural Resource Protection	
Protect and restore critical areas	Basin-wide
Provide habitat for wildlife and fish	Basin-wide
Camp Creek drainage improvements	Grays Harbor County
Encourage longer rotations between tree cutting in forests	Basin-wide
Encourage improvement of forest management practices	Basin-wide

Selection Criteria

The Flood Authority has developed a process for evaluating recommended actions. The process includes a list of project considerations and a set of project criteria. The criteria has not yet been applied to proposed projects because the projects have to be sufficiently defined and scoped before the criteria can be applied successfully. None of the projects proposed for the Chehalis River basin have been adequately defined at this time.

Project Considerations

The Flood Authority reviewed and commented on draft considerations for evaluating projects at the May 2009 work session. Those considerations have been revised and are presented here.

- **Definition of the Project.** Has the project been sufficiently defined and scoped to be considered and evaluated as a potential project by the Flood Authority? What is the intent of the project? Who will benefit?
- **Implementing Agency**. Is there an identified agency or jurisdiction who will take the lead on the project? Is there an identified agency or jurisdiction that will be in charge of maintenance on the project?
- **Ability to Meet Goals**. Does the project meet the goals outlined in the Chehalis River Basin CFHMP?
- **Effectiveness of Mitigation.** What flood hazard problems does the project solve? Is it a permanent or temporary solution? Is it a complete or partial solution? How much of the basin would be affected? Has the project been evaluated for downstream and upstream impacts (both positive and negative)?
- **Feasibility**. Are there technical obstacles that would prevent the project being constructed?
- **Cost and Funding Sources**. How expensive is the project and who will bear the cost? Are funding sources available, both in the short-term and long-term?
- **Cost-effectiveness**. How much benefit does the project deliver per dollar invested?
- **Environmental Impacts**. Does the project have significant environmental impacts or can adverse impacts be mitigated?
- **Permitting Ease**. What approvals or permits will be required? Are those approvals or permits likely to be granted?
- **Timeliness**. How long will it take to implement the project? Are there other projects that must be completed before this project can begin?
- **Acceptability**. Is the project acceptable to the stakeholders in the Chehalis basin?

Project Criteria

The Flood Authority has translated the project considerations into criteria that can be used in numerical ranking system. These rankings will serve as one consideration used by the Flood Authority in determining which projects to support and fund.

Three of the project considerations are framed as yes or no questions. The answer to all three questions needs to be yes, or the project is not ready to rank. The three questions are:

- Is the project sufficiently defined?
- Is there an identified implementing agency or agencies?
- Is the timeline of the project acceptable to the Flood Authority?

The other considerations are framed as criteria for which each project can be ranked high, medium, or low. These are shown in Table 9-2.

Table 9-2. Project Criteria

Criteria	Prioritization Ranking		
	LOW	MEDIUM	HIGH
Goals	Meets no/few goals	Sufficiently meets multiple goals	Meets most goals very well
Effectiveness of Mitigation	Not effective	Moderately effective	Very effective
Upstream and Downstream Impacts on People and Structures	Significant negative impact	Neither positive or negative impact	Positive impact
Technical Feasibility	Difficult to implement	Moderately able to implement	Easy to implement
Funding	Unlikely to be funded	Potential to be funded	Likely to be funded
Cost-Effectiveness	Benefits do not meet costs	Benefits meet or somewhat outweigh costs	Benefits significantly outweigh costs
Environmental Impact	Significant negative impact	Neither positive or negative impact	Positive impact
Permitting	Unlikely to be permitted	Unclear how likely to be permitted	Likely to be permitted
Acceptability	Unpopular/affects few	Not popular with some groups	Popular/affects many