

Flooding in the Chehalis River Basin: Synthesis

prepared for

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Transportation Synthesis Reports (TSRs) are brief summaries of currently available information on topics of interest to WSDOT staff. Online and print sources may include newspaper and periodical articles, NCHRP and other TRB programs, AASHTO, the research and practices of other state DOTs and related academic and industry research. Internet hyperlinks in the TSRs are active at the time of publication, but host server changes can make them obsolete.

REQUEST FOR SYNTHESIS:

Don Nelson, WSDOT Environmental and Engineering Programs Director, and Don Wagner, WSDOT Southwest Region Administrator, initially requested a synthesis of information on Chehalis River flooding and future strategies. Nancy Boyd, WSDOT Deputy State Design Engineer and point of contact on the developing Chehalis Flood committee, submitted a follow-up request for a summary of publications and timeline of events for flooding in the Chehalis River Basin.

BACKGROUND AND TIMELINE:

The Chehalis River Basin of western Washington is the second largest in the state, second only to the Columbia Basin. In the last two decades, four 100-year floods have occurred there: in January and November 1990, February 1996, and December 2007.

Federal Involvement

There is a long history of government flood projects, studies, and proposals in the basin, with particular focus on the flood-prone Centralia Reach of the upper river, near the Twin Cities of Lewis County, Centralia and Chehalis. In 1931, 1935, and 1944 Army Corps reports on the basin determined that flood control was not feasible. In 1965 a federal study began that determined large-scale projects were not justified, though levees, channel modifications, and headwater dams may be. In 1972 interim reports were published, and beginning in 1974 a levee alternative was evaluated for the Centralia area. In 1982 an Army Corps feasibility study recommended increasing storage of the Skookumchuck Reservoir on the Skookumchuck River, a tributary which joins the Chehalis River near Centralia. Preconstruction engineering and design began in 1988; work was suspended in 1991, when the project was determined unfeasible; and a final report was released in 1992.

The Army Corps' began another reevaluation of the Centralia Flood Damage Reduction Project in 1998. Their final General Reevaluation Report (GRR) and accompanying Environmental Impact Statement (EIS) of 2004 expanded the original reservoir project to include a system of setback

levees and non-structural components². The proposal was authorized in the Water Resources Development Act of 2007, but relies upon the backing of state and local parties.

WSDOT's Role Over Time

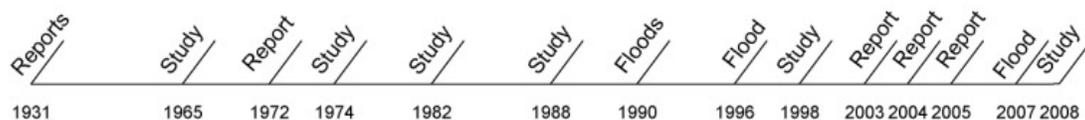
Extreme flood events along the Centralia Reach have severely impacted transportation. In 1990, I-5 was closed for one day; in 1996, four days; and in 2007, four days. In 2004 the Army Corps estimated that transportation-delay costs for the freeway were 3.4 million dollars per day of closure, and that a 100-year flood could be expected to bring 4.5 days of closure costing 15.3 million dollars².

After the 1996 event, WSDOT and the FHWA produced a cost estimate of raising I-5 for 100-year flood protection. In 1998 the Washington Legislature requested that WSDOT consider flooding in the Chehalis Basin, and the Chehalis Basin Flood Reduction Technical Committee was formed, later leading to the Alternatives Sub-Committee. These committees consisted of members from various agencies and interested political groups with technical expertise on the basin⁵. A series of flood-reduction alternatives was developed. Work was finished in 1999 and results were eventually published in the 2004 GRR.

There is also an ongoing I-5 widening project in the area. Environmental Impact Statements have been published for the whole length, Toutle Park Road in Cowlitz County to Maytown in Thurston County, 2003, and for a section in the Centralia Reach, Rush Road to 13th Street, 2005.

Since the most recent flood in December 2007, Washington has renewed involvement. [House Bill 3066](#) of the 2007-2008 Legislature has called for \$50 million to be appropriated to WSDOT for a Chehalis-Centralia flood-control project.

Figure 1. Timeline of Chehalis Basin studies and floods



1931–1944: Three Army Corps reports released for basin in 1931, 1935, and 1944.

1965: Federal study of Chehalis River and tributaries begins.

1972: Interim federal report for Centralia-Chehalis area.

1974–1980: Levee alternative considered for Centralia area.

1982: Army Corps considers feasibility of modifying Skookumchuck Reservoir.

1988–1992: Reevaluation finds 1982 project not feasible; project abandoned; final report released.

1990: 100-year flood events on Chehalis River in January and November; I-5 closed for one day.

1996: 100-year flood event on Chehalis River in February; I-5 closed four days, prompting WSDOT cost estimate for raising freeway.

1998: WSDOT forms Technical Committee on Chehalis Basin flooding.

Army Corps begins second reevaluation of 1982 study.

2003: EIS for I-5 widening project, Toutle Park Road to Maytown.

2004: Army Corps releases reevaluation study for Centralia flood reduction.

2005: EIS for I-5 widening project, Rush Road to 13th Street.

2007: 100-year flood event on Chehalis River in December; I-5 closed four days.

2008: WSDOT to lead Chehalis-Centralia flood reduction project.

SYNTHESIS SUMMARY:

The publications presented in this synthesis have been arranged chronologically, beginning with the most recent. Summaries have been included as available. Many of the summaries are from the “Upper Chehalis River Basin Annotated Bibliography” developed by Northwest GIS Services, Inc., 1999, in cooperation with WSDOT, and available online at <http://www.nwgis.com/images/Upper%20Chehalis%20Bibliography.doc>. Summaries are also from Table 1-2 of the US Army Corps of Engineers 2004 GRR on the Centralia Flood Damage Reduction Project, detailed in the synthesis.

Where possible, links to online resources are included, with page-number references to key material.

OFFICIAL PUBLICATIONS:

1. I-5, Rush Road to 13th Street project, Lewis County, Washington: NEPA environmental assessment

USDOT, FHWA, and WSDOT Southwest Region, 2005, Vancouver, Wash.

This EIS is for a current Chehalis Basin widening project on 3.7 miles of I-5, from Napavine to Chehalis. Project impacts are evaluated for such hydrologic parameters as surface water, ground water, wetlands, vegetation, floodplains, and geology and soils (adapted from “Environmental Assessment Executive Summary,” online at http://www.wsdot.wa.gov/NR/rdonlyres/A4D278B7-896B-4C8C-B97C-BDFB28BDD75D/0/15RushRd_EA_Summary.pdf).

2. Centralia flood damage reduction project, Chehalis River, general reevaluation study: environmental impact statement

US Army Corps of Engineers, 2004

This report documents the development of a recommended plan for flood control in the Centralia region of the Chehalis River Basin. Seven alternatives were developed and analyzed, with the main text of the report summarizing related technical studies. [The seventh alternative, described under *Related Links: Final General Reevaluation Report*, is a proposal developed by the WSDOT-led Alternatives Sub-Committee.] Technical studies are detailed in appendices. An EIS for alternatives is included under separate cover. A National Economic Development (NED) Plan consists of setback levees, increased reservoir storage, and non-structural features. A Locally Preferred (LP) plan calls for a greater increase in reservoir storage and increased protection from levees on the Skookumchuck River. The Recommended Plan is the LP Plan.

Area flood and flood-control history are provided, as well as regional environmental characteristics. (See *Related Links* below for guides to key information of the Final GRR and EIS.)

Related Links:

- **Project Main Page**

<http://www.nws.usace.army.mil/PublicMenu/Menu.cfm?sitename=cent&pagename=home>

This web page contains links to project history, status, and reports, notably the Final GRR and EIS and their appendices.

- **Final General Reevaluation Report**

<http://www.nws.usace.army.mil/PublicMenu/documents/CENT/GRR-1.pdf>

A detailed account of the area’s flood-control history begins on page 20 of the pdf, including area federal studies (Table 1-1), recent local activities, existing flood-control projects, and prior Army Corps reports (Table 1-2). Beginning on page 42 of the pdf is a background on regional flooding, with summaries of 1990 and 1996 events. Discussion of transportation-related damages, including I-5 closures, begins on page 73 of the pdf.

Development of a flood-control strategy begins on page 79 of the pdf, including descriptions of seven alternatives and a screening to determine an optimal plan, the NED Plan (p. 137 of the pdf). Alternative 7 (p. 97 of the pdf) is the “Interagency Committee Alternative” developed

by WSDOT and other agencies, which includes a series of flood-control measures, beginning with non-structural ones.

The LP Plan suggested by Lewis County is on page 141 of the pdf. The Recommended Plan on page 154 of the pdf includes [excerpt]:

- [a] 20,000 ac.-ft. modification plan for the Skookumchuck Dam,
- levee construction of 100-year level protection on the Chehalis River,
- construction of a levee providing 100-year protection on the Skookumchuck River, and
- elevation of structures that would incur increased inundation as a result of the project to mitigate for induced damages.

Structural and non-structural features of the Recommended Plan are detailed on page 157 of the pdf. Additional non-structural features to be adopted by local communities are:

- a new 100-year floodplain to be defined by FEMA,
 - a flood warning system,
 - restriction of development in the floodplain,
 - continued restriction of fill in the floodplain,
 - and enhanced stormwater management to meet Washington's criteria (allowing for detention of the 25-year design storm).
- **Final Environmental Impact Statement**

Part 1, Chapters 1-4

http://www.nws.usace.army.mil/ERS/reposit/Centralia_FEIS_1of2.pdf

A summary of the environmental characteristics of the study area begins on page 91 of the pdf, starting with physical characteristics, such as hydraulics, climate, and geomorphology. A description of the Chehalis River near Centralia states (p. 108 of the pdf):

In the Centralia reach (RM [River Mile] 65.8 to RM 75.2), the river channel deepens, and stream velocities decrease substantially. The Centralia reach is caused by a natural sill in the river more similar to a reservoir or lake than to a river.

Part 2, Chapters 5-12

http://www.nws.usace.army.mil/publicmenu/DOCUMENTS/cent/FEIS_2of2.pdf

Chapter 9 (p. 70 of the pdf) contains public and agency commentary to the draft report. Some of the commenting agencies are Department of the Interior (p. 83 of the pdf), EPA (p. 103 of the pdf), WSDOT (p. 115 of the pdf), Washington Department of Ecology (p. 117 of the pdf), and Fish and Wildlife Service (p. 132 of the pdf). The latter is an in-depth report and includes background on flooding and environmental conditions in the Chehalis Basin.

3. I-5, Toutle Park Road to Maytown: Cowlitz, Lewis and Thurston Counties, Washington: final environmental impact statement

FHWA and WSDOT, 2003, Olympia, Wash.

This is an EIS for a widening project in the Chehalis Basin which passes through the Centralia Reach.

4. Centralia flood damage reduction project, Chehalis River, Washington, general reevaluation study: draft environmental impact statement

US Army Corps of Engineers, Seattle District, 2002, Seattle, Wash.

5. Flood policy on the Chehalis River in Lewis County, Washington: who makes the decisions? [Master's Thesis]

Katarzyna Pierzga and Amy Manchester Harris, 2000, The Evergreen State College, Olympia, Wash.

This public administration master's thesis researches the effects of pro-growth advocates in local government on flood policy in Lewis County. Government and community responses to area flooding of the 1990s are presented, which were obtained through interviews and a survey, respectively. Background information covers early river history, flood-control policy, growth management, political groups and their actions, and pro-growth policy. In conclusion, public policy

recommendations are made. Also included in this thesis are a bibliography and appendices on interviews, Chehalis River flood history, supporting materials, information on assessing growth coalition indicators, floodplain management organizations and their relationships, and survey results.

Related Links:

- **Thesis Index**
<http://www.crcwater.org/issues11/20001006index.html>
This page, a part of the Chehalis River Council's website, provides links to thesis chapters, appendices, and an overview.
- **Chapter VI: The Politics of Flood Plain Management on the Chehalis River**
<http://www.crcwater.org/issues11/20001006chapter6.html>
This chapter identifies several of the organizations involved in flood mitigation and their efforts. The groups described and related agencies are:
 - Chehalis River Council (Lewis Co. Conservation Dist.),
 - Lewis County Flood Action Council (Lewis Co. Economic Development Council),
 - Chehalis River Basin Technical Team (WSDOT)—members later formed the Chehalis River Basin Alternatives Sub-Committee,
 - Chehalis River Flood Hazard Reduction Project Executive Committee (Lewis Co., along with Thurston and Grays Harbor Co.'s, Centralia, and Chehalis),
 - Lewis County Flood District Zone Control Plan Citizens' Advisory Committee (Lewis Co., Board of Commissioners), and
 - Chehalis River Partnership (citizen effort).
- **Appendix III: Supporting Materials: Tom Fitzsimmons, Wash. Dept. of Ecology Director, et al, to Hon. Richard Graham, Lewis Co. Commissioner, and Col. James M. Rigby, US Army Corps of Engineers, Seattle District Commander, February 2, 1999**
<http://www.crcwater.org/issues11/20001006app3.html>
This letter, by members of several Washington and federal agencies—including WSDOT, expresses concerns over the Army Corps' proposal as set forth in its *Chehalis River Basin Flood Reduction Interim Report, December 1998*. The authors consider proposed effects upon the hydrology of the entire Chehalis Watershed and recommend alternative methods.
- **Appendix VII: Additional Supporting Materials: An Introduction to the Chehalis Basin Flood Reduction Alternatives Sub-Committee [Draft]**
<http://www.crcwater.org/issues11/20001006app7.html#20>
Lois Lopez, Washington State Emergency Management Division, May 1999
This article, written for the Chehalis River Council's quarterly publication *Drops of Water*, covers the history and work of the WSDOT-led Alternatives Sub-Committee.

6. Chehalis Basin Flooding: WSDOT Report to the Legislature, December 30, 1999
WSDOT, 1999

"This report presents findings and progress made on flood management and flood hazard reduction projects in the Chehalis River Basin." Four tasks led by Lewis County composed the scope of the work: (1) project coordination and management of activities, (2) analysis of alternatives, (3) base flood boundary and floodway analysis, and (4) model review and verification.

- Task 1 achieved partial progress in the form of project meetings between Lewis County, its consultants, and WSDOT. Other meetings incorporated local officials, Watershed Program participants, the Alternatives Sub-Committee, and other agencies to cover newly developed information, receive recommendations, coordinate activities, and incorporate recommendations.
- Task 2 achieved partial progress in the form of interagency work to provide technical services and support for determining flood reduction strategies. Technical analysis was begun on proposals and other issues identified by the Alternatives Sub-Committee. [For proposed flood-reduction measures of the Alternatives Sub-Committee see *Centralia Damage Flood Reduction Project: Related Links: Final General Reevaluation Report*.]

- Task 3 achieved good progress. Lewis County's consultant, with aid from FEMA and the Army Corps, worked to update floodplain statistics in order to establish effects of the 100-year flood.
- Task 4 did not occur.

7. Post Flood Study, Chehalis River at Centralia, Lewis County, Washington

US Army Corps of Engineers, 1999

[*Summary from US Army Corps of Engineers 2004*] Provides updated flood information on the discharge and stage for the 50-year and 100-year floods on the Chehalis River in the vicinity of Centralia . . . The study also addresses the effects of raising the road surface elevation of I-5 in the Chehalis-Centralia corridor on flood levels in the area. Study found discharges and flood levels had significantly changed from those published in the 1980 FEMA report due to the change in the hydrologic record. The 100-year event at Grand Mound gauging station increased from 58,700 cfs to 74,300 cfs, or approximately .9 foot in stage.

8. Chehalis River Basin flood control project, description of flood plan modification alternatives

Pacific International Engineering, 1998, Edmonds, Washington

[*Summary from Northwest GIS Services, Inc. 1999*] This report is a response to a request from the Chehalis River Basin Technical Committee during its meeting on September 17, 1998, at Lewis County Public Works Department. The report contains detailed flood reduction recommendations. The sites where engineering modifications are recommended include: Skookumchuck Dam, Mellen Street bridge, and State Route 6 bridge vicinity. These alternatives would provide substantial flood flow bypass and would be most effective when all are completed . . .

The report lists and describes modification alternatives in geographic detail. Some commonly flooded areas are also listed with a geographic reference. The report provides cost estimates and describes the benefits of alternatives (the primary benefit is eliminating the need to raise Interstate 5). It discusses possible affects on and mitigation for fish, wildlife, soils, wetlands, and archeological sites.

9. Chehalis River Basin flood control project, pre-feasibility analysis of alternatives

Pacific International Engineering, 1998, Edmonds, Washington

[*Summary from Northwest GIS Services, Inc. 1999*] This report documents the results of a study done by Pacific International Engineering with the goal of providing an alternative to pre-existing plans for controlling flooding in the Upper Chehalis River Basin. The computer models UNET and HEC-1 were used to simulate flood flows and runoff in the basin's complex network of open channels and storage areas. The report includes descriptions of the physiology of the basin and each of its major sub-drainages. Information about the basin's geology, fisheries, wildlife, climate, soils and hydrology, as well as the history of past flood control efforts is included. The results of the model are presented in hydrographs that compare computed peak flow and maximum stage profiles during major flood events at various locations on the Chehalis and Skookumchuck rivers. The report contains several alternatives to controlling flooding and a detailed evaluation of two of the most promising alternatives: a floodway excavation with changes to an existing abatement, and modifications to the Skookumchuck Dam.

10. Long Road, Washington, flood damage reduction study, detailed project report and environmental assessment

US Army Corps of Engineers, Seattle District, for Lewis Co. Diking Dist. #2, 1998

[*Summary from Northwest GIS Services, Inc. 1999*] This report was prepared in response to a letter from the Lewis County Diking District #2 (Long Road District), during 1993, which requested federal flood protection assistance. Currently, much of the Long Road District

(LRD) is subject to annual flooding and flood damages. The LRD is bordered by embankments of Interstate 5 and the Tacoma Eastern Railroad and has experienced flooding from the Chehalis River backing up Salzer Creek. After examining structural and nonstructural alternatives, the Corps of Engineers proposed a levee that would provide a 45-year level of protection, which is acceptable to the LRD and Lewis County.

The report describes the topography and community within the LRD and recognizes that complete flood control within the District is not possible, since, for a large flood, any cross dike would be outflanked and backflooded. This report goes on to describe flood damage reduction studies conducted over the past 15 years.

The report includes an examination of all known practical structural and nonstructural alternatives for meeting the study objective of reducing flood damages to the extent practical in the LRD. It also outlines national economic development, environmental quality, regional development and social effects criteria. Nonstructural alternatives are being pursued by local governments in cooperation with the Federal Emergency Management Agency. The 45-year levee plan is the most cost-effective alternative in reducing flood damages. It is supported by Lewis County and would not cause any significant adverse environmental impacts.

The report describes coordination with government agencies and public outreach efforts . . . Appendices included give a detailed hydrological analysis, project cost estimate, sponsorship letters, and an environmental assessment.

[A levee was installed in 2000.]

11. Post event report: winter storm of 1996-97, federal disaster DR-1159, Western Washington summary (final document)

Prepared for Federal Emergency Management Agency, Region X, by the U. S. Army Corps of Engineers, Seattle District, Engineering Division, Hydrology and Hydraulics, 1997, Seattle, Wash.

[*Summary from Northwest GIS Services, Inc. 1999*] This report characterizes and analyzes the winter storm event of 1996-97, which resulted in a federal disaster declaration for King, Kitsap, Lewis, Pierce, Snohomish, Thurston, and Yakima counties. It details the meteorological phenomena leading up to the disaster declaration, as well as the effects, analysis, and conclusion for specific natural hazards (urban and riverine flooding, lacustrine flooding, groundwater flooding, surface ponding, and landslides).

Maps included show counties declared a disaster, and applicants for assistance from wind, ice, snow, and landslide damage and building failure. Also included are graphs showing annual precipitation since 1949 and earlier, significant flood events for several major rivers, various lake elevations for 1994-1997, and other supporting documentation. No recommendations are given.

12. Southwest Washington flood disaster economic adjustment strategy: counties of Grays Harbor, Lewis, Cowlitz, Wahkiakum and Clark

Prepared for the Cowlitz-Wahkiakum Council of Governments by EMHCO and Associates, 1996, Vancouver, Wash.

[*From Northwest GIS Services, Inc. 1999*] The purpose of the study is to assess economic damage and develop specific county-level strategies to address near- and long-term economic recovery. The report outlines the study approach, then gives details for each county, identifying economic significance, flood areas, local impact from historical flooding, existing flood plans, and flood protection facilities . . .

The report discusses the long history of flooding, lack of follow through on structural recommendations, and how flooding has negatively impacted development in the area. Tables detail types of economic impacts (industrial, commercial, agriculture, etc.); Lewis County has experienced the highest economic impact of all five counties.

The report details the strategy and specific recommendations from the Flood Action Council (FAC) and the Economic Development Council. The FAC supports non-structural flood reduction measures, but also recommends a tax-supported, multi-year process for identifying and constructing structural flood control facilities.

Maps show locations of small business loan applications from the 1995-96 flooding for five counties, for each county, and for the Centralia-Chehalis area, as well as a map showing the large urbanized area around Centralia-Chehalis within the 100-year and 500-year flood zones. Contact names are listed at end of the report.

13. Comprehensive Flood Hazard Management Plan for Lewis County, Volume 1: Lewis County Department of Public Services, document 4107-004
ENSR Consulting and Engineering, 1994, Chehalis, Wash.

[From *Northwest GIS Services, Inc. 1999*] This plan thoroughly addresses flood issues in the Chehalis, Nisqually, and Cowlitz rivers that fall within Lewis County, focusing primarily on the Centralia/Chehalis area. It was prepared with guidance from a Planning Advisory Committee (including county, Washington Department of Ecology, ENSR, and KCM, Inc. representatives) for the purpose of reducing flood hazards and flood control costs. The Planning Advisory Committee recognized that large flood control structures are the only alternative to preventing flooding in the Chehalis/Centralia area. However, since none have been built to date due to low benefit-cost ratio, environmental concerns, and lack of funding, this plan focuses on minimizing impacts of flooding to developed areas and preventing development and other activities that will create new flood hazards. Because of the non-structural nature of this plan, most recommendations are not geographically specific, but specific flood problem areas are identified.

Detailed baseline data is given for the Chehalis/Centralia area (soils, wetlands, wildlife, stream flows, past flooding). The plan outlines the history of flooding in this area and lists flood control structural alternatives.

14. Floods of November 1990 in western Washington

Larry L. Hubbard, 1994, US Geological Survey, Open File Report 93-631, Portland, Ore.

This report documents the flooding of November 1990 and describes related storms and flood damages. There is a map of flood and precipitation measuring sites. Peak stages and discharges are tabulated; rainfall is shown for 10 measurement sites; and daily precipitation is shown from two weather stations and flood discharges from 46 stream-gaging stations.

15. Chehalis River, Washington, 1992: 1:100 000-scale metric topographic--bathymetric map: 30 x 60 minute series (topographic--bathymetric)

US Geological Survey and National Ocean Service, 1993, Denver, Colo.

16. Skookumchuck Dam Modification Project, Centralia, Washington

US Army Corps of Engineer, 1992

[From *Northwest GIS Services, Inc. 1999*] This report summarizes technical work completed so far, and the history of the Skookumchuck Dam modification project, suspended in August of 1990 . . . This report covers the Skookumchuck River Basin, the Town of Bucoda, the City of Centralia, and parts of Lewis and Thurston counties.

This document also provides an overview of two smaller project studies that occurred in conjunction with the Skookumchuck Dam modification project: the Salzer Creek Reconnaissance Report (geographically specific flood reduction recommendations listed here, report completed in 1990) and the Centralia/Chehalis Flood Warning and Flood Response Study (general recommendations only).

The report gives detailed baseline data of the Skookumchuck River regarding hydrology, climateology, streamflow characteristics, flood control regulation, hydropower, hydraulic

analysis, geotechnical considerations, environmental concerns, and economic analysis. Exhibits include correspondence and other supporting documentation for the project.

17. Floods of January 9-11, 1990 in northwestern Oregon and southwestern Washington

Larry L. Hubbard, 1991, US Geological Survey, Open File Report 91-172, Portland, Ore.

[*From Northwest GIS Services, Inc. 1999*] This report documents storms, flooding, and flood damages, of January 9-11, 1990, for Western Washington. Tables included show flood stages, discharge rates, and precipitation totals for selected areas. A map shows flood determination points and climatological stations from which data were collected. No recommendations are given.

18. Interagency Flood Hazard Mitigation Team report in response to the January 18, 1990, disaster declaration, FEMA-852-DR-WA, covering Benton, Grays Harbor, King, Lewis, Pierce, Thurston, and Wahkiakum Counties

Federal Emergency Management Agency, Mitigation Division, Federal Regional Center, Region X, Federal Insurance Administration, 1990, Bothell, Wash.

[*From Northwest GIS Services, Inc. 1999*] This report addresses flood and other storm related issues, and identifies potential projects for consideration by the state in the development of their Section 409 Flood Mitigation Document, as well as projects for funding under Section 404, the Hazard Mitigation Grant Program . . .

An introduction and purpose of the report is presented, followed by an explanation of the hazard mitigation planning process, description of the storm and damages, jurisdictions affected, and development of the recommendations. Work elements describe specific issues to be addressed and are followed by recommendations. Most recommendations are basin-wide, such as update FEMA maps based on priorities, use consistent design standards throughout the watershed, and design roads and drainage structures to be fail-safe when overtopped or when the capacity is exceeded. However, a few site-specific recommendations are provided for the Chehalis/Centralia area, such as rebuild and improve the airport levee to prevent overtopping of Interstate 5 from Salzer Creek to the National Avenue exit.

19. Flood summary: Chehalis River Basin: January 1990 event (and Nov. '90 event addendum)

US Army Corps of Engineer, Seattle District, 1991, Seattle, Wash.

20. Final environmental impact statement supplement: Chehalis River at South Aberdeen and Cosmopolis, Washington flood control project

US Army Corps of Engineers, Seattle District, 1990, Seattle, Wash.

21. Salzer Creek Flood Damage Reduction Report

US Army Corps of Engineer, 1990

[*Summary from US Army Corps of Engineers 2004*] The Salzer Creek Flood Damage Reduction Study, completed in September 1990, looked at flooding in the Salzer Creek basin, which occurs primarily from October through March. The primary plans considered were 6,000 feet of levee to protect the City of Centralia, and a small levee and pump plant to protect the cities of Centralia and Chehalis. The plan would protect portions of the cities of Centralia and Chehalis from the 100-year event flood on the Chehalis River and a larger event on Salzer Creek. The recommended plan consisted of a pump station, an approximately 1,000 foot long levee that would cross Salzer Creek at I-5 and that would prevent Chehalis River backwater flooding, and still allow Salzer Creek to flow through.

22. General design memorandum draft: Chehalis River at South Aberdeen and Cosmopolis, Washington, flood control project

US Army Corps of Engineers, Seattle District, 1988, Seattle, Wash.

- 23. Environmental impact statement supplement draft: Chehalis River at South Aberdeen and Cosmopolis, Washington flood control project**
US Army Corps of Engineers, Seattle District, 1988, Seattle, Wash.
- 24. Centralia flood damage reduction: draft interim feasibility report and draft environmental impact statement**
U.S. Army Corps of Engineers, Seattle District, 1982, Seattle, Wash.
- [*Summary from US Army Corps of Engineers 2004*] Documents investigation of the feasibility of reducing flood damages in the cities of Centralia and Chehalis and surrounding areas. Recommended modification of the existing Skookumchuck Dam to provide flood control storage.
- 25. Flood insurance study: city of Chehalis, Washington, Lewis County**
US Federal Insurance Administration, Federal Emergency Management Agency, 1979, Washington, DC
- [*From Northwest GIS Services, Inc. 1999*] The purpose of this study is to investigate the existence and severity of flood hazards in the City of Chehalis. This report will be used to convert the City of Chehalis to the regular flood insurance program by the Federal Insurance Administration, and for local and regional planners to promote sound land use and floodplain development.
- The study area included the City of Chehalis, the Chehalis River from river mile (rm) 60.5–7.0, and the following tributaries: Newaukum River, rm 0–10.8, Salzer Creek rm 0–7.6, Coal Creek, rm 0–3.8, and Dillenbaugh Creek, rm 0–4.8.
- This report describes the hydrologic analysis carried out, the history of settlement, and the floodplain management approach. Various tables show floodway data for the study area and river profile maps. The flood insurance zones are described, but no recommendations are given.
- 26. Chehalis River at South Aberdeen and Cosmopolis, Washington: communication from the Secretary of the Army transmitting a Corps of Engineers report**
US Army Corps of Engineers, 1979, US GPO, Washington, DC
- 27. Special Study, Suggested Hydraulic Floodway Chehalis and Newaukum Rivers**
U.S. Army Corps of Engineers, 1976
- [*Summary from US Army Corps of Engineers 2004*] Delineated the floodplain and suggested hydraulic floodway for Chehalis River from Chehalis to Adna and the Newaukum River from its mouth to the I-5 bridge.
- 28. Special Study, Suggested Hydraulic Floodway, Chehalis and Skookumchuck Rivers**
US Army Corps of Engineers, 1974
- [*Summary from US Army Corps of Engineers 2004*] Delineated the suggested hydraulic floodway for the area covered by the June 1968 floodplain information report.
- 29. Adna Division, Chehalis River Project, Washington: concluding report**
Bureau of Reclamation, Pacific Northwest Region, 1973, Boise, Id.
- 30. Flood plain information: Chehalis, Wishkah and Hoquiam Rivers, Aberdeen - Hoquiam - Cosmopolis, Washington**
US Army Corps of Engineers, Seattle District, 1971, Seattle, Wash.
- 31. Floods in Aberdeen, Hoquiam, and Cosmopolis, Washington: how to avoid damage**
US Army Corps of Engineers, 1971

- 32. Flood plain information, Chehalis and Skookumchuck Rivers, Centralia - Chehalis, Washington**
US Army Corps of Engineers, 1968, Seattle, Wash.
[Summary from US Army Corps of Engineers 2004] Delineated the floodplain along the Chehalis River from the Lewis/Thurston county line to Chehalis and along the Skookumchuck River from the mouth to the Lewis/Thurston county line.
- 33. Floodplain Information, Chehalis and Skookumchuck River, Bucoda, Washington**
US Army Corps of Engineers, 1968
[Summary from US Army Corps of Engineers 2004] Delineated the floodplain along the Skookumchuck River from the Lewis/Thurston county line to about 1 mile upstream of Bucoda.
- 34. Upper Chehalis River Basin, Washington: reconnaissance report**
US Dept. of the Interior, Bureau of Reclamation, 1965, Boise, Id.
- 35. Coffee Creek, Channel Excavation and Debris Removal under Section 208 of 1954 Flood Control Act**
US Army Corps of Engineers, 1965
[Summary from US Army Corps of Engineers 2004] Examined floodway problems along Lum Road in Centralia and recommended clearing and snagging on 1,660 feet of Coffee Creek (completed March 1966).
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