SPECIAL STUDY

SUGGESTED HYDRAULIC FLOODWAY

CHEHALIS RIVER

Satsop to Porter and Vicinity

Grays Harbor County, Washington

PREPARED FOR

WASHINGTON STATE DEPARTMENT OF ECOLOGY

BY DEPARTMENT OF THE ARMY, SEATTLE DISTRICT

CORPS OF ENGINEERS, SEATTLE, WASHINGTON

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Front Cover: Elma Vicinity During Flood of 28 January 1971.

1.0 Introduction. This special study report was prepared by Seattle District, U.S. Army Corps of Engineers, for the State of Washington, Department of Ecology, on behalf of Grays Harbor County. The purpose of the study is to assist state and local governments in identifying flood hazard areas and to provide a basis for planning and regulating land use in the flood plain. This study delineates the 100-year flood plain boundary and suggested hydraulic floodway for the Chehalis River from the town of Satsop upstream to the vicinity of Porter, Grays Harbor County, Washington.

2.0 Scope. The report shows the extent and depth of flooding and a suggested hydraulic floodway for a 100-year frequency flood, for approximately 16.5 miles of the Chehalis River, from river mile (R.M.) 20.2 near the confluence with the Satsop River, upstream near Porter R.M. 36.7.

Special field and aerial surveys were conducted to obtain 22 cross sections on the Chehalis River and to develop a 5-foot contour interval topographic map. This map was developed by photogrammetric methods, using aerial photographs taken on 30 July 1974. Additional data used in the study includes:

a. High-water marks for the 22 January 1972 flood.

b. Observed flood plain boundaries taken from aerial photographs of the 28 January 1971 flood.

c. Washington State Highway Department topograph maps.

d. Streamflow records prepared by the U.S. Geological Survey.

e. Rainfall records prepared by the National Weather Service.

3.0 Past Floods. Major floods on the Chehalis River usually occur from October to March, caused by high rates of precipitation with accompanying snowmelt. The rivers in the watershed rise rapidly during heavy rainfall because of the relatively quick runoff caused by steep terrain and channel slopes. Crest stage usually is reached within a few hours. In the immediate vicinity of the confluence of the Chehalis and Satsop Rivers, backwater effects may prolong high stages on either river for several hours.

The January 1972 flood was the largest recorded flood in the Chehalis River basin. The flood was most severe in upper portions of the Chehalis River basin, with comparatively moderate runoff from the tributary system downstream from Grand Mound.

A potential for extreme floods exists in the lower Chehalis River, downstream from Satsop, due to coincident timing of flood peaks from the main stem Chehalis River and the local tributary system. Intense maritime storm

systems, following 2 to 3 days apart, could produce such coincident peaking of both main and tributary systems. A combination of storm systems, similar to those decribed above, occurred in December 1933 which is the second largest flood experienced in the lower portions of the Chehalis River basin. The middle portion of the Chehalis River basin between Grand Mound and Satsop, which includes the study area, experiences occasional flooding due to storm combinations that cause coincident or near coincident flood peaks.

4.0 Hydrologic Analysis. Hydrologic investigation was accomplished to establish the 100-year frequency flood for each study reach, using U.S. Geological Survey streamflow records for the streamgage in the Chehalis River system at Porter, Washington. This information was used as a guide to the relative flows of the various streams in the watershed, preparatory to development of hydrographs and simulation models. The investigations also included studies of drainage area characteristics, climatological records, flood discharge magnitudes and frequencies, regional flood relationships, and computerized flood routings as described below. Table 1 shows discharges for the 1972 flood and the 100-year flood at various locations in the study area.

4.1 Chehalis River. The 100-year frequency flood discharge of 61,700 c.f.s. for the Chehalis River was estimated from regional flood relationships and from a computerized watershed model developed through the Corps of Engineers' "Streamflow Synthesis and Reservoir Regulation Program" (SSARR). The model was developed for the Chehalis River and tributary system from the Chehalis River at Grand Mound to the confluence of the Chehalis and Satsop Rivers.

Hydrographs for other gaged locations such as Chehalis River at Grand Mound, Rock Creek at Cedarville, and Cloquallum Creek at Porter were prepared from statistical correlation with the 100-year discharge at Porter. Ungaged local inflow characteristics (timing, shape, and magnitude) were estimated from the 1971 and 1972 observed floods and difference in volume between the flood hydrographs used at Grand Mound and Porter for the 100-year frequency flood. Two flood cases were investigated for the confluence of the Chehalis and Satsop Rivers, as indicated on table 1.

TABLE 1

FLOOD DISCHARGES

LOCATION	RIVER MILE	DRAINAGE AREA SQ-MI	CASE A 1/ Chehalis River DISCHARGE CFS	CASE B 2/ Satsop River DISCHARGE CFS	1972 DISCHARGE CFS
Chehalis River near Grand Mound	59.70	895	56,000		49,200
Chehalis River at Porter	33.30	1,294	61,700		55,600
Chehalis River at South Elma	25.75	1,409	60,800		55,000
Chehalis River above Satsop River	21.0	1,455	59,600	25,000	55,800
Satsop River at the Mouth 3/	0.0	300	11,100	54,000	13,500
Chehalis River below Satsop River	20.20	1,754	70,600	79,000	69,300

1/ CASE A - A 100-year flood of Chehalis River at Satsop, plus coincident flow from Satsop River.

2/ CASE B = A 100-year flood of Satsop River at confluence, plus coincident flow from Chehalis River.

3/ Listed discharges for Satsop River at the mouth and Chehalis River above the Satsop River are coincident.

5.0 Hydraulic Analysis. Backwater calculations were made to develop water surface elevations for the 100-year frequency flood under natural conditions, and to develop the boundaries of a suggested hydraulic floodway. A hydraulic floodway is a portion of the flood plain needed to pass a regulatory flood without a significant rise in water surface elevation. For this study, a regulatory flood is defined as the 100-year frequency flood, and a significant rise in water surface elevation is defined as 1 foot. The remaining portion of the flood plain is called the floodway fringe. The fringe area is not required for conveyance (flood carrying capacity) of floodflows and may be filled, diked, or otherwise obstructed without causing a significant rise in water surface elevation. Table 2 shows predicted water surface elevations for both natural and floodway conditions.

5.1 Backwater Calculations. The water surface profile for the 100-year frequency flood on the Chehalis River was calculated with the aid of a computer program for mathematical modeling of water surface profiles. The Chehalis model was calibrated to reproduce the observed water surface profiles of the 21 January 1972 flood, which had a flow of approximately 55,600 c.f.s. at Porter.

5.2 Floodway Calculations. A subroutine of the backwater program was used to establish the suggested hydraulic floodway boundaries shown on plates 1, 2, and 3.

The suggested hydraulic floodway limits for the main channel of the Chehalis River were determined by removing an equal percentage of flood-carrying capacity (conveyance) from each side of the flood plain so that the remaining constricted flow path would carry the 100-year frequency flood without causing an increase in water surface elevation of more than 1 foot above the natural flow condition. A conveyance reduction determined by this study ranged from 8 to 50 percent on the Chehalis River. Maximum increases in water surface elevation, and channel and overbank velocities under suggested hydraulic floodway conditions, are as follows:

Chehalis River

Maximum Water Surface Increase	+1.0 feet
Maximum Overbank Velocity Increase	+0.90 feet/second
Maximum Channel Velocity Increase	+0.58 feet/second

6.0 Regulatory Floodway. A regulatory floodway is needed for land-use regulation to assure that sufficient area is preserved in the flood plain to safely pass a major flood, such as the 100-year frequency flood. The floodway developed in this study is called a suggested hydraulic floodway

TABLE 2

CHEHALIS RIVER

WATER SURFACE ELEVATIONS - 100-YEAR FREQUENCY FLOOD

CROSS SECTION 1/	NATURAL FLOW (M.S.L.)	HYDRAULIC FLOODWAY (M.S.L.)	DIFFERENCE (FT)
20+70	26.7	27.5	+0.8
21+22	30.4	31.3	+0.9
22+00	30.6	31.5	+0.9
1+00	30.6	31.6	+1.0
23+00	31.0	32.0	+1.0
2+00	31.9	32.9	+1.0
24+00	32.4	33.4	+1.0
24+76	33.1	34.1	+1.0
25+25	33.8	34.8	+1.0
26+27	35.1	36.1	+1.0
26+73	36.1	37.1	+1.0
27+50	37.5	38.5	+1.0
28+12	38.9	39.9	+1.0
28+92	40.2	41.2	+1.0
29+78	41.7	42.6	+0.9
3+00	43.4	44.3	+0.9
31+89	46.4	47.3	+0.9
4+00	47.5	48.4	+0.9
32+55	48.6	49.5	+0.9
34+00	50.1	50.9	+0.8
35+00	51.8	52.6	+0.8
35+87	53.5	54.4	+0.9

1/ Station numbers correspond to cross sections shown on plates 1, 2 and 3.

because it is based primarily on hydraulic factors and is not intended for use as a regulatory instrument until implemented or revised by cognizant state or local authorities, after consideration of local political, social, economic, and environmental factors.

7.0 Flood Proofing. The fringe areas of the flood plain can be obstructed without causing a significant rise in flood depths. These areas are generally suitable for development, provided that structures are properly flood proofed by filling, diking, or other protective construction. Minimum floor elevations for flood proofing can be determined from the elevation of the site relative to the 100-year frequency flood profile, and adding a freeboard of at least 2 feet. Freeboard is needed because of possible increases in flood depths that might be caused by unpredictable debris accumulations, sediment disposition, or channel shifts.

8.0 Authority. This report was prepared under authority granted by Section 206 of the 1970 Flood Control Act, Public Law 89-789, as amended. If additional studies are required, such as hydraulic evaluations of additional floodway alternatives, the U.S. Army Corps of Engineers can perform such studies upon request through the Washington State Department of Ecology.