PLAN OF SURVEY

SKAGIT RIVER FLOOD CONTROL STUDY

1. Summary of data. -

a. Location. - The Skagit River has the largest drainage area in Washington State excluding the Columbia River. The Skagit River and its tributaries are located in northern Washington on the west slope of the Cascade Mountains with drainage from Snohomish, Skagit, and Whatcom Counties and a small amount from Canada.

b. Purpose. - To determine if additional flood control measures and related water uses are justified on Skagit River and its tributaries, and if justified to prepare plans and recommendations on the most desirable plans of increased flood control.

c. Beginning date of study. - October 1960.

d. Scheduled completion date. - 15 October 1963.

e. Approved Federal cost estimate (Incl 3, PB-6). $135,000.

f. F. Y. 1961 allocation (allotted 12 Oct 60). - $30,000.

g. Balance required to complete. - $105,000.

2. Authorization. - The study was authorized by resolutions by Senate Committee on Public Works adopted 4 January 1960, and House Committee on Public Works adopted 9 June 1960, which state " * * * That the Board of Engineers for Rivers and Harbors, be, and is hereby, requested to review the reports on Skagit River, Washington, published as House Document numbered 187, 73d Congress, 2d session, and other reports, with a view to determining whether any modification of the recommendations contained therein is desirable at the present time with particular reference to provision of flood control and allied improvements in the basin." The sponsors of the resolutions were Senators Warren G. Magnuson and Henry M. Jackson, and Representative Jack Westland of the State of Washington.

3. Existing conditions. -

a. Description of basin. - The Skagit River and its tributaries drain 3,140 square miles of the western slopes of the Cascade Mountains, as shown in Inclosure 1. The drainage area is roughly T-shaped with the top of the "T" extending north and south about 100 miles along the Cascade crest. The northern part of the basin is drained by the Skagit which has its source in Canada 28 miles north of the international boundary, from where it flows south and west for 135

See attached 30 June 1960 Status Report giving a narrative on our previous reports and status.

miles to the salt waters of Skagit Bay. About seven miles above its mouth, the river divides into two main distributaries, the North and the South Forks. The southern part of the basin is drained by the Sauk River, the Skagit River's largest tributary, which enters the Skagit about 66 miles above its mouth near the Town of Rockport. The Baker River, another major tributary, drains the southern slopes of Mt. Baker and Mt. Shuksan and enters the Skagit about 56 miles above its mouth at the Town of Concrete. Other important tributaries are the Cascade River, Thunder Creek and Ruby Creek. The upper reaches of the Skagit River are mountainous and timber covered. From Rockport to Sedro Woolley, the river flows through a valley 1 to 3 miles wide but below Sedro Woolley the valley widens to a flat, fertile outwash plain which joins with the Samish Valley on the north and the Stillaguamish River delta on the south.

b. Existing development. - The upper Skagit River and the Baker River have been developed for power production by the construction of several hydroelectric projects. These include Ross, Diablo and Gorge Dams on the Skagit River, and Upper Baker and Lower Baker Dams on the Baker River. The City of Seattle has preliminary plans for construction of another hydroelectric plant on the Skagit River at the Copper Creek damsite. The Skagit delta below Sedro Woolley is highly developed with farming the major occupation. Dairying is the largest single type of occupation but many farms grow a variety of crops.

c. Existing flood control conditions. - (1) A Federal project, authorized by the Flood Control Act of 1936, provides for partial control of floods in the lower valley by diversion of part of the floodwaters through a bypass to be constructed between the Skagit River at Avon and Padilla Bay and other works. The project has not been undertaken because of lack of economic justification. It has been classified inactive and was recommended for abandonment in the unpublished survey report transmitted to Congress 28 November 1956, dated 21 February 1952.

(2) Emergency flood control work. - Since 1947, the Corps of Engineers has spent about $185,000 on reconstruction of damaged or destroyed flood control structures on the Skagit River under appropriate emergency flood control laws.

(3) Improvements by non-Federal agencies. - Existing measures for control of floods consist of flood control storage behind Ross and Upper Baker Dams and dikes and levees built by local interests. Ross Dam, owned by the City of Seattle, is operated under FPC license to provide 120,000 acre-feet of flood storage which reduce flood peaks by 15,000 c.f.s. for natural flows of about 160,000 c.f.s. Upper Baker Dam, owned by Puget Sound Power and Light Company, a private company, is operated under FPC license to replace lost channel storage amounting to 16,000 acre-feet.

Downstream from Sedro Woolley are 16 Diking Districts with levees protecting about 45,000 acres against high river stages and against high tides. In addition to the area in Diking Districts, about 1,000 acres have been leveed by individual landowners. Of the 46,000 acres inclosed by levees about 36,000 acres are in the Skagit River basin and 10,000 are in the Samish River basin protecting against high tides only. In the Skagit and Samish Basins, the total length of levees is 120 miles of which 40 miles are main Skagit levees. These Skagit levees are of varying heights giving varying safe channel capacities presently estimated as follows:

Sedro Woolley to Mt. Vernon, 120,000 c.f.s.

Mt. Vernon to mouth, 90,000 c.f.s.

The Nookachamps Creek area southwest of Sedro Woolley has low levees protecting against small spring and summer high waters. Inundation of the farm and pasture lands is fairly frequent but the farm economy is geared to these conditions. The area acts as a natural storage reservoir during higher floods reducing downstream flood peaks.

The private levees, storage in Ross and Upper Baker Reservoirs and natural storage in the Nookachamps Creek area give the area west of Burlington protection against almost all spring floods and against winter floods with a frequency of about once in 5 years.

d. Flood conditions. - The maximum flood of record was 220,000 c.f.s. at Sedro Woolley in November 1909. The flood of December 1921 had a peak flow of 210,000 c.f.s. at Sedro Woolley. Historical floods occurring in 1815 and 1856 are estimated to have had peak discharges of 400,000 c.f.s. and 300,000 c.f.s., respectively. Flood flows of 90,000 c.f.s. at Sedro Woolley cause minor damages, primarily in the area southwest of Sedro Woolley due to minor levee breaks and in the Nookachamps Creek area which is protected only against low spring and summer high waters. When flows exceed 150,000 c.f.s., right bank overland flow occurs from levee breaks and from outflanking of the right bank levee at Burlington. Also, the flood-waters cross the low divide between Burlington and Sedro Woolley and flow into the Samish Basin. With regulation at Ross and Upper Baker Dams, a 150,000 c.f.s. flow at Sedro Woolley has a frequency of about 25 years. Damages from this flood occur primarily in the left bank diked area below Sedro Woolley and in the Skagit Valley above Sedro Woolley. Damages total about $800,000 under 1951 conditions and on the basis of 1951 prices. Flows of 210,000 c.f.s. at Sedro Woolley have frequencies of about 200 years under existing conditions. On the basis of 1951 conditions and prices damages from flows of this magnitude would total about $6,600,000. Of this total about $5,300,000 in damages would occur west of Sedro Woolley and $1,300,000 east of Sedro Woolley. Damages occur primarily to buildings and their contents and to cropland.

4. Improvements desired by local interests. - Public hearing will be held 8 February 1961, but meetings and discussions with interested citizens and Skagit County officials indicate local interests want improvements for flood control consisting of storage, strengthened dikes and or channel deepening. Bank protection against erosion is desired also.

5. Object of investigation. - The problems of the Skagit Basin are primarily flood control and prevention of bank erosion. The objective of this study is to find the most economically feasible solutions to these primary needs and prepare a comprehensive basin plan for flood control.

6. Source, nature and extent of available pertinent data. -

a. District Office. -

(1) Prior flood control reports by Corps of Engineers.

(a) Report on preliminary examination of Skagit River, Washington, published as House Document Numbered 125, 69th Congress, 1st session (1925).

(b) Report on Skagit River under the provisions of House Document Numbered 308, 69th Congress, 1st session, and published as House Document Numbered 187, 73d Congress, 2d session (1934).

(c) Report on Survey of Skagit River and Appendix dated 21 February 1952.

(2) Field data acquired for prior flood control and navigation reports, and from emergency flood control work.

(3) Engineering and benefit data developed for prior reports.

(4) Hydrologic data from U. S. Geological Survey water supply papers and from prior reports.

(5) Charts and maps including:

(a) 1:24,000 scale, recent U.S.G.S. quadrangles with contour interval of 20 feet covering the Skagit River flood plain from the mouth to Sedro Woolley.

(b) 1:62,500 scale, recent U.S.G.S. quadrangles with contour intervals of 50 and 80 feet covering the Skagit River flood plain from Sedro Woolley to Newhalen except 6 miles near Rockport.

(c) 1:125,000 scale, recent U.S.G.S. quadrangles of the flood plain near Rockport, excluded from (b) above, and of the Sauk River.

(d) Miscellaneous small scale U.S.G.S. and Forest Service maps of the remainder of the Skagit Basin.

(e) U.S.C. & G.S. charts of Skagit Bay.

(f) 1950 levee survey, scale 1" = 400', Seattle District File No. E-6-6-78, showing main Skagit River levee top elevations from Burlington to the river mouth.

(g) Miscellaneous areas surveyed by Seattle District for emergency flood control works.

(6) Recent water surface profiles from Concrete to mouth including North and South Forks.

(7) Economic data from prior reports.

b. Other Federal agencies. - (1) Department of Agriculture. - Data on value of various lands including value of crops. Detailed valuations may be obtained from the Skagit County Agricultural Extension Agent.

(2) Department of Commerce. -

(a) Coast and Geodetic Survey. - Basic tidal and survey control data.

(b) Census Bureau. - Basic data on population and industry of Skagit County and Skagit River Basin.

(c) Weather Bureau. - Basic meteorological data.

(3) Department of the Interior. -

(a) Fish and Wildlife Service. - Required remedial measures to preserve fish and wildlife resources.

(b) Bureau of Mines. - Effect of flood regulation on mineral resources.

(c) U. S. Geological Survey. - Basic mineral, hydrologic and topographic data.

c State agencies. - Miscellaneous reports on resources, lt: census and industry.

d. Economic reports by private consultants for cities the basin including Burlington Comprehensive Plan by raham and Company.

Economic studies. - a. Economic base studies specified in)-2-118 will be made. Available data on economic developments ends will be obtained, supplemented by field studies. Projec- of economic growth will be made as required for economic es.

b. Flood damage appraisal made in 1950 will be supplemented ield appraisal that will establish improvements since 1950. damages will be reevaluated under present-day prices for s water surface elevations under present conditions.

c. Initial economic studies will be limited to potential control benefits. Using the basic data obtained in a and b economic studies will be made to evaluate proposed schemes rovement and establish economic justification. These evalua- will be based on a comparison of conditions with and without posed improvements for both existing and future conditions. ification for a multiple-purpose storage project is indicated, ic studies of related water resources such as power, water ar ner uses will be required. In the event of a favorable le-purpose project, cost allocations will be made in accordance tandard Procedures and information to satisfy Senate Resolution 3 will be obtained.

Engineering studies required. -

a. Improvements under consideration. - Studies for the of floods will include consideration of channel improvements ersion, raising and strengthening of existing dikes, adding kes, upstream storage by dams and downstream storage by flood-improved lands.

b. Method of selecting specific improvements. - Previous s considered all of these alternatives and found none of them ed for construction by the Federal Government. On the basis reports flood control storage at only one location had any lity of being economically justified, that being at Upper am and then, only in conjunction with generation of power. ction of Upper Baker Dam was completed in 1959 by Puget Sound nd Light Company. Prior to granting of the FPC license it ermined that no flood control storage, other than for replace- lost channel storage, would be justified. A review of all of ernatives in "a" above, will be made to determine if changed a or conditions would increase the benefit-cost ratios to allow

economic justification of any of them. If economic justification is not indicated by the review, no further studies will be undertaken. Any scheme of flood control found to have apparent economic justification will receive further study to a stage where adequate project estimates can be developed.

c. Field and office studies required. -

(1) Field surveys will be brought up-to-date as required, particularly with respect to levee profiles and sections to reflect changes made since the previous reports. Channel cross sections obtained for backwater computations in previous reports will be checked to determine if the channel section has changed. If no appreciable change has occurred no further channel sections will be obtained. Elevations of winter 1959-1960 high-water marks, of observed river profiles and as otherwise necessary for hydraulic computations will be obtained. Additional topography for preliminary damsite or other investigations will be taken only as required.

(2) Hydrology and stream regulation. - Basic hydrologic data will be brought up-to-date. Frequency curves under natural conditions and under existing conditions with storage at Ross Dam will be developed. The latter will be correlated with observed and computed flood profiles to determine economic limits of flood protection. Flood frequency curves will be established for flood control schemes having apparent economic justification, such as upstream storage. If justification for multi-purpose projects, including power is indicated, power and reservoir regulation studies will be made utilizing stream flow data. Protection against the standard project flood developed for the 1952 survey report was found to have a very low benefit-cost ratio. This flood will not, therefore, be reviewed as it is apparent that protection against lesser flows is more economical.

(3) Foundation and material studies. - Subsurface investigations made for previous reports will be utilized for preliminary studies. In areas for which data are lacking a minimum of foundation explorations will be made for the preliminary studies. More detailed foundation explorations will be made only as necessary for schemes of flood control found to have apparent economic justification.

(4) Design and estimates. - Design of flood control works considered for previous reports will be reviewed considering changes in criteria and conditions since those reports. Cost estimates will be reviewed and updated to present-day prices when possible. If this is not feasible due to significant design changes, costs will be reevaluated on a unit price basis.

9. Constraints and controls. - The flood control study will follow ideas and proposals outlined in this plan of survey. If changes or additions become necessary the plan of survey will be revised to reflect these changes. Preliminary economic and engineering studies will be made to ascertain feasibility of various schemes of flood control. Those shown to be economically feasible in the preliminary study will be investigated further but if any scheme is found to be uneconomical at any stage, studies on that scheme will be stopped, and reported as unjustified. Detailed field investigations and surveys will not be made unless required for basic studies or to further studies justified for recommendation.

10. Coordination and cooperation with other agencies. - The principal sponsoring bodies in the preliminary phases of the study are the State of Washington, Skagit and Snohomish Counties. As the study progresses other interested parties, such as Diking, Drainage and Flood Control Districts, City of Seattle and Puget Sound Power and Light may be involved. Coordination with regional offices of Federal agencies and departments will be initiated as required in EM 1120-2-101, paragraph 1-142c(2)(a). Coordination with State and local agencies will be initiated when the need arises so that this office may work closely with representatives of these organizations. Addresses of the more important local interests are:

Mr. Frank Gilkey, Skagit County Engineer
Court House
Mt. Vernon, Washington

Mr. Earl Barnwell, Snohomish County Engineer
Court House
Everett, Washington

Mr. Don Bordner, President
Skagit County Flood Control Council
Route 2
Mt. Vernon, Washington

Mr. Ward Tyler
Engineering Department
City of Seattle
County-City Building
Seattle 4, Washington

Mr. E. A. Fontaine
Vice President, Operations
Puget Sound Power & Light Company
1400 Washington Building
Seattle 1, Washington

Washington State agencies having possible interest in Skagit River flood control projects and their areas of interest include:

Agency	Area of interest
Mr. Earl Coe, Director Department of Conservation General Administration Building Olympia, Washington	Flood control, irrigation, bank erosion and multiple-purpose developments
Mr. Gregory Hastings, Supervisor Division of Flood Control Department of Conservation General Administration Building Olympia, Washington	Flood Control
Dr. Bernard Bocove, Director Department of Health General Administration Building Room 214 Olympia, Washington	Pollution abatement
Mr. Milo Moore, Director Department of Fisheries 4015 - 20th Avenue West Seattle 99, Washington	Migratory fish
Mr. John A. Biggs, Director Department of Game 600 North Capitol Way Olympia, Washington	Fish and wildlife (game)
Mr. L. T. Webster, Supervisor Department of Natural Resources Social Security Building Olympia, Washington	State forests
Director Department of Commerce and Economic Development General Administration Building Olympia, Washington	Economic development

Federal agencies having possible interests in Skagit River flood control projects and their areas of interest include:

Agency	Area of interest
Department of Agriculture.	
Mr. D. C. McGrew, State Conservationist Soil Conservation Service Engineering and Watershed Planning Unit Room 301, Hutton Building Spokane 4, Washington	Flooding and drainage of agricultural lands
Mr. J. Herbert Stone, Regional Forester U. S. Forest Service P. O. Box 4137 Portland 8, Oregon	Forest lands, management and recreation
Department of the Interior.	
Mr. Leo Laythe, Regional Director Region 1, Fish and Wildlife Service Bureau of Sport Fisheries and Wildlife Interior Building, P. O. Box 3737 Portland 8, Oregon	Fish and wildlife
Mr. Harold T. Nelson, Regional Director Region 1, U. S. Bureau of Reclamation P. O. Box 937 Boise, Idaho	Irrigation
Administrator Bonneville Power Administration P. O. Box 3537 Portland 8, Oregon	Power
Regional Director National Park Service 180 New Montgomery Street San Francisco 5, California	Recreation
Mr. F. M. Veatch, District Engineer U. S. Geological Survey 207 Federal Building Tacoma 1, Washington	Hydrologic data
Department of Commerce.	
Division Engineer Bureau of Public Roads P. O. Box 3900 Portland 8, Oregon	Road relocations on Federal lands

Agency (Federal cont'd)	Area of interest
Department of Commerce. (Cont'd)	
Regional Director Weather Bureau Regional Office 609 Federal Office Building Seattle 4, Washington	Hydrologic data
Department of Health, Education and Welfare.	
Officer in Charge Public Health Service Water Supply and Pollution Control 211 United States Court House Portland, Oregon	Water supply and pollution abatement
Federal Power Commission.	
Regional Engineer San Francisco Regional Office Federal Power Commission 555 Battery Street San Francisco 11, California	Power

11. Public hearing. - A public hearing is scheduled for 8 February 1961 at Mt. Vernon, Washington. An additional public hearing will be held at the conclusion of the study if deemed necessary.

12. Work schedule. - See bar graph attached (Incl 3).

13. Assistance and review. - Quarterly review of the study by representatives of the Division Engineer will be made in accordance with recently established procedures. The Chief of Engineers will be notified when plans and cost estimates are available for advance review if it appears that the plan of improvement will be economically feasible and will be recommended. The assistance of the technical staff of the Office, Chief of Engineers, will be requested in the event that major problems requiring such assistance develop in the course of the study. The scheduled submission date of the report is 15 October 1963.

14. Estimated cost of major elements of study. The estimated cost of each major element of study is shown on the attached study cost estimate (PB-6).

3 Incl
1. Basin Map, File No. E-6-6-156
2. Work schedule
3. Study cost estimate (PB-6)