

BASIN DESCRIPTION AND SUMMARY
OF CORPS OF ENGINEERS INVESTIGATIONS
SKAGIT RIVER, WASHINGTON

1. Basin description - The Skagit River basin lies on the western slope of the Cascade Range in the northern part of the State of Washington. (Basin map inclosed). The basin drains an area of 3,140 square miles, extending from British Columbia on the north to the basins of the Stillaguamish and Snohomish Rivers on the south, and easterly from Skagit Bay to the summit of the Cascade Range. The Skagit River has its source in Canada 23 miles north of the International Boundary, and flows south and then west for 135 miles to Skagit Bay. The largest tributaries are the Sauk and Baker Rivers. Upper reaches of the basin are steep, mountainous valleys which broaden but maintain their mountain walls as the river progresses downstream. The main river is in a valley from 1 to 3 miles wide above Sedro Woolley. Below Sedro Woolley, the valley falls to nearly sea level and widens to a flat, fertile outwash plain which includes the Semish valley on the north.

2. The entire valley floor of the Skagit River and its delta comprise the flood plain. The flood plain covers 90,000 acres, 68,000 acres of which are delta land downstream and west of the town of Sedro Woolley, and 22,000 acres of river bottom land east and upstream of this town. The major portion of the bottom land east of Sedro Woolley is in developed farmsteads, while the remainder is mostly uncleared and swampy. Delta area farms are highly developed, with well maintained buildings, residences, and other improvements. Encroaching on the agricultural land are the urban communities of Burlington, LaConner, and part of Mount Vernon, occupying a total of 1,270 acres. The flood plain contains thousands of structures, including a full range of farms, residential, commercial and industrial buildings, and connecting roads and utilities, all of which are exposed to damage from recurring floods. The total valuation of lands in the 68,000-acre delta area through and below Sedro Woolley is estimated at \$113,300,000 under 1962 conditions.

3. Basin economy - Although the Skagit River basin comprises most of Skagit County, as well as parts of Snohomish and Whatcom counties and a very small portion of British Columbia, most of the land area and developments are within the boundaries of Skagit County. Skagit County had a 1960 population of 51,350. The rate of population growth for the last decennium was 1.7 percent annually as compared to 1.8 percent for the state and the nation. Contributing growth factors have been the increase in row cropping and related fruit processing, ship building

activity in Anacortes, construction of the Naval Base on nearby Whidbey Island, and the construction of two oil refineries and a chemical plant at Anacortes.

4. Total employment in Skagit County has increased from 13,709 in 1950 to 17,269 in 1960, at an average annual rate of 2.3 percent. This compares to an annual rate of increase in employment of 1.8 percent for the State. Most important sources of employment in 1960 were agriculture, forest products and miscellaneous manufacturing. The seasonal nature of lumber and agricultural industries results in unemployment in Skagit County greater than that for the State. In recent years, Skagit County unemployment has been between 8 and 9 percent of the active labor force, whereas for the entire State unemployment has been about 6.6 percent. Personal income in Skagit County totaled \$96,400,000 in 1960, as compared to \$62,800,000 in 1950.

5. In 1960, the total log production in Skagit County was about 178,000,000 board-feet, of which about 84,000,000 board-feet came from privately owned lands. During the last 11 years, log output has averaged 157,000,000 board-feet annually. Most of this log cut is moved by truck to pulp and paper mills in Everett and Bellingham.

6. While forest, agricultural and fishing industries provided the chief source of employment and income during the settlement and development years prior to 1940, increasing diversification of manufacturing has characterized growth during the past two decades. The cement plant at Concrete has a daily capacity of 6,000 barrels of raw cement. The Skagit Steel and Iron Works, founded in Sedro Woolley in 1902 as a foundry machine shop, has expanded to include the repair and manufacture of sawmill and heavy logging equipment. Construction of two refineries and a petrochemical plant at Marches Point, between Anacortes and Mount Vernon, provided the base for renewed activity during the past decade. In 1958 "the value added by manufacture" for Skagit County was \$41,036,000 and the payroll of production workers amounted to \$13,036,000.

7. Deep-draft navigation contributes to the economy of the basin. In 1960, a total of 7.7 million tons of foreign and coast water traffic passed through Anacortes, and 41,100 tons of coastwise and internal shipments moved up and down the Skagit River. Traffic through Anacortes consists primarily of lumber, fish and petroleum products. The bulk of river traffic in recent years has consisted of rafted logs. The Skagit River is navigable to Marblemount, 78 miles above the mouth. However, regular commercial navigation is maintained only to Mount Vernon. Boats can cross the tide flats of the river mouth only at mean or higher tide stages. The North Fork now carries the major part (about 80%) of the Skagit River low flow and has sufficient depth for navigation. Practically all commercial navigation has been via the North Fork in recent years. Dredging of minor shoals and removal of snags in the North Fork

and the main stem of the Skagit River have been accomplished to meet the needs of existing navigation.

8. Dams - Hydropower projects have been developed in the Skagit River Basin by the City of Seattle, Puget Sound Power and Light Company, and the Lone Star Cement Corporation.

Seattle City Light has constructed three power dams. Ross Dam at River Mile 105 has gross storage of 1,405,000 acre-feet, multi-purpose storage of 120,000 acre-feet for hydropower generators and flood control, and installed generator capacity of 446,000 kw. Ross reservoir supplements low flows for run-of-river powerplants located at Diablo and Gorge Dams downstream. Diablo Dam at River Mile 100 has installed generator capacity of 159,000 kw, and Gorge Dam at River Mile 96 has installed generator capacity of 175,000 kw.

Puget Sound Power and Light Company operates two dams on the Baker River, one of the main tributaries of the Skagit. The first and lower plant was completed in 1927 with a capability of 103,000 kw, and the upper unit at Baker Lake was completed in 1959 with a generator capacity of 94,000 kw.

The Lone Star Cement Corporation operates two small plants on Bear Creek, a tributary of the Baker River. These plants have a combined capability of 2,100 kw, and are operated to service the company-owned cement plant at Concrete.

9. Stream flows - Mean annual flows in the Skagit River range from 10,000 to 21,500 c.f.s. at Mount Vernon. The maximum discharge of record at Sedro Woolley was 220,000 c.f.s. in 1909 and the minimum was 2,830 c.f.s. in 1915. Large historical floods are the 1815 flood with an estimated discharge of 400,000 c.f.s., and the 1856 flood with an estimated discharge of 300,000 c.f.s. At the present time there is a decrease of flows from Sedro Woolley to Mount Vernon of 15,000 to 25,000 c.f.s. because of valley storage. With full development of the valley, this reduction will be substantially reduced. Base flow is normally low from August through March. During April or May, the flow increases because of the melting snowpack and normally crests in early June. Winter flows are characterized by frequent sharp rises resulting from concentrated 2- to 5-day storms or a series of storms. All major floods of record on the Skagit River have occurred between November and February, and have been caused by high rates of precipitation with accompanying snowmelt. This type of flood has a crest which is normally higher and of shorter duration than the annual spring snowmelt high water.

10. Flood damages - The delta lands west of Sedro Woolley have been inundated many times by the Skagit River since the area was first settled about 1869. River levees in the diking districts are not capable of preventing damages from high winter floods. Estimates of damage from historical floods under 1963 prices and conditions are tabulated below:

Date of Flood	Discharge near Concrete (c.f.s.)	Discharge at Sedro Woolley (c.f.s.)	Damage in Flood plain west of Sedro Woolley (\$)
16 Nov 1896	-	185,000	11,900,000
19 Nov 1897	-	190,000	11,980,000
16 Nov 1906	-	180,000	11,810,000
30 Nov 1909	-	220,000	14,060,000
30 Dec 1917	-	195,000	12,067,000
12-13 Dec 1921	(30-yr. frequency)	210,000	13,273,000
27 February 1932	(12-yr. frequency)	157,000	10,500,000
13 Nov 1932	-	125,000	6,600,000
22 Dec 1933	-	110,000	2,350,000
14 Jan 1935	131,000	-	9,050,000
27 Nov 1949	-	140,000	6,870,000
10 Feb 1951	-	150,000	11,360,000
30 Apr 1959	-	99,000	500,000
24 Nov 1959	-	93,000	390,000
100-yr. frequency	-	273,000	20,913,000

The average annual flood damage in the Skagit flood plain was found to be \$2,170,000 at 1963 prices and conditions. Projected annual flood damages covering a forecasted 100-year period of growth in the basin and the present level of flood protection are estimated to be \$3,450,000.

11. Existing flood control works

a. **Levees** - Farmlands and towns in the flood plain downstream from Sedro Woolley are protected by levees to prevent flooding from the river and from tidal saltwater. A total of 40 miles of levees have been constructed over a period of time on the banks of the river in the flood plain. Levee systems are operated by 16 diking districts to protect a total of 45,000 acres of land. About 1,000 acres of land are protected by private levees.

The levee systems vary in top width and height and protect against flows ranging from 90,000 c.f.s. to about 140,000 c.f.s. with one-foot of freeboard, provided that low sections are sandbagged in advance of the flood crest. Sod is grown on the river slopes to minimize erosion. Heights vary from 5 to 10 feet and top widths range from 3 to 12 feet in width. Levees are usually riprapped in the vicinity of river bends. The foundation of the levee system is sand and silt formations. The differential head of water during flood periods cause seepage, boils and blow-outs. The raising of the levee system to increase the degree of flood protection is not feasible because of these adverse foundation conditions.

b. **Upstream storage** - The City of Seattle owns and operates a system of three hydroelectric power plants on the upper Skagit River. The upper site, Ross Dam and Reservoir, is the only existing development with a significant amount of flood storage. The lower sites, Gorge and

Diablo Reservoirs are not used for flood regulation, but only for power generation. Ross Dam has 1,023,000 acre-feet of usable storage, of which 120,000 acre-feet are reserved for flood control in conformance with the Federal Power Commission license. In addition, induced surcharge storage up to a maximum of approximately 95,000 acre-feet may be utilized. Ross Dam flood storage is used only when the discharge at Concrete is forecast to be 90,000 c.f.s. or greater. Under average conditions Ross Dam storage will reduce flood crests by 15,000 to 25,000 c.f.s. at Sedro Woolley.

Two reservoirs on the Baker River are operated by the Puget Sound Power and Light Company for the production of electric power. The upper reservoir at Baker Lake is regulated to avoid increasing floods above natural conditions. The normal operation for power may result in a small variable amount of space available to aid in regulating high discharges in November and December, but there are no requirements for reservation of storage to reduce floods.

12. Proposed flood control improvements

a. Avon Bypass - The Avon Bypass was authorized by the Flood Control Act of 1936. The project provides for a channel to divert a portion of the flood water from the Skagit River to Pedilla Bay, and for improvement and construction of four miles of levee on the right bank of the Skagit River between the towns of Burlington and Sedro Woolley. Following authorization, local interests were unable to meet the requirements of local cooperation which included furnishing necessary highway and railway bridge crossings, rights-of-way lands and utility relocations. Because local cooperation requirements could not be satisfied, the project became inactive.

A restudy of the flood control needs in the Skagit River Basin was authorized following major flooding in the valley in 1959. In ensuing studies flood control was found to be a most urgent water resource need in the Skagit River delta. The Avon Bypass shown on the inclosed map was found to be one of the most effective means of providing flood control in the lower valley. Accordingly, the Bypass channel proposal has been restudied in detail as part of the present Skagit River basin flood control studies. The design capacity of the Bypass would be 60,000 c.f.s. The Bypass in combination with minor improvement of the downstream levee and channel system would provide safe channel capacity for flows of 180,000 c.f.s. downstream from Sedro Woolley. In terms of overall flood protection, this would protect against floods with a probability of occurrence of once in 30 years.

In addition to flood control, the Avon Bypass can provide benefits for recreation, for a resident sports fishery, and possibly for rearing of migratory steelhead and salmon. A survey report recommending authorization of these added purposes is being readied for submission in the latter part of 1964.

b. Levee improvement and channel widening. Minor improvement of existing flood protection downstream from the Avon Bypass is embodied in a survey being readied for completion in FY64. This same survey report will also include the recreation and fishery proposals for the Avon Bypass noted in the preceeding paragraph.

In brief, the proposed improvements will increase the channel capacity from a minimum of about 90,000 c.f.s. to a minimum of 120,000 c.f.s. These improvements will permit more effective utilization of the Avon Bypass for flood control. The improvements are an essential part of obtaining the 30-year level of flood protection, described in the preceeding section on the Avon Bypass.

13. Multi-purpose water needs - Water resource needs under study in the Skagit River Basin are a high degree of flood control, irrigation water for some portion of 68,000 acres of fertile soil in the delta, domestic and industrial water supply for an expanding population, recreation, and increased low water flows to enhance a migratory fishery that is second in importance only to the Columbia River in the State of Washington. Upstream storage would be an essential factor in satisfying the above noted water supply needs.

14. Potential storage - Only a few potential sites for multi-purpose development remain in the Skagit River basin. Of these, the Cascade site, located on the Cascade River about 8 miles from its confluence with the Skagit River, and the Copper Creek site, located on the main stem of the river at Mile 87, are being considered for development by the City of Seattle for run-of-river power projects. Only minor storage for non-power purposes appears feasible at these sites.

The Lower Sauk River is the only location in the Skagit River basin at which major upstream storage is possible. The site could provide 700,000 acre-feet of storage, and could increase flood protection in the lower basin from 30-year protection provided by the Avon Bypass and levee improvements in the delta to more than 100-year protection. Multiple-purpose storage in the Sauk project would provide hydroelectric power, recreation, and low flow augmentation for water supply, fisheries and navigation in addition to flood storage. Flood control storage in the lower Sauk River basin is essential to provide the high degree of flood protection necessary for development of the Skagit River basin.

15. Puget Sound and Adjacent Waters Study - Congress has recognized the water resource planning needs of the basin in the Puget Sound and Adjacent Waters Comprehensive Study, authorized by the Flood Control Act of 1962. The Puget Sound Comprehensive Study will evaluate the importance of upstream storage in satisfying long range water resource needs in the basin. This will be a coordinated study involving all Federal and State agencies with an interest in water resource planning. The study will

require about five years and will begin in January 1964.

16. Navigation

a. Authorized project - There is an existing project adopted 25 June 1910 which provided for various channel control works at the mouth to develop a navigation channel through the South Fork. This project is inactive and no funds have been expended in the project works for many years.

b. Navigation study - In May 1947 a resolution adopted by the U.S. House of Representatives authorized a review of reports on the Skagit River, Washington, for navigation from Concrete to the mouth. After a delay caused by curtailment of work during the Korean War, report studies were resumed and are now scheduled for completion in FY64. These studies are directed toward determining the feasibility of providing a shallow draft navigation channel in the Skagit River from its mouth to Concrete, Washington. The report is now scheduled for completion in FY64.