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CORPS OF ENGINEERS, U. S. ARMY
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F0092 (Skagit River & Tribs) HYS

Report on Survey for Flood Control of SKAGIT RIVER AND TRIBUTARIES, WASHINGTON

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were made of the damage caused by a flood of record and possible future higher floods. Estimates are based on the 1951 state of development in the valley. West of Sedro Woolley the valley agricultural lands are highly developed and it is expected that future flood damages will be much the same as under existing conditions, unless some major economic change now unforeseen should occur. The total average annual flood damages in the Skagit Valley are estimated at $188,000 on the basis of November 1951 prices and with 120,000 acre-feet of flood control storage at Ross Reservoir. Results of the flood damage determinations are summarized in table 5. Further information on this subject is given in the appendix.

Table 5. - Flood damage summary
November 1951 prices

Area	Damages	
	210,000 cfs.	1949 flood 135,000 cfs.
West of Sedro Woolley:		
Skagit diked section, right bank	$3,100,000	$ 24,400
Skagit diked section, left bank	1,160,000	173,000
Skagit, Nookachamps area	215,000	50,000
Skagit, other areas	148,000	59,300
Samish section	700,000	0
Total west of Sedro Woolley	$5,323,000	$306,700
East of Sedro Woolley	1,280,000	280,000
Total	$6,603,000	$586,700

68. Existing Corps of Engineers flood control projects. - Authorized project. - The Flood Control Act of 1936 authorized a project for the partial control of floods in the lower valley by diversion of part of the floodwaters through a bypass to be constructed between the river at Avon and Padilla Bay. Other project works include channel widening and bank revetting between Burlington and Avon, concrete control works at the head of the bypass, and a concrete weir near the outlet. The latest approved estimated cost is $3,150,000 for construction and $1,832,000 for lands and damages (1938 annual report of the Chief of Engineers). Local interests are required to provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project, hold and save the United States free from

damages due to the construction works, and maintain and operate all the works after completion in accordance with regulations prescribed by the Department of the Army. The terms of local cooperation have not yet been met and no Federal funds have been appropriated for this project.

69. Emergency flood control work. - Since 1947 the Corps of Engineers has spent more than $158,000 on reconstruction of damaged or destroyed flood control structures under appropriate emergency flood control laws. This work is summarized in the following tabulation:

Nature of work	Date completed	Federal cost
Bank revetment near Utopia----------	February 1947	$13,419.07
Bank revetment at Burlington Bend---	September 1948	49,963.43
Levee repair, District No. 15-------	December 1949	6,662.75
Levee repair near Milltown----------	April 1951	64,939.73
Levee repair near Conway----------	May 1951	23,275.55
Total----------		$158,260.53

70. Improvements by other Federal and non-Federal agencies. - Existing works for control of floods on Skagit River consist of dikes built by local interests and a flood control storage reservation in Ross Reservoir, owned by the city of Seattle. Together, these works are adequate to protect the areas west of Burlington against all spring floods and also to give a fair degree of protection against all but the more severe winter floods. Except as noted in the previous paragraph, local interests have performed maintenance and major repairs to the works described herein.

71. Dikes and diking districts. - Downstream from Sedro Woolley are 16 diking districts, organized and operating under the laws of the State of Washington, and embracing a total area of approximately 45,000 acres. To 1947 the districts have expended a total of about $2,355,000, or $52 an acre on the construction and maintenance of levees. In addition to the area inclosed by district levees about 1,000 acres have been leveed by individual landowners. Of the total area inclosed by levees, the Skagit River section has 36,000 acres protected against high river and sea

To protect against a peak flood flow of:	Project first costs (1951 prices)		
	Bypass with no levee improvement	Levee improvement only	Combination
200,000 cfs.	$9,600,000 (bypass, 110,000 cfs. existing levees 90,000 cfs.)	$ 5,900,000	None, levees least cost
300,000 cfs.	$16,000,000 (bypass, 210,000 cfs. existing levees 90,000 cfs.)	17,000,000 +	$10,800,000 (bypass, 95,000 cfs., levees, 205,000 cfs.)
415,000 cfs. standard project flood	No data	No data	$17,000,000 (approx.) (bypass, 215,000 cfs., levees, 200,000 cfs.)

91. The studies of diversion plans and improvement to the existing levee system indicate that for any plan, levee improvement would be a major component. If allowable design capacities are near 200,000 second-feet, consideration of a diversion channel is not warranted. If design capacities are appreciably greater than 200,000 second-feet, then a combined levee and diversion project would be most economical. This situation suggests a progressive flood control improvement program with improvement to the existing levee system being the first that should be undertaken.

92. The maximum flood of record (1909) had an estimated discharge of 220,000 second-feet at Sedro Woolley. Taking into consideration the existence of Ross Reservoir, a recurrence of the 1909 flood under existing conditions would result in a discharge of about 185,000 second-feet at Sedro Woolley, requiring a channel capacity below Burlington of about 170,000 second-feet. These reductions in peak flow would be caused first by storage in Ross Reservoir, which would give a lower peak at Sedro Woolley, and second, by natural storage in the Nookachamps Creek area. The least degree of protection believed advisable for a Federal flood control project is one which would give protection against a

flood somewhat greater than the maximum of record. For the discussion herein, a flow of 250,000 second-feet at Sedro Woolley may be considered as the minimum design flood. The flow of 250,000 second-feet at Sedro Woolley would be reduced by natural storage in the Nookachamps Creek area so that 220,000 second-feet would be the resulting discharge to be taken care of below Burlington. The first cost of improving the levees to this capacity would be $7,500,000 (1951 prices) and the annual cost, $375,000. Average annual flood control benefits determined from the damage-frequency curves would amount to $150,000. The benefit-cost ratio is therefore 0.40. Similar computations for higher and lower degrees of protection indicates that no higher benefit-cost ratio can be attained. From approximate cost studies for a project to give complete protection against the standard project flood, the benefit-cost ratio was found to be very low. Further details of the economic analysis are given in the appendix to this report.

93. Nookachamps Creek area. - If levees were extended upstream to protect this area, the natural storage effect of reducing downstream peaks would be lost and the entire levee system would have to be raised. If Nookachamps area were included in the example in the previous paragraph, downstream project costs would be about $8,100,000, (excluding the cost of Nookachamps levees) or an increase of $600,000. The annual cost of this increase would be $30,000 whereas Nookachamps area annual benefits would be only about $15,000; and furthermore, this comparison does not include the cost of levees required in the Nookachamps area.

94. Changing mouth of North Fork. - Some local interests have advocated modifying the course of North Fork near its mouth to achieve lowered flood stages in that branch and in the main river. The suggested change in the North Fork would affect its lower mile and one-half where the river leaves the diked channel and flows through the tide flats to Skagit Bay. Local interests desire that the North Fork continue a straight course into Skagit Bay instead of making the