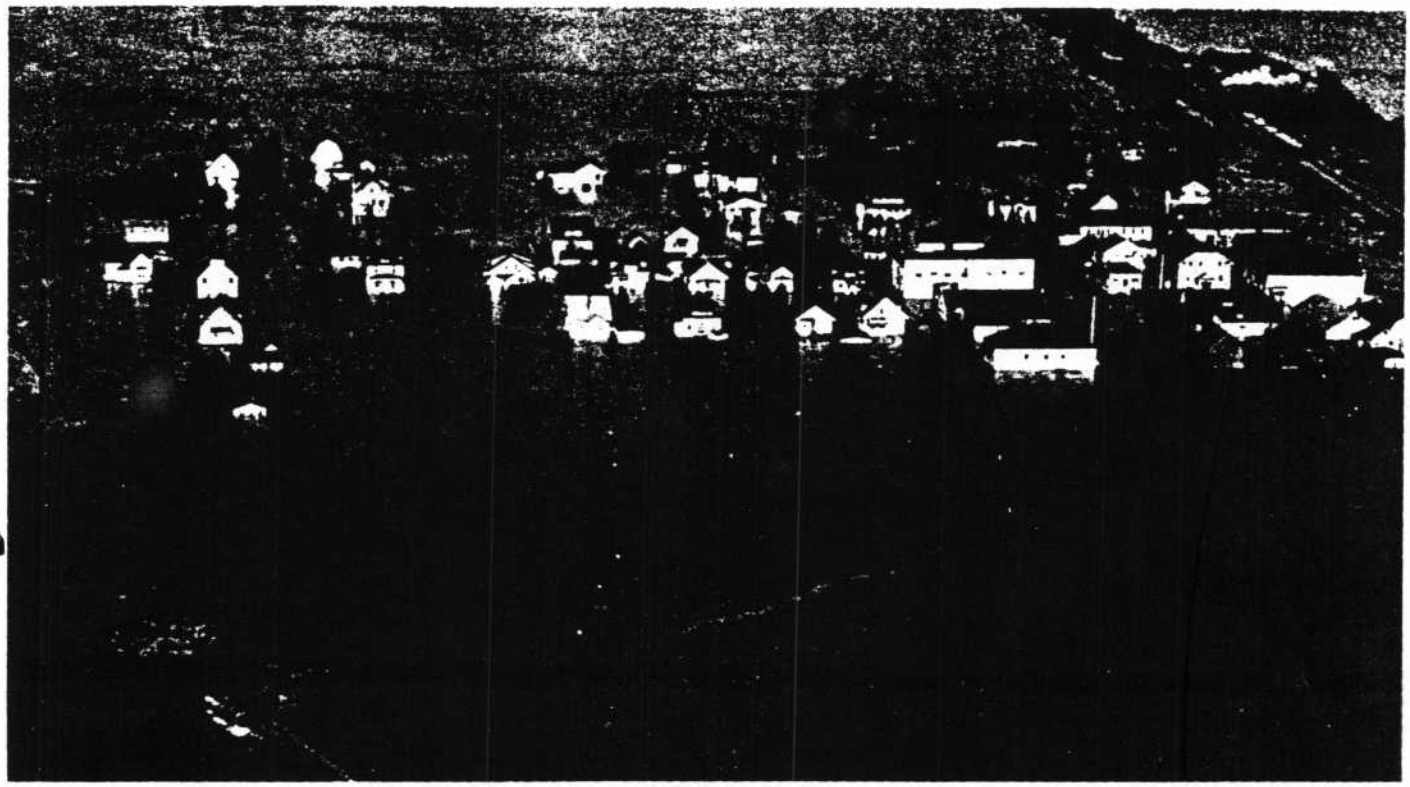
JULY 1966

FLOOD PLAIN INFORMATION STUDY

SKAGIT RIVER BASIN

WASHINGTON



SUMMARY REPORT

PREPARED AT THE REQUEST
OF
THE WASHINGTON STATE DEPARTMENT OF CONSERVATION

U. S. ARMY ENGINEER DISTRICT, SEATTLE, WASHINGTON

P 003391

COVER PHOTOGRAPH

Conway, Washington during February 1951 flood. View is northeasterly with the South Fork of the Skagit River located about 100 feet left of the levee break. Corps of Engineers photo.

FLOOD PLAIN INFORMATION STUDY
Skagit River, Washington

SUMMARY REPORT

TABLE OF CONTENTS

PHOTOS

PLATES

(Bound at end of text)

(DRAFT)

INTRODUCTION

In 1960 the Department of Conservation of the State of Washington, requested the Corps of Engineers to make a report on the character and extent of the present day flood hazard in the Skagit River valley. The Corps of Engineers undertook the study as provided for by the Flood Control Act of 1960. The information developed is presented in two volumes consisting of this SUMMARY REPORT and a more detailed presentation called a TECHNICAL REPORT.

This SUMMARY REPORT is a digest of the information in the TECHNICAL REPORT prepared in less technical form for general public usage. Informa- in the SUMMARY REPORT includes descriptions of the flood plain, maps showing areas subject to flooding by a very rare flood and by a lesser flood. Information is presented on problems associated with flood plain development and suggestions are made on how flood hazards can be minimized or prevented. Descriptions are also given of various procedures for reducing future flood losses.

The TECHNICAL REPORT contains engineering information defining the flood hazard and is intended primarily for use by professional engineers and State, county and city planning commissions in developing, guiding and controlling use of flood plain lands to minimize flood damage. The TECHNICAL REPORT contains historical information on flooding, on flood damages and on protection afforded by present flood protective work. The report includes detail maps which can relate potential flood stages to any location on the flood plain. Methods of reducing future flood damages are presented in detail.

Copies of the TECHNICAL REPORT are available for inspection in the offices of the Board of Skagit County Commissioners, the Skagit County Engineer, the Skagit County Agricultural Extension Agent, the Skagit County Planning Director, and the Skagit County Civil Defense Coordinator.

Inquiries and comments regarding either report, and requests for copies of TECHNICAL REPORT maps or the SUMMARY REPORT should be made to:

Director, Department of Conservation
State of Washington
ATTENTION: Supervisor of Flood Control
335 General Administration Building
Olympia, Washington 98501

Federal agencies interested in obtaining more detailed information should contact:

District Engineer
U. S. Army Engineer District, Seattle
ATTENTION: NPSEN-PL-R
1519 Alaskan Way South
Seattle, Washington 98134

The District Engineer and his staff will welcome visits from all groups or individuals who wish to discuss the subject of flooding and flood plain control at greater length or obtain additional information.

HOW TO DETERMINE THE FLOOD HAZARD

The SUMMARY REPORT will be of greatest interest to persons planning to buy property, to construct, or to evaluate a current flood hazard in the flood plain.

As the Skagit valley has not experienced even a moderate flood since 1959, there is a tendency among some valley residents to disregard the flood problem. The much larger flood of 1951 is even less well remembered. The flood of 1921, which had more than twice the peak discharge of 1959, is practically forgotten. However, recent disasterous floods in other parts of the nation clearly illustrate that a long flood-free period is no assurance of future immunity to flooding. In view of the lack of recent flood experience, there has been an increase in occupancy of the flood plain.

The topographic maps, Plates 3 through 6, following the text show land areas subject to flooding. Green areas indicate land which would be flooded by a recurrence of a river flow at Sedro Woolley approximately equal to the 1921 flood. Red areas show additional land which would be flooded by a larger flood of 275,000 cubic feet per second, having an estimated probability of occurrence of once in 200 years. However, these maps do not show the depth of flooding. If such information is needed for a specific location, a visit to the County Engineer's office is suggested. His copy of the TECHNICAL REPORT contains aerial photographs showing every road and building in the flood plain downstream from Marblemount, and profiles from which the flood surface elevations can be taken. If the ground elevation is known, the depth of water during flooding can be estimated. With this information, the prospective builder or purchaser will be in a much better position to decide how best to develop his property.

The Flood Photo Map Index, Plates 1 and 2, show the sheet number of the specific flood photo map having flood information for a particular area in the basin. With this information a particular flood area map can be ordered from the State Supervisor of Flood Control as noted in the Introduction.

THE BASIN

The Skagit River originates in a network of narrow, precipitous mountain canyons in Canada and flows southwesterly 135 miles from the border to Skagit Bay. The river drains an area of about 3,100 square miles. The Sauk River, the major tributary, originates on the western slopes of the Cascade range in Snohomish County and joins the Skagit near the city of Rockport. During high floods, the Skagit River overflows the low divide between the Skagit and Samish River flood plains and the waters from both streams intermingle on the Samish River flood plain as shown on Plate 3. Flood problems of the two streams are, therefore, closely related and both basins are treated as one large basin in this report. Cities and communities in the Skagit River basin include Mount Vernon, Sedro Woolley, Burlington, Concrete, LaConner, Clear Lake, Lyman, Marblemount, Hamilton, Rockport, Conway and Van Horn. A detail map of the Skagit River basin, not included in the SUMMARY REPORT, is contained in the TECHNICAL REPORT.

THE FLOOD PLAIN

The flood plain, shown on Plates 3 through 6, includes the entire floor of the Skagit River valley, the deltas of the Samish and Skagit Rivers, and relcaimed tidelands adjoining the Skagit, Samish and Stillaguamish basins. The flood plain comprises 90,000 acres, including 68,000 acres of fertile farmland downstream, and west of Sedro Woolley. A large portion of the farmland west of Sedro Woolley is protected from small floods by levees, but would be flooded by large floods that overtop or breach the levees.

The central business district of the city of Mount Vernon is within the flood plain, but is protected by levees from all but major floods. The city of Sedro Woolley is situated on a terrain which slopes upward from the river, and only minor flooding has occurred within the city limits in recent times. The city of Burlington has been inundated by major floods, but high levees west and south of the city have restrained the relatively mild floods of recent years. The communities of Concrete, Marblemount, Rockport, Lyman and Van Horn are on high ground and are therefore not subject to flooding. LaConner has not been flooded in recent years because of protection afforded by levees north of the city and along the Skagit River. Many of the smaller communities on the flood plain are subject to flooding. Allen, Bow, Blanchard and Edison in the Sammamish River basin are also subject to flooding, should the Skagit River floods overflow the low divide between the two basins in the vicinity of Sedro Woolley.

FLOOD CHARACTERISTICS

Skagit River floods result from storms which, moving in from the Pacific Ocean, have their rainfall intensified as the air currents are forced upward over the Cascade Mountains. Temperatures accompanying the storms are often high enough to melt part of the snowpack. If, in addition, the ground is saturated from previous rains, rapid runoff takes place. Swollen creeks and streams quickly fill the main river channel to capacity. As the increasing flow proceeds downstream, the flatter grades cause a reduction in velocity and the river spreads out onto the flood plain.

When the river overflows its banks, a sheet of water quickly spreads across the flood plain. The water is generally shallow at the beginning and some inundated roads remain passable. However, water may stand several feet deep in old river channels and other depressions. As the flow increases toward the peak of the flood, water extends to the outer limits of the flood plain and rises to greater elevations. The normal river banks may disappear from sight, submerged beneath a mile-wide expanse of water. Vehicles being driven along drowned roads are endangered as the force of flowing water may be enough to carry cars and trucks off the pavement into ditches and fields. Homes in the flood plain may be inundated, furniture water-logged, basements filled with silt and debris. With greater depth and the force of flowing water, buildings may be moved off their foundations or undermined.

As the water moves toward Skagit, Padilla and Samish Bays, it may be blocked by a road fill with inadequate culvert openings. When this happens, the water rises until it spills over the roadway, creating a falls on the downstream side which may completely washout the road. Where bridges have inadequate clearances above high water, debris such as logs, brush, and small structures may be trapped at piers or on girders and accumulate until the bridge opening is virtually blocked. This causes an additional rise in the water surface and may result in collapse of the bridge.

The two most recent floods of the Skagit River occurred on 30 April and 24 November 1959 and were a little over 90,000 cubic feet per second at Sedro Woolley. This is less than half the magnitude of several floods which have occurred in the last hundred years. Pictures of previous major flood conditions are shown in Photos 1 and 2. A summary of record floods is given in the following table.

Photo 1. December 1921 floodwater flowing over road between Burlington and Bayview Ridge, looking eastward toward Burlington. (Courtesy Mrs. Melvin Bell)

Photo 2. Historic photograph of flooding in Conway during the December 1921 flood. Floodwaters were reportedly two feet higher on the buildings before this photograph was taken. (Courtesy of Mrs. Ragena Moore)

Flood Dates	Discharge near Concrete 1/ (cubic feet per second)	Discharge near Sedro Woolley 1/ (cubic feet per second)	Estimated Damages in flood plain west of Sedro Woolley 2/
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	-	210,000	13,273,000
27 Feb 1932	147,000	-	10,609,000
13 Nov 1932	116,000	-	6,600,000
22 Dec 1933	101,000	-	2,350,000
25 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	90,700	92,000	500,000
24 Nov 1959	89,300	91,000	390,000

1/ These are actual discharges. Ross Dam storage was partially effective in 1949 and 1951 and fully effective after 1953.

2/ Damages are at 1963 prices and development, and based on full use of Ross Dam flood control storage for all flows.

The 1909 flood was the largest since reliable records were started in 1896. Greater floods can, and probably will, occur at rare intervals. If all of the flood-producing conditions should take place at the same time, the unlikely would become the possible. For example, if the river should be running high, with the soil saturated and a deep, wet snowpack over the basin, and if a series of storms should follow each other in from the Pacific Ocean, precipitation and snowmelt could cause a flood much larger than the 1909 highwater.

An examination of existing levees indicates that all areas behind the levees do not have the same degree of flood protection. With sand bagging of low areas and minor flood fighting, some areas may be flooded when Skagit River flows reach 90,000 cubic feet per second, while others would be safe until a flow of about 140,000 cubic feet per second is reached. Floods of these magnitudes are expected to recur at frequencies of 3 and 14 years, respectively. The capacity is based on the assumption of failure when the flood level is one foot below the average of low elevation in the levee system. Average annual flood damages in the flood plain are estimated to exceed $2,216,000 a year at 1963 prices. Damage to farmland and crops, farm buildings and equipment, commercial buildings, roads and railroads, dikes, and transmission lines are included in the estimate.

The only dependable flood storage in the basin effective in reducing flood flows is at Ross Dam in the Upper Skagit River (For location see TECHNICAL REPORT). The effect of this flood storage is, and has been since 1953, to reduce all flood flows in the lower basin. The 1909 flood of 220,000 cubic feet per second - shown in preceding table - at Sedro Woolley would be reduced to approximately 200,000 cubic feet per second by this storage.

FLOOD FIGHTING

About 43 miles of levees protect flood plain areas west of Sedro Woolley from spring floods and minor winter floods of the Skagit River. Dikes along saltwater bays and channels prevent inundation by tidal flows. Sixteen diking districts inclose a total of 45,000 acres of land.

During the period 1935-1938, approximately $276,000 was spent by the Works Progress Administration in constructing revetments of steel cables and brush mats along both banks of the Skagit River between Burlington and Concrete. Since 1947, the Corps of Engineers has spent $194,000 in reconstructing levees damaged by floods.

The Avon Bypass channel was authorized by Congress in 1936, but was placed in an inactive status pending assurances of required local participation. The Bypass would extend from the Skagit River near Burlington to Padilla Bay, as shown on Plate 1 and would enable the present levee system downstream from Sedro Woolley to withstand a flood of about 150,000 cubic feet per second, measured at Mount Vernon. The Bypass is presently being restudied to fix a firm alinement and for submission to the voters of Skagit County to determine whether the County would be willing to purchase necessary lands and make relocations for the project.

In 1966, the Corps of Engineers will submit to the Congress a report recommending a flood control project for levee and channel improvements from about Mount Vernon to the mouth. With these improvements the lower river could accommodate a flow of 180,000 cubic feet per second at Sedro Woolley without downstream flooding. This compares to a present minimum safe channel capacity of only 90,000 cubic feet per second. A flood of 180,000 cubic feet per second magnitude has an expected frequency of recurrence of about once in 35 years.

The Corps of Engineers is currently making a comprehensive study of water resources in the Skagit River basin which is scheduled to be completed and reported to Congress within 4 years. Flood control is a major aspect of this study. An investigation will be made of the possibility of storing flood runoffs behind multiple-purpose dams and of other flood control measures to augment existing protective works.

FLOOD PREVENTION MEASURES

In recent years there has been a trend toward urban expansion and industrial development into the flood plain agricultural areas. As this trend toward higher land use continues, the flood damage potential will be greatly increased. We must recognize that flood plains are among the most attractive and valuable sites for human occupancy and activity. Throughout all human history, civilizations have risen and flourished in river valleys. Almost all major American cities are situated on riverbanks, and much of our best farmland lies on the floors of alluvial valleys. People desire access to riverbank areas for the enjoyment of outdoor recreational activities. Industries need access for transportation and water supply.

Any development of the flood plain should be tempered by the fact that the flood plain can only be borrowed. Basically, the unprotected flood plain belongs to the river, which, in accordance with physical law, may demand its return at any time. The flood plain may be thought of as a gigantic drain which may carry enormous quantities of water from the hills and mountains to the sea. Between storms, when the river is fed by underground seepage and streamflow is confined to a low-water channel, the flood plain is temporarily available for the uses of man. During periods of heavy, continuous rainfall, the capacity of the low-water channel is exceeded and the river calls upon its flood plain to carry the load. This is just as normal during the rainy season as low flow is during dry weather.

Under these conditions, what can be done to obtain the most beneficial use of the present day flood plain with the least damage? The first consideration is to give the river working room. Nothing should be done to obstruct the low-water channel, as this will cause the river to overflow its banks unnecessarily. Everything possible should be done to permit water which has overflowed onto the flood plain to run off as quickly as possible. For example, highway fills across the flood plain should have sufficient culvert openings to pass flood flows without causing the water to back up excessively.

Lack of working room for a river often is found where levees have been built by piecemeal, haphazard, "do-it-yourself" methods. Levees built on the edges of river banks to conserve land, confine the river to a narrow channel and the flow can no longer spread out across the flood plain. Such confinement results in higher water surface elevations and increased flow velocities which cause erosion. When levees are needed, a uniform, overall system should be planned, including a flow study to establish the distance required between levees on each side of the river to contain high flows. Similarly, highway and railroad bridges should be high enough to pass both flood waters and floating debris.

Another consideration for living successfully with a river is to carry out floodproofing measures, that is, adapting buildings to withstand several feet of water with a minimum of damage. One simple but effective method is

to build or raise structures several feet above the ground. This would require a few extra steps, but the ground floor could be used for parking or for certain kinds of storage. Other waterproofing measures include closing basement windows permanently - for example, with glass brick; using treated timbers in the lower portions of structures; applying waterproof cement on floor coverings; avoiding the use of carpeting, upholstery and veneer as much as possible.

Emergency measures such as moving furnishings above floor level when flooding is imminent also reduce flood damage. Such measures, however, are contingent upon the receipt of a warning or forecast in time to take the necessary action. In the past, responsibility for this service has not been clearly defined, but Civil Defense centers now coordinate information supplied by the U. S. Weather Bureau, river gages, law enforcement and county engineering units, and arrange for broadcasting flood and evacuation warnings by commercial radio and television stations.

In the absence of flood control, the most effective means of preventing flood damage is zoning. The zoning of cities to separate residential, commercial, and industrial areas is commonplace. The zoning of counties, including regulations restricting flood plain usage, is not common practice but is just as desirable and as legally sound. This report is concerned only with zoning ordinances pertaining to flood plains. The objective of such zoning is to reserve the flood plain for those uses which are best suited to it and the least subject to damage from highwater. The part of the flood plain subject to inundation every few years could be zoned for agriculture, including buildings necessary for farm operation. Public and commercial activities which can recover quickly from inundation could be allowed, such as parks, playfields, parking lots, and drive-in theaters. A useful method for determining the limits of this zone would be to use the highwater mark on one of the larger recorded floods. For example, limits of a Skagit River flood having a frequency of 50 years are shown on the flood topographic maps of Plates 3 through 6.

Beyond this zone, but still in the flood plain, are those lands where flooding is less frequent but continues to be a definite possibility. For the Skagit study, the 275,000 cubic feet per second flood was chosen to represent this outer area and is shown in red on the flood topographic maps. The zoning ordinance for this area might permit all types of construction, but with certain safeguards, such as requiring the first floor of structures to be higher than the theoretical flood.

At this point, attention should be called to the fact that the zoning of private and other non-Federal lands in the flood plain is the responsibility of counties and cities under the authority granted by State law. Land use planning was authorized by the Washington State Legislature in a 1959 act.

In the absence of zoning laws, other means are available to provide some control over use of the flood plain. Subdivision ordinances determine the conditions under which tracts may be divided into lots for sale or building developments. Such ordinances may incorporate flood maps and water surface profiles, and require that floor elevations be above a selected flood height and that land fills be constructed so as to insure that no restriction will be made in the floodway capacity.

Federal loan agencies, such as the Federal Housing Agency, Veterans Administration, Farmers Home Loan Administration, and Urban Renewal Administration, may exert an influence on development of the flood plain by withholding approval of loans for improvements in locations known to be subject to flooding. This report may be of value to agency appraisers by identifying the extent of known and probable flooding.

LOOKING AHEAD

Experience has shown that there is no substitute for a comprehensive zoning ordinance to prevent the disastrous mistakes which occur when the inexperienced or uninformed seek to develop the flood plain. The present high rate of population growth and the resulting increase in building and subdividing can affect all areas suitable for residential construction purposes. This is particularly true on the edges of the larger metropolitan communities, and, with improved transportation, soon will apply to the more remote localities. Early settlers in western Washington valleys knew that they and their families would be living there for years to come and had the good judgment to build their homes on the highest available part of their holdings. As a result, flood damage along many streams has been confined primarily to crops.

The danger is that promoters of new housing sites, shopping centers, and motels may lack a long-range viewpoint and unintentionally saddle future owners with flood susceptible, depreciated and hazardous property.

The responsibility for flood plain zoning lies with county or municipal planning commissions. The task of mapping the county, determining its present uses, and arriving at a fair and reasonable recommendation for the best future use of all areas, is a difficult one and should be undertaken by only these agencies or groups which are well qualified to perform the work. As all interested groups must be consulted, preparation of a plan and passage of an ordinance placing it in effect may take several years. Therefore, efforts to develop ordinances cannot begin too soon.

A useful first step would be for the County Board of Commissioners, or the governing body of an incorporated city, to make a policy statement as to their desires and intentions regarding zoning. These desires would provide valuable guides for planning commissions in developing and preparing a zoning plan.

Those interested in doing additional reading on the subject of flood plain zoning may wish to examine a list of books and other publications given in the TECHNICAL REPORT.