SKAGIT RIVER FLOODING:

AN OVERVIEW

Skagit County
Rural Development Committee

P 003491

photo by Jon Brunk

SKAGIT RIVER FLOODING:

AN OVERVIEW

by

The Skagit County Rural Development Committee

Subcommittee on Floodplain Education

March 1976

TABLE OF CONTENTS

INTRODUCTION:

In late summer of 1974 the Skagit County Rural Development Committee appointed a sub-committee to study the effects of flooding on Skagit County. The Sub-Committee on Floodplain Education recommended that the results of this study should be presented to the public as a general purpose program primarily aimed at educating the public to the potential problems of flooding and the various alternatives that are available to reduce or mitigate the effects of future flood action.

The results of this study were combined into a series of nine articles which were subsequently printed in the Skagit Valley Herald. A tenth article was added after Skagit County experienced a flood during the month of December, 1975.

The purpose of this series of articles is to alert the public of the current potential of the Skagit River in respect to the increasing encroachment of development onto the floodplain area and to stimulate public participation in land use planning alternatives. Information for these articles was gathered from the Army Corp of Engineers, Washington State Department of Conservation, Geological Survey and others.

NOTE: Rural Development is a program of the United States Department of Agriculture implemented at the Skagit County level by a committee consisting of representatives of USDA agencies working with other groups and agencies both public and private. Through continuing commitments, it tries to strengthen the economic foundation and the quality of life in non-metropolitan areas. Rural development committees stimulate and aid community action by initiating and supporting study and projects leading to positive agricultural, forestry, outdoor recreation and manpower development, planning for future change and environmental improvement. Organizations belonging to the RDC at the Skagit County level are: The Cooperative Extension Service, County Planning Department, Soil Conservation Service, Department of Natural Resources, Agricultural Stabilization and Conservation Service, County Engineers, U.S. Forest Service, Farm Home Administration, National Park Service, Department of Fisheries, Department of Ecology, and the Department of Game.

P 003494

1. THE SKAGIT RIVER SYSTEM

The Skagit, third mightiest river in the western portion of the United States, flows southwesterly from its source high in the Cascade Mountains in Canada for 163 miles to tidewater in Skagit Bay. It falls, 1,600 feet in this distance, 1,570 feet from its source to Marblemount. The remaining 30 feet of fall are distributed over 92 miles in the lower basin.

Three major tributaries augment the Skagit's flow; the Cascade which joins it near Marblemount; the Sauk near Rockport; and the Baker at Concrete. Although the valley floor begins to lose its narrow profile at Bacon Creek, the flattening of the valley floor is gradual.

During high floods, the Skagit River overflows the low divide between the Skagit and Samish River flood plains and the water from both streams intermingle on the Samish River flood plain. Flood problems of the two streams are, therefore, closely related and both basins are generally treated as one large flood plain.

The flood plain includes the entire floor of the Skagit River valley, the deltas of the Samish and Skagit Rivers, and reclaimed 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 potential or loss of life and monetary damage arising from a major flood has risen in past years due to commercial and residential development in the flood plain. Under 1970 prices and conditions the average annual flood damages are estimated to be $4,766,000. Existing flood control measures and structures combine to mitigate potential flood damage somewhat, but maximum protection is only achieved for floods occurring at a frequency of once every 14 years.

Some low-lying "protected" areas are subject in inundation by only a three-year flood. The central business district of the city of Mount Vernon is within the flood plain, but is afforded some measure of protection by levees from all but major floods. 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. Burlington has been inundated by major floods, but high levees west and south of the city have restrained the relatively mild flooding condition of recent years.

The cause of floods on the Skagit River 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 waterlogged, 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 wash the road out. 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 communities of Concrete, Marblemount, Rockport, Lyman and Van Horn are on higher ground and are therefore not as subject to flooding. LaConner has not been flooded in recent years, but is subject to serious inundation as are the communities of Allen, Bow, Blanchard and Edison in the Samish River basin and Conway, Hamilton and Avon in the Skagit River basin.

The Skagit River is subject to two distinct types of floods: winter and summer. In the past most of the exceptional winter floods have occurred in November or December; the summer floods in May or June.

Large winter floods in the Skagit River basin are caused by water released through the action of strong and long-continued winds which bear warm moisture-laden atmosphere from the Pacific Ocean to the Cascade Range; this action causes precipitation and snowmelt. These winds are known locally as "chinook" winds and are caused by air currents blowing toward the center of an area of low barometric pressure.

The floodwater released through the action of a chinook is composed of both rainwater and water from melted snow and ice. The rainwater and part of the water from snow and ice are from precipitation that occurs during the chinook in the form of rain, snow and sleet. The remainder of the floodwater results from the melting of old snow and ice, which consists not only of snow but also of rainwater that has been absorbed and entrapped by the snow during earlier occurrences of precipitation.

The crests of summer floods are caused mainly by the hot summer sun melting the glaciers and the snowfields in the high sparsely timbered or open areas. The crests of the summer floods are probably swelled to a minor degree by snowmelt from the heavily timbered regions which lie just below the glaciers and adjacent snowfields.

The peak stages of the greatest summer floods are considerably lower than those for the great winter floods. The summer floods, however, are of much longer duration and are greater in volume than the winter floods. The crops are growing at the time of summer floods and, if the dikes break, the great damage done is accentuated by the fact that the long duration and great volume of the floods prevent repairing of the dikes.

11. HISTORY OF FLOODING AND FLOOD POTENTIAL

Throughout the years, major flooding has occurred in the Skagit River basin. The Corps of Engineers Technical Report of the Skagit River and United States Geological Survey Water Supply Paper 1527, by James E. Steward and G. Lawrence Bodhaine, contain descriptions of several of these floods. A brief description of these follows.

ABOUT 1815: Highest flood; gauge height of 20 feet at Diablo Dam; at Rockport the river was at least 15 feet above the flood mark of the 1917 flood; at Concrete a gauge height of 69.3 feet; at Sedro Woolley the flood exceeded the 1909 flood by 7 feet, covered the highest ground in the town with 1.5 feet of water, about 10 feet of water in present business district, and a gauge height of 63.5 feet.

1856: Second highest flood; Reflector Bar (Diablo Dam) gauge height of 18.5 feet; Concrete gauge height of 57.3 feet; Sedro Woolley gauge height about 60 feet.

NOVEMBER 19, 1897: From Birdsview east, the highest the river has ever been due to a warm chinook wind and heavy rain, the river rose suddenly and after 36 hours the rain subsided suddenly. Cascade, Sauk, and Baker Rivers were high and caused a peak on the Skagit at the mouths of each stream. Because of the sudden stopping of the rain, channel storage greatly reduced the crest as it was moving downstream. At Marblemount and Concrete the flood was 1.3 feet and 3.6 feet higher respectively than the 1909 flood.

NOVEMBER 30, 1909: A series of low pressure storms moved through the area, with the last storm moving in on November 26 and lasted through November 29th, dumping 8.3 inches of precipitation at Sedro Woolley. On the 26th and 27th the precipitation was in the form of snow above 2,500 feet. But on the 28th and 29th a warm rain melted snow up to 4,000 feet elevation. The result was the largest flood since the initiation of flood records. At the Reflector Bar (Diablo Dam), the crest was 2.4 feet higher than the 1897 flood. At Newhalem the gauge was 22.0 feet above the datum gauge. At Concrete, the gauge was 36.4 feet with water reaching the footing of a hotel near the cement plant. Down river the flood breached a dike near Burlington, pushing water over most of the land between Burlington and the Swinomish Channel. The gauge height at Sedro Woolley was 56.5 feet.

DECEMBER 30, 1917: This flood was remarkable for the length of time it remained high, rather than the crest, which was comparable to the 1896 flood and was 2.5 feet below the 1909 flood crest. At Sedro Woolley, the gauge was 54.1 feet.

DECEMBER 12-13, 1921: The weather in November of 1921 was below average temperatures and excessive precipitation. December was cold, but snowfall was less than average, much of which was melted off by excessive rain on the 10th and 12th. Between 6 p.m. of the 9th and midnight on the 12th. Silverton (in Snohomish County, east of Everett) received 14.2 inches of precipitation, David Ranch near Ross Dam received 10.2 inches and 3.4 inches fell at Sedro Woolley. Twenty-four maximums at these stations were 5.9, 5.0 and 2.0 inches, respectively. These conditions created the second largest flood on record and caused a dike break just above the Great Northern Railway Bridge between Mount Vernon and Burlington dumping 60,000 cubic feet per second (cfs) of water into the Samish River Delta area.

NOVEMBER 17-28, 1949: The 1949 flood had a profile of short duration peak. The peak discharge near Concrete was 153,000 cubic feet per second which diminished to 114,000 cfs near Mount Vernon. The weather combined with channel storage had a marked effect on this result. Precipitation records indicate that little rainfall occurred in the lower end of the basin. Other records indicate that no snow was on the ground as far east as Diablo Dam, where temperature high's and low's were 58 and 39 degrees respectively. Due to the low amount of precipitation and no snow in the lower end of the basin, the contribution of the tributaries in this area towards the total flow was probably minimal. Thus, natural channel storage facilities handled the Skagit crest as it came down river, thus possibly reducing the crest discharge from 153,000 cfs to 114,000 cfs. The USGS Report mentions that upstream storage reduced the peak by 45,000 cfs at the Dalles, near Concrete.

FEBRUARY 10-11, 1951: The 1951 flood, on the other hand, was an example of a long duration flood. Although the peak discharge was smaller, the duration of high water was considerably longer than the 1949 flood. At Concrete, the crest reached a discharge of 129,000 cfs (10 year flood frequency) compared with 153,000 cfs (14 year flood frequency) in the 1949 flood. The difference though, can be seen when comparing the Mount Vernon discharge. For 1951, the crest reached 144,000 cfs (15 year flood frequency) compared with 114,000 cfs (5 year frequency) in 1949. Flood damages were estimated at $26,270,000.

The two most recent floods of the Skagit River occurred on April 30 and November 24, 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. The 1909 flood, however, was the largest since reliable records were started in 1896.

Greater floods have, and probably will, occur at rare intervals. If all 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 flood.

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 cfs is reached. Floods of these magnitudes are expected to recur at frequences of three 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.

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. 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.

III. EXISTING FLOOD CONTROL DEVICES:

Many people in Skagit County feel we have adequate protection against future floods. There are even those living outside the flood plain that think a major flood would not affect them.

The fact is our diking system will only offer protection against minor floods, and if there should be a weak point anywhere along our levees then even a small flood can produce a great deal of damage. The dams up-river are of some help, but we must remember that these structures were in operation during the 1949 and 1951 floods.

Those living outside the flood plain, say, on the hill in east Mount Vernon, would certainly feel the effects of a flood. Water and sanitation, transportation, utilities, all would be affected. Even Anacortes would feel the pinch from a flood as their water system is primarily provided by the Skagit River. Most of our business and industry are located in potential danger areas and any amount of flooding would cause a great deal of monitary damage.

Let's take a look at our existing flood control devices and see how effective they really are.

DIKING--Diking is known to have been practiced in the lower reaches of the Skagit in the early 1890's. In general, it was due to the efforts of individuals who were interested in keeping the summer floods away from their seeded farm land. Some areas near the river mouth were completely surrounded by dikes at an early date. In the beginning, the dikes were not very high but were raised to a sufficient elevation to confine minor floods to the river channel. However, many breaks occurred downstream from Avon during the 1894 and 1897 floods.

Farmland and towns in the delta flood plain west of Sedro-Woolley are protected by levees that prevent minor flooding from the river and from tidal salt water. About 43 miles of main line river levees prevent flooding of land by spring floods and by minor winter floods. Levees along salt water bays and channels prevent inundation by tidal flows. In 1889 Sterling Dam was constructed at the head of Gages Slough which was a distributary of the Skagit from the northern part of Sterling Bend. This was the commencement of major diking in the vicinity of Burlington and Sedro-Woolley. Since that date, the entire river from near Burlington to Skagit Bay has been diked. These dikes have been strengthened almost continually especially after each major flood.

To date 15 diking districts have been formed between Burlington and the mouth of the Skagit, enclosing a total of 45,000 acres of land within the levees. The dikes range in capacity from 91,000 cubic feet per second (3 year interval) to 143,000 c.f.s. (14 year interval) at the Mount Vernon gauge.

Overtopping of low areas in the levee system begins at flows of 84,000 c.f.s. Through sandbagging of low areas and minor flood fighting, the levees can provide capacity for a 91,000 c.f.s. flow with an average minimum freeboard of one foot.

The levees, varying in height from 5 to 10 feet, with top widths of 3 to 12 feet, usually have been constructed of river sediment ranging from fine sandy silt to silty fine sand. Coarser grained material encountered in some areas indicates hillside borrow has been used to a minor extent for original construction or repair. Sod is grown on levee slopes to minimize erosion, with riprap generally provided in the vicinity of river bends. The state, Skagit County, and diking and drainage districts, as well as the federal government, have given aid in rebuilding sections of levees damaged by floods.

During the February 1951 flood, the water surface was approximately at the top of the dike in two places near Burlington. Yet the peak discharge for this flood at the gauging station near Mount Vernon was only 144,000 c.f.s. This indicates the great possibility that future floods will breach these dikes and flood the lowlands. The dikes near the mouth did fail in several places in 1951.

Fairly effective flood protection works for the existing agricultural development have been completed on the flood plain from Burlington towards the mouth of the Skagit. Unfortunately, as one moves east of Burlington, flood protection slackens. A need may arise for future flood protection east of Burlington, depending on future development proposals.

DAMS--Hydropower projects have been developed in the Skagit River basin by the City of Seattle and the Puget Sound Power and Light Company.

Seattle City Light has constructed three power dams on the main river. Ross Dam, at river mile 105, controls 30 percent of the basin's runoff and is the only project that has storage for flood control along the lower river. Of the 1,022,800 acre-feet of useable storage 120,000 acre-feet is allocated for flood control. This storage, under average conditions, can reduce flood crests by 15,000 to 25,000 c.f.s. or less than 10 per cent at Sedro-Woolley. Ross Dam seems to contribute significantly to total flood control, although it may not be very effective if the storm center is west of the dam or if the storage facility is saturated. Installed generator capacity is 360,000 kw. Ross Dam reservoir supplements low flows of run-of-river plants at Diablo and Gorge dams downstream. Diablo Dam at river mile 100 has a generator capacity of 122,000kw and Gorge Dam at river mile 96 has a generator capacity of 134,000 kw.

The Puget Sound Power and Light Company operates two dams on the Baker River, one of the main tributaries of the Skagit. The first constructed and downstream dam was completed in 1927 and now has an installed capacity of 103,000 kw. The upstream dam at Baker Lake was completed in 1959, and has a generator capacity of 94,000 kw.

These dams provide 16,000 acre-feet of flood storage on the Upper Baker Reservoir to compensate for natural channel storage loss when the dams were constructed. Unfortunately, this amount of storage does not contribute significantly towards flood control according to the Corps of Engineers. Dams on the Skagit have not stopped flooding in the past.

NOOKACHAMPS CREEK AREA Although this is not a flood control project or an area that is protected from floods, it does have a signigicant influence on flood control. This area of about 5,000 acres provided approximately 34,000 acre-feet of storage for the 1951 flood and reduced the peak by 6,000 c.f.s.

P 003501

IV. PROPOSED FLOOD CONTROL STRUCTURES:

Apathy concerning flood control is a major hinderance in securing adequate flood control devices and regulations in most flood plains throughout the country.

Communities are reluctant to spend money on flood control projects until flooding does occur. Then there is a chorus of voices haranging governmental agencies for more protection. After a time this dies down and apathy again replaces action.

Some agencies, commissioners, and individuals continue to study flood plains through high and lows in public cooperations and interest and have suggested several alternatives. These projects have their good and bad points, are costly and demand a great deal of study and planning. It must be remembered that in dealing with a powerful entity like a river every action has a reaction. Dams affect fish runs, water fluxuation and change upriver ecological systems. Upriver developments affect water runoff, and so on.

Following is a list of some of the more dominant proposed flood control structures.

SAUK DAM--The lower Sauk Dam has not been authorized by Congress but preliminary figures have been computed for it. The purpose of the dam would be to reduce peak runoff from the Sauk River system, which contributes about one third to the runoff of the Skagit River above Mount Vernon.

A dam could provide 134,000 acre-feet of flood control storage and 250,000 acre-feet of total storage. This project has the potential to provide for floods occurring once every 100 years. The total investment cost of the project would be $184,000,000, with $86,000,000 allocated to flood control and $98,000,000 for power production. No benefit-cost ratio or non-federal financial figures were determined for the project.

However, dam construction would severely reduce anadromous fish runs presently utilizing the Sauk River system and eliminate spawning areas by inundation and fluxuation of the water level. Annual losses in deer, steelhead, and grousse just within the proposed dam area itself has been calculated to be high. Also many acres of agricultural and forest land would be lost due to dam construction.

Another type of structure for which there has been some discussion is that of a free-flowing flood control dam which would store water only when needed, such as when the river is in danger of flooding. To date, there have been no studies done to test the feasibility of such a dam, but preliminary examinations show the cost-benefit ratio of such an undertaking to be out of proportion, thus construction would most likely not take place at this time. In the event that the Skagit system is included into the Federal Wild and Scenic River System no dams would be allowed on the Sauk River.

AVON BYPASS--The bypass proposal, or Avon Bypass, is an eight mile diversion channel of 360 bottom width. It was authorized in 1933 and reactived in 1960. Currently it is a deactived project which can be reactivated if the county desires. The bypass location proposed by the Corps of Engineers would cut through Gages Slough, follow the toe of Bayview Ridge and discharge into Padilla Bay at the mouth of Indian Slough. With this alignment, the Corps also proposed a four mile levee extension and improvement extending from the Bypass past Burlington to the high ground between Sedro-Woolley and Burlington proper. The Bypass would develop a completely controlled seven mile long channel with access to populated areas. The project would have about 340 acres of water surface and about 440 acres of adjacent land for public use. Construction of the levee and channel improvement would limit use of the Bypass to divert flood flows to once in about four years, for a duration of only one to three days. During the remainder of the time, the bypass would be fully usable for recreation purposes such as fishing, picnicing and other water oriented activities.

There has not, however, been an environmental impact study done at this time to study the effect of additional fresh water and silt on the environment and acquatic resources of Padilla Bay. It is not known whether this change would effect the shellfish population and water fowl of the bay and to what extent migratory fish would be affected. It is also estimated that approximately 500 acres of agricultural land would be lost due to construction of the channel. Cost of the project has been set at around 36 million dollars.

BAKER DAM--The Baker Dam project currently being investigated by the Corp of Engineers, proposes to lower the level of the reservoir to increase flood storage from 16,000 acre-feet to 84,000 acre-feet. This would increase the protection level from a minimum of three years to six years. The cost of the project would be in terms of lost power, which (in 1968 dollars as given by the Puget Sound and Adjacent Waters Study) would be $133,000.

LEVEES--The Flood Control Act of 1966 authorized the strengthening of existing levees and channel improvements along the lower 17 miles of the Skagit River. This work would remove serious obstructions to flood flows, lower channel velocities, and reduce upstream river stages. The improvements would provide protection to the level of 120,000 cubic feet per second discharge or an eight year frequency flood. The cost of such a project would be approximately $10,080,000 of which about $400,000 would be the non-Federal share. This project would have Federal participation, although it, too, is in the disactive category.

The Puget Sound and Adjacent Waters Study proposes the construction of new levees at the Nookachamps, Hamilton, and Sedro-Woolley. These new levees would have a design capacity of 135,000 c.f.s. for a three mile levee at Hamilton and a four mile levee at Sedro Woolley under Alternative Plan "A" in the study.

Under Alternative "B" the levees at Hamilton and Sedro Woolley would be larger in order to maintain the 100 year protection provided in Alternative "A". The Nookachamps levee would provide 20 year protection and would be designed to overtop before other levees downstream would.

STREAM CHANNEL IMPROVEMENT AND REALIGNMENT---Stream channel improvement results in end effects much the same as those which would occur from dikes or levees. Here, however, the improvements would involve dredging operations (removal of abstructions and/or straightening the channel course). Channel improvements of this type have a distinct advantage over the levee system in that when flood waters rise, any inundation is relatively slow. The velocity or surge associated with a dike failure does not exist.

Dredging operations would be controlled by the surrounding topography, and attempts to go beyond such limitations will either reap no benefit or will simply move the flood problem to other areas. Attempts to reduce stream roughness must recognize the possibility of vegetative regrowth or sediment deposition, both of which may return the roughness to its original value.

It is reasonable to expect that channel improvements and realignment may require more land area than other alternatives. In many cases, this land area may not be available at acceptable cost. Thus, a concrete-lined or other-lined channel may be necessary. In any event, aesthetics of the improvement must not be ignored. If dredging and realignment are undertaken, stream water ecology may be affected. Forces created by flowing water are often underestimated; it is quite difficult to force a meandering channel to assume an "artificial" path in all instances. Unless suitable protection is designed to offset erosive energy of the stream, the meander of the natural channel will reoccur.

WATERSHED TREATMENT--In many instances, flood damage reduction can be effected through the treatment of upstream watershed areas. While such treatment may be quite logical and feasible, this activity probably will not influence the flow rate in any but rather small streams.

Land use is one form of watershed treatment. For example, if an area which is naturally forested or occupied by other vegetation is subsequently denuded by industrial or residential development (with it associated impervious area), the precipitation-runoff relationship for that area can be seriously changed. Vegetation which previously "consumed" portions of the precipitation and controlled the runoff, particularly on steep slopes, would be removed. Increased amounts of runoff would then occur, and more quickly, from the same precipitation quantities. Rapid transition from rural to urban living is a major cause of watershed changes. These are examples of what may be defined as poor land management practices.

P 003504

V. NON-PHYSICAL CONTROLS:

Despite large expenditures of monies for flood control projects in past years, the increase in flood damages has led to a new approach for reducing these damage amounts.

This approach is the application of control over the use of land lying adjacent to the river through planned development and management of flood hazard areas. While flood plain areas can probably never be considered flood free, planning will allow selection of flood risks according to the type of development desired.

Studies of floodplain use show that some encroachment is undertaken in ignorance of the hazard, some occurs in anticipation of increased protection, and some takes place because by shifting the cost of the hazard to society, it becomes profitable to private owners to do so.

Floodplain management is an alternative to flood control projects. It is designed to provide an approach which will permit the use and development of floodplain lands for the optimum benefit of the regions population and its economic activities, without having to provide structural measures of protection to prevent flood damages.

A floodplain management plan can reduce present and future flood damages by controlling and directing the amount and location of development on the floodplain by the use of floodplain zoning and regulations. Floodplain zoning, subdivision regulation, building codes, and other code enforcement procedures can supplement floodplain management as a means of non physical controls.

Floodplain zoning and regulation involves the division of the county into districts, and the regulation within these districts of: 1) uses of structures and land, 2) height and bulk of structures, and 3) the size of lots and density of use. The characteristic feature of zoning that distinguishes it from other controls is that the regulations differ from district to district. For this reason, it can be used to set special standards for land uses in flood hazard areas. The division into districts of lands throughout the county is based on the comprehensive plan which is used to guide the growth of the county.

Subdivision regulations guide the division of large parcels of land into smaller lots for the purpose of sale or building development. Subdivision regualtions with special reference to flood hazards often: 1) require installation of adequate drainage facilities, 2) require that location of flood hazard areas be shown on the plat map 3) prohibit encroachment in floodway areas, 4) require filling of a portion of each lot to provide a safe building site at an elevation above selected flood heights or provide for open support elevation to achieve the same ends, and 5) require the placement of streets and public utilities above a selected flood protection elevation.

Building codes neither regulate where development takes place nor the type of development, but rather building design and materials. Building codes can reduce flood damages to structures by setting specifications to: 1) prevent flotation of buildings by requiring proper anchorage, 2) establish minimum floor level elevations consistent with flooding potential, 3) restrict use of materials which deteriorate when exposed to water and, 4) require structural design consistent with water pressure and flood velocities.

Floodproofing standards applied through building codes and regulations to floodplain structures can permit economic development in the lower risk areas by holding flood damages and other adverse affects within acceptable limits.

Sanitary and well codes establish minimum standards for waste disposal and water supply. Sanitary codes commonly prohibit use of onsite waste disposal facilities such as septic tank systems in areas of high ground water and flood hazards. Well codes often establish special flood proofing regulations for facilities located in flood hazard areas.

P 003505

Other measures that could be incorporated in floodplain management techniques are: 1) flood forecasting, 2) warning signs and, 3) tax adjustments.

The National Flood Insurance Program was enacted in 196? to offer flood insurance protection to property owners in flood/mud slide prone areas that was not available before. The program provides monitary protection for existing development and locational protection for proposed or improved development. It also encouraged communities to adopt minimum land use controls which would start to minimize the total flood/ mud slide damage in a community. The National Flood Insurance Program does not stipulate that development cannot be placed in a flood hazard area, but that necessary precautions must be made so that damages are kept to a minimum.

Skagit County adopted its first Comprehensive Plan in 1963 and a subsequent Zoning Ordinance in April of 1966. In December of 1971 Skagit County adopted an amendment to the zoning ordinance that specifically dealt with flood management regulations.

It specified that all lands lying below the 50 year frequency flood level, as established by the U.S. Army Corps of Engineers, shall be classified as floodplain and are subject to certain conditions; among them being that the floor level of structures for residential, commercial or industrial use shall be located above the 50 year frequency flood level. This admendment further stipulated that all construction or structures on land within the floodway (15 year frequency flood level or below) be permitted by conditional use permit only.

In August of 1974, this amendment was further amended to raise the flood level from the 50 to the 100 year frequency flood level in order to: 1) bring the County into compliance with State laws and, 2) enable residents of Skagit County to purchase flood insurance under the National Flood Insurance Program.

Floodplain regulations are not aimed at uses per se but rather the pattern and form that such uses take. Not to be overlooked is the certainty that all of the floodplain is going to be flooded at some time, and that the hazard accompanying any use is much greater in some portions than in others.

Thus, the process of identifying the floodway zone is a way of separating the higher hazard areas from those of lower hazard. Once a community has completed identification of the high hazard or floodway area, it has gained the type of knowledge necessary for intelligent issuance of building permits for the less hazardous fringe areas of the floodway.

The concept of differentiating the floodway and the floodway fringe represents a sort of compromise between the desire to prevent the shifting of costs resulting from floodplain occupance from individuals to the community, and the desire to permit individual landowners as much freedom as is reasonable in the use of their lands.

Adoption of non physical controls is only one of a variety of resources available for reducing flood damages. Such regulations must be approximately combined with other floodplain management techniques to reasonably minimize flood losses. A basic difference between regulations and visible forms of protection, such as dikes and dams, is that the former are not likely to induce uses incompatible with a residual flood threat. Visible dams and dikes, such as those which have been built in earlier years, tend to encourage a false sense of security.

P 003506

VI. WATER RUNOFF AND DRAINAGE PROBLEMS:

The Skagit River and its tributaries comprise a 90,000 acre flood plain. Heavy rains, accompanied by warm, moist wind, that melted the snow pack caused rapid rises in tributaries that in turn caused flooding to down-stream areas of the Skagit in our most recent flood. The magnitude and intensity of a storm cannot always be used as an index of the resultant river discharge. Other factors, such as temperature, degree of soil saturation and moisture content of the snow pack, largely influence the rate of the total runoff produced by a particular storm. The conditions leading to our most recent storm which caused flooding was not all that unusual but resulted in severe flooding in places.

Let's examine the drainage and runoff conditions that contributed somewhat to the past flood: Generally speaking, soils within the Skagit watershed area are of four types, the low fertile river valley soils, upland less permeable soils, the steeper gravelly forested soils and rock found in the high mountainous areas. The upland and forested soils have relatively low water holding capacity and shed water very quickly onto the lower river valley where drainage problems usually occur. The steep rocky mountains also shed water readily to the forested areas complicating problems even more.

Due to the pattern of urban development in Skagit County most of our agricultural base is located in the fertile valley, while a great deal of urban growth is taking place on the upland soils. At the same time, most of the forested soils are in forest production and are logged periodically. Upland logging and urbanization can drastically affect water runoff. The influences of forest cover on total runoff has some significance to streamflow but the major damage usually occurs from land slides and debris carried by the streams. Although several studies have indicated that increases in streamflow do occur following cutting, in most cases this results from higher soil moisture in the clear cut areas where transpiration has been greatly reduced. In this area, the greatest increases in peak streamflow occur during the first fall storms when soil moisture is high in the cut over areas, but some storage capacity remains in the drier soils under a timber stand. During the recent flooding, both soils in clear cuts, as well as under forest cover were saturated before the peak of the storm. But due to the heavier snowpack in the clear cut areas more water had the ability to run off of the melting snow with little interception from vegetation. Even with the above in mind, during most storms the influence of sustained yield timber harvest on either precipitation or streamflow can be considered less damage-wise than the debris and land slides occuring as a result of a storm.

Another important aspect of water runoff occurs in urbanized areas. Upland development that occurs mostly on less permeable soils causes a significant increase in runoff amounts and changes the natural water runoff patterns. For example, comparing a two block area which is flat and has a silt loam soil, is currently being used as pasture, to the same type of land which is being used for multi-family appartments, we can see an increase in runoff. Using a 10 year frequency storm that produces 2.6 inches of water in 24 hours the pasture would yield 36 gallons per minute during its peak runoff. On the other hand, the multi-family apartment complex would yield a runoff of approximately 99 gallons per minute during its peak. Using this example one can see a never-ending battle for urban dwellers to properly dispose of excess runoff water generated by them. This also exerts increased pressure on those living in the lowlands who must some way handle the water before it reaches the bay. The existence of ponded water in and around Mount Vernon is a vivid example of trapped runoff water with no place to go except to be evaporated or absorbed by the already saturated soil. The Skagit River watershed has undergone significant land use changes since 1909 when the worst flood on record occurred. Many of these changes have added to and increased runoff rates affecting the total flow of the Skagit River. But total affects of these changes have gone relatively unnoticed in predicting chances of floods far greater than what we in Skagit County just witnessed last December.

VII. DEVELOPMENT IN THE FLOOD PLAIN:

Early settlers in the flood plain built dikes and levees to protect their crops from mild spring floods, which from time to time caused the Skagit to overflow its banks and wash over the farm land. Since that time dike and levee improvements have continued to reclaim more and more usable farmland.

These improvements in the late 1890's and early 1900's, combined with the construction of the various dams on the upper Skagit have helped control some of the intermittent seasonal high waters, yet cannot stop any major flooding in the Skagit Valley. These dams and dikes have, however, created a sense of security for some property owners and residents of the floodplain which has provided the impetuous towards more development in the floodplain areas.

Development in the floodplain in the early days was primarily related to agricultural production. This involved generally large acreages of crop lands on the flats and pasture and grazing areas in the upriver portions. Generally these lands were not appreciably damaged by intermittent flooding. However, today's intensive farming methods and specialized cropping techniques would be quite extensively damaged by water flow over the lower valley's floodplain.

Residential development in the floodplain has primarily centered around existing cities and towns and has until recently not tended to be dispersed in a variety of concentrated locations.

Flooding adversely affects the quality and dollar values of residential housing available. Floodwaters rarely carry entire houses off their foundations, however, significant damage, such as shifting and settling of foundations, damp rot in timbers, buckling of floors and walks, shorting of electrical systems, and the soiling of furniture, rugs and draperies, often result from flooding. The homeowner must spend funds which might have otherwise gone for home improvements on costly flood damage repairs.

Observations of a number of homes built in the early 1900's, especially in the farming areas, show the majority have high foundations or elevated living areas which reflect their respect for the flood potentials of the Skagit River. Many newer homes built in the floodplain prior to 1967 were not required to build to any certain flood elevations and did not. These are amoung the residential structures which are most susceptible to incurring flood damage.

After 1967, elevation of structures was required in both the State of Washington and Skagit County. In 1974 the Skagit County Zoning ordinance was amended to require the first floor level of structures for residential, commercial and industrial use be located above the 100 year frequency flood level.

Commercial and industrial intrusion on the floodplain has historically been associated with processing of the natural resource products in the area; canneries, lumber mills and other associated facilities. Most intensive type developments have been located in cities and towns in the floodplain because of their proximity to employees, source materials and transportation facilities.

Today, a floodplain site is generally unacceptable to most large scale industries and some commercial ventures because of danger to plant and equipment and the cost of flood protection. Most industries are not likely to be willing to make substantial investments necessary to build their sites up above maximum flood danger levels.

The type of development most likely to be impacted by flooding are recreational subdivisions and "riverfront" lot developments generally located upstream from Sedro-Woolley. The growing amount of leisure time and increasing demand for second homes, recreation cabins and some permanent homes with waterfront have caused great pressures on the floodplain areas in Skagit County. It is these adjacent developments that are directly effected by the intermittent rise and fall of the river that are going to request additional protection from frequent flooding or high water by means of rip-rapping or other protective structures.

Prior to the Zoning Ordinance going into effect in Skagit County (1966), there were several similar developments that were located, or were partially located in the floodway of the rivers. The development at Cape Horn for example, has approximately one-half of its lots located within the floodway (15 year frequency flood) and the majority of the remainder is within the floodplain of the Skagit. More often than not people purchase lots in these developments not realizing that they are in danger of being flooded. There could be some question whether such an intense development, if proposed today, would be allowed under present conditions and regulations.

Any structure in the County built on the floodplain for residential, commercial or industrial use would require a floodplain management permit from the Skagit County Planning Department. In 1974, the Planning Department issued 57 permits for structures whose estimated values were $845,000. In comparison, 1972 floodplain management permits number 60 with their value at $1,077,000. The majority of floodplain management permits are for single family residences which does show there is a large amount of capital invested in the floodplain areas.

The potential cost of a major flood in the Skagit Valley would unquestionably go into the millions of dollars. The cost would be spread between those who occupy the floodplain and are directly affected and also those who live out of the floodplain who pay for relief, repair and other clean up work.

Any development in the floodplain should be seriously studied to ascertain the ramifications of any such development. As more and more developments encroach onto our floodplain more pressure is put on government to spend more money for flood protection. As the river is made safer from floods more development takes place which puts agriculture under a great deal of pressure.

P 003510

VIII. COSTS OF FLOODING:

The flood that last December brought disaster to many Skagit families is already being spoken of as the "flood of the century" by some. The term implies that we will not expect to see another costly and dangerous outpouring of rain, snow and wind until about the year 2075.

However, none of the western Washington rivers, which rampaged their banks last December came even close to 100-year flood stage. Preliminary assessment indicates that the Nisqually hit the highest level in flood frequency at 40 years, but did only negligible damage due to the lack of development in that flood plain. The Skagit, on the otherhand, suffered a 10-year flood and over 150 homes were damaged.

The largest flood on the Skagit according to historical evidence, occurred long before the first white man arrived on the scene. Man has been keeping records of floods on the Skagit since 1896 and we have had about 37 floods since that time. This would average a flood about every other year and nine major floods during the period.

The flood plain of the Skagit River covers about 90,000 acres of land. About 68,000 acres of this flood plain is fertile agricultural land. Competing with this farmland are thousands of structures, including a full range of farm, residential, commercial, and industrial buildings with connecting roads and utilities. Much of it has been inundated many times since it was first settled in 1869.

The old timers were willing to accept this as a matter of course - just look at the many homesteads built upon elevated foundations at the highest point on the tract. As a result, flood damage in the past was confined primarily to crops. And while farmers may disagree, floods may produce short-term losses, but long-term gains through soil development and revitalization.

The greater part of past flood damage has been to land and crops in the lower valley. Major damage results from the drowning of grasses and other plants, loss of livestock, sheet erosion caused by overflow of fallow ground, leaching of fertilizer, infestation by weed seed, carrying away of fences, the deposition of sand, gravel and driftwood, temporary loss of pasture because of ground saturation and loss of land through streambank erosion. When tidal dikes in the delta are breached by impounded floodflows, the resulting saltwater intrusion reduces productivity from one to three years.

Next in importance is damage to buildings, including shifting and settling of foundations, damp rot in timbers, buckling of floors and walls, shorting of electrical systems, the rusting and silting of vehicles, tools and appliances, and the soiling of furniture, rugs, and draperies. The contents of commercial buildings depreciate in value and losses in sales occur because of suspended operations.

The damage to levees by erosion and overtopping is significant. Highway and railroad embankments and shoulders suffer erosion, undermining of pavement, and temporary weakening as a result of subgrade saturation.

Although damages occur primarily in the area west of Sedro-Woolley in the floodplain, they do not stop there but continue up the river valley. Upstream of Sedro-Woolley much of the floodplain is uncleared or unsuitable for farming, but is an attractive location for summer home developments. Flood damages are increasing rapidly in these areas because the developments are often located on reaches where the riverbank is low. The damages result from bank erosion and from overtopping of low riverbanks and low levees.

The total costs of selected historical floods calculated in 1972 prices and conditions are as follows:

STORM	PEAK FLOW AT CONCRETE CFS	RECURRENCE INTERVAL YEARS	DAMAGE 1972 PRICES & CONDITIONS
NOV. 1909	260,000	100	$34,980,000
DEC. 1921	240,000	70	32,850,000
FEB. 1932	147,000	12	25,291,000
-------	220,000	50	32,780,000
NOV. 1949	154,000	14	14,340,000
FEB. 1951	139,000	10	26,270,000

It must be noted that not all people are in agreement as to the type and amount of damage involved with the crops and farm land. Several years after the 1951 flood, a survey was taken to determine damages incurred by farmers due to the flood.

It was determined from the responses that flood damage was not as high as first thought, and in most cases, except where land was lost, or where sand was deposited on crop land, farmers recovered very quickly from the flood.

Two reasons could explain this. First the amount of time passed since the flood could have minimized the amount of damages incurred in the minds of the farmers. The other explanation might be that major flooding in the Skagit occurs during the winter months when most of the farm land is non-productive except for a few winter crops and pasture land.

It was felt that the inactive crop land would not be damaged by slow inundation. This point of view is supported by the fact that continued agricultural use of the highly flooded Nookachamps area is made. As a result of this survey it would seem far more damage occurs during high water times in the late spring and early summer.

The important point is that earlier damage estimates can be questioned. Although no figures are available to determine the magnitude of the reduction of damages, the amount of percentages would likely not be as high as projected by the Corps of Engineers, and if crop and livestock damages are substantially reduced, this would greatly reduce the benefits provided by flood control projects. And a reduced benefit-cost ratio would make it more difficult to build marginal and submarginal flood control projects.

Although farmers who have been flooded suffer greatly, in most cases (except for livestock losses,) they recover from the affects of a flood much faster than do owners of residents and small business establishments. But while agricultural damage estimates are believed to be overestimated, each additional home or commercial structure allowed in the flood plain increases the potential for increased damages.

P 003512

IV. FLOOD PLAIN MANAGEMENT:

The importance of flood damage prevention is becoming more pronounced with our expanding population. Vacant lands are being covered with subdivisions, shopping centers and commercial areas. Often these lands are subject to serious flood hazards which developers do not or will not recoginze.

Most promoters lack a long-range viewpoint. They may unintentionally saddle future owners with flood susceptible, depreciated and hazardous property. It then becomes the public sector's responsibility either to guide the use of land in the flood plain or to "bail out" an uninformed public by spending a great deal of money to "flood proof" potential flood hazard areas.

There is little question that housing and other development in the flood plain on the Skagit is denser and larger now than it was in 1951, not to mention more perilous times. Flood plains by definition are where rivers flood. The flooding creates the plains. So one lesson can be drawn, a flood somewhat smaller than those in the past may do worse damage today simply because there is more to damage by water rushing homeward to the sea. That is one good reason why governmental planners now are starting to ban further development on the flood plains.

In August of 1966, the President of the United States, issued an executive order which clearly points out that the executive branches of the Federal Government shall not expand, loan, or issue grants with federal money in flood hazardous areas until the flood hazard is fully analyzed. The federal government now uses the carrot and stick approach through the Flood Insurance Program to regulate flood plain development.

The program was established by the National Flood Insurance Act of 1968 (enacted as part of the Housing and Urban Development Act of 1968) to make specified amounts of flood insurance, previously unavailable from private insurers, available under federal auspices. In return for the provisions of subsidized insurance to existing properties, the Act requires that State and local governments adopt and enforce land use and control measures that will guide land development in flood-prone areas in order to avoid or reduce future flood damage. A 1969 amendment to the Act expanded the definition of flood to include mudslides, and mudslide area restrictions are also required, where applicable.

Flood plain zoning is the most common and perhaps the easiest way to accommodate local development objectives with the requirements of the National Flood Insurance program. Zoning of counties, including control of flood plain uses, is just as desirable and legally sound. The purpose for such zoning is to reserve the flood plain for those uses which are not only best suited to it but are least subject to damage during high water.

Part of the flood plain is liable to be inundated every few years. This area could be zoned for agricultural uses, including farm buildings necessary for farm operations. Certain other public and commercial activities which can recover readily from inundation could be allowed such as parks, playfields, parking lots, golf courses, etc.

At present, governmental agencies, the Corps of Engineers, and planning bodies all across the country are working towards effective floodplain management programs which are an alternative to flood control projects. A floodplain management program can be accomplished in a variety of ways. The primary concern of the program is to minimize structures on the floodplain and/or to

P 003513

require that new structures be built to offer minimum resistance to floodwater in certain crucial areas. Some objectives of the floodplain management program are as follows:

1. Prohibition of floodplain uses such as filling, dumping, storage of materials, structures, buildings and any other works which would increase potential flood heights and velocities by obstruction to flows and loss of valley storage. (This would be most critical east of Sedro Woolley.)

2. Protection of human life and health.

3. Minimization of public and private property damages.

4. Minimization of surface and ground water pollution which will affect human, animal or plant life.

5. Control of development which would create an additional demand for public investment in flood control works.

6. Control of development which would create an additional burden to the public in the costs of rescue, relief, emergency preparedness measures, sand bagging, pumping, and temporary dikes or levees.

7. Control of development which would create an additional burden to the public for business interruptions, factory closing, disruption of transportation routes, interference with utility services and other factors that result in loss of wages, sales, production and result in tax write-offs.

8. Provisions for public awareness of the flooding potential and to discourage the victimization of unwary land and home buyers.

9. Maintenance of stable tax base through the preservation or enhancement of property values for future floodplain development. In addition, development of future flood blight areas on floodplains will be minimized and property values and the tax base adjacent to the floodplain will be preserved.

What are Skagit County's alternatives? At present, cost-benefit ratios do not warrant the costs of construction of new flood control devices such as dams, the Avon Bypass, etc., but as development continues to encroach onto the agricultural land, cost-benefit ratios become more in favor of constructing these flood control structures. If we do limit growth on the flood plain through floodplain management and keep it confined to higher ground, then a great deal of time and money will be needed to study water run-off and drainage problems caused by any new construction. If, on the other hand it would seem more feasible to construct, say, a dam, then fish and game losses, recreation and timber reductions and the costs of construction to Skagit citizens would all have to be taken into consideration.

There are no pat answers as to which is the best way to go. The Skagit County Rural Development Committee hopes that all Skagit County Citizens will take an active part in each and every floodplain management decision. Only in this way can an adequate foundation be laid for a management program which would protect residents of the floodplain and enhance the mighty Skagit.

X. DECEMBER, 1975 FLOOD:

On November 30th a cold front moved into the Skagit area covering the area between Burlington and the Cascades with a moderate amount of snow. On December 1st a new front moved into the area raising the freezing level higher up in the mountains and dumping rain on the valley as the temperature continued to raise. Melting snow and rain water begain swelling ditches, streams and the Skagit River, which began flooding sometime Tuesday night. The weather continued to stay warm and rainy through Wednesday with wind coming up in the afternoon causing wave action which threatened dikes and other structures along the river. Several critical periods were met during the flood when tides were high and the winds strong. Peak high water level was reached Thursday night when the river creasted at 35.6 feet at the Riverside Bridge in Mount Vernon. Twenty-six feet of water in the river at this point is considered flood stage by the Skagit County Engineers. Clear weather and cooler temperatures begining Thursday affected immediate receeding along the river as soon as the crest past. By Friday, December 5th, the water level was dropping and water receeded at a remarkably rapid rate. The river lacked only 2,000 cubic feet per second of becoming a flood of the same magitude as the 1951 flood which caused a major levee break near Conway.

Seattle City Light, owner of Ross Dam which controls approximately one-third of the Skagit River's flow, started to store water in Ross Reservoir at the request of the Corps of Engineers on November 30, 1975. The maximum storage was reached on December 4th, and totaled 94,000 acre feet. This water was then slowly released at the request of the Corps so that the Department could lower the Ross Reservoir water level down to its normal flood control elevation. This point was reached on December 9, 1975.

At the time of the flood crest at Concrete (which amounted to a measured value of 122,000 cubic feet per second) the inflow into Ross Reservoir was approximately 24,000 cfs. The Ross plant was releasing at that time, slightly less than 5,000 cfs, there fore, the added inflow into Ross Reservoir that was not released, namely, 19,000 cfs would have added substantially to the Concrete crest, thereby creating a peak flow of approximately 141,000 cfs.

Therefore, Ross Dam had control over approximately 17% of the river flow at that time. It has been calculated that the control they had enabled them to reduce the flood level at Concrete by approximately two and one-half feet.

The damages in this county could have been far greater if it wern't for the extensive diking system on the lower Skagit River, not to mention the massive effort by local people and the military to prevent the dikes from slipping or breaking in weak spots. The majority of agricultural land flooded was in the unprotected areas such as the Nookachamps drainage area, the Upper Skagit east of Sedro Woolley, with some intermittent flooding on the Samish River. Damage estimates are very approximate at this time for crops, fences, machinery, livestock, ponds and debris. Crop damage is very vague, depending on how long the water stood in a field. Much of the flooded land was in hay and pasture and damage may not be apparent until the growing season begins. Reduction in other crops, such as seed plants and berries, will also be easier to asses in the spring.

Following is a brief overview of the damages incurred during the December flood:

P 003515

Drainage Systems:	$287,000	
Water Disposal System:	$58,800	
Buildings:	$2,163,000	1.5 million private,
Debris Removal:	$47,700	663,000 public

Damage to: Roads	$43,600
Streets, Mount Vernon	$18,350
Bridges	$38,000
Culverts	$1,000
Debris Clearance on Roads:	$2,700
Damage to roads under Federal Aid System:	$145,700
Damage to DNR Roads:	$240,800
Crops of Engineers (Debris Clearance, Protective Measures, Damage to Water Control Facilities, Damage to Recreational Facilities):	$350,000
Rock Work Estimates:	$299,000

Farm Damages:		
Land Damage by Sedimentation and Erosion:		225 Acres
Livestock Losses:		125 Head (90 from one dairyman)
Machinery:		Limited Data
Fences:		81,000 Feet
Debris Removal:		500 Acres
Crops:	Hay, Silage Grain	175 Tons
	Vegetable Seed Crops	55 Acres
	Bulbs	30 Acres
	Cabbage Seed	14 Acres
Soil Losses:		Could not be determined

The Department of Game estimated that $65,450 worth of damage was done as a result of the flood. This is broken down as follows:

Barnaby Slough	$13,050
Skagit Wildlife Rec. Area	$35,700
Dikes, Equipment & Access Areas	$16,700

It was difficult to put an amount on the damage done to resource areas.

The effects of flooding on salmon survival include the following: 1. Dislodging of eggs from the stream bed. 2. Movement and shocking of eggs during early developmental stages causing death. 3. Smoothering of eggs due to deposition of silt or burying caused by deposition of transported stream-bed materials. 4. Spawning salmon may be washed out of their spawning areas. 5. Accumulation of debris may cause a block to the upstream passage of salmon thus eliminating spawning areas. 6. Channel changes may result in drying up sections of a stream previously used for spawning. 7. Log jams block juvenile salmon access to upstream rearing areas.

The impact of flooding was more severe in tributary streams, particularly in the lower Skagit. Though flooding was not as severe in Skagit tributaries above the Sauk River. The Sauk River below Darrington was altered due to many channel changes.

Future Skagit River salmon returns will undoubtidly be effected by the 1975 December flood. The combined low escapement of pinks and poor survival will effect returns in 1977. Though chinook were assumed to be less effected. The reduced survival in tributaries and the Sauk River, may result in lower returns in 1979. Coho production is more dependent on summer stream flows and returns in 1978 should not be impacted as a result of flooding. Chum returns in 1979 will be influenced more by the low escapement than by flooding.

P 003516

As can be determined from the above figures, Skagit County suffered damages in the millions of dollars. Even though the December flood was a relativly small flood, with no major breaks occuring in the dikes, losses were high. Some of the damages to agriculture, fisheries resources and soil erosion is very difficult to determine and no figures have been computed for them at this time.

What can Skagit County expect in the future? Larger and more damaging floods than the one we just experienced are likely to occur. How we protect ourselves and property from this possibility is a hard question to answer. If we allow the flood plain to be developed, then flood control structures may be our only alternative, costly as it may be. If, on the other hand, flood plain management seems to be the best tool available to us, plans should be carefully laid out to ensure equitable treatment for all those living in the flood plain.

This is the last of our series on flooding in Skagit County. The Skagit County Rural Development Committee hopes that some of the information presented here has been of some value to the reader in understanding the mighty Skagit.