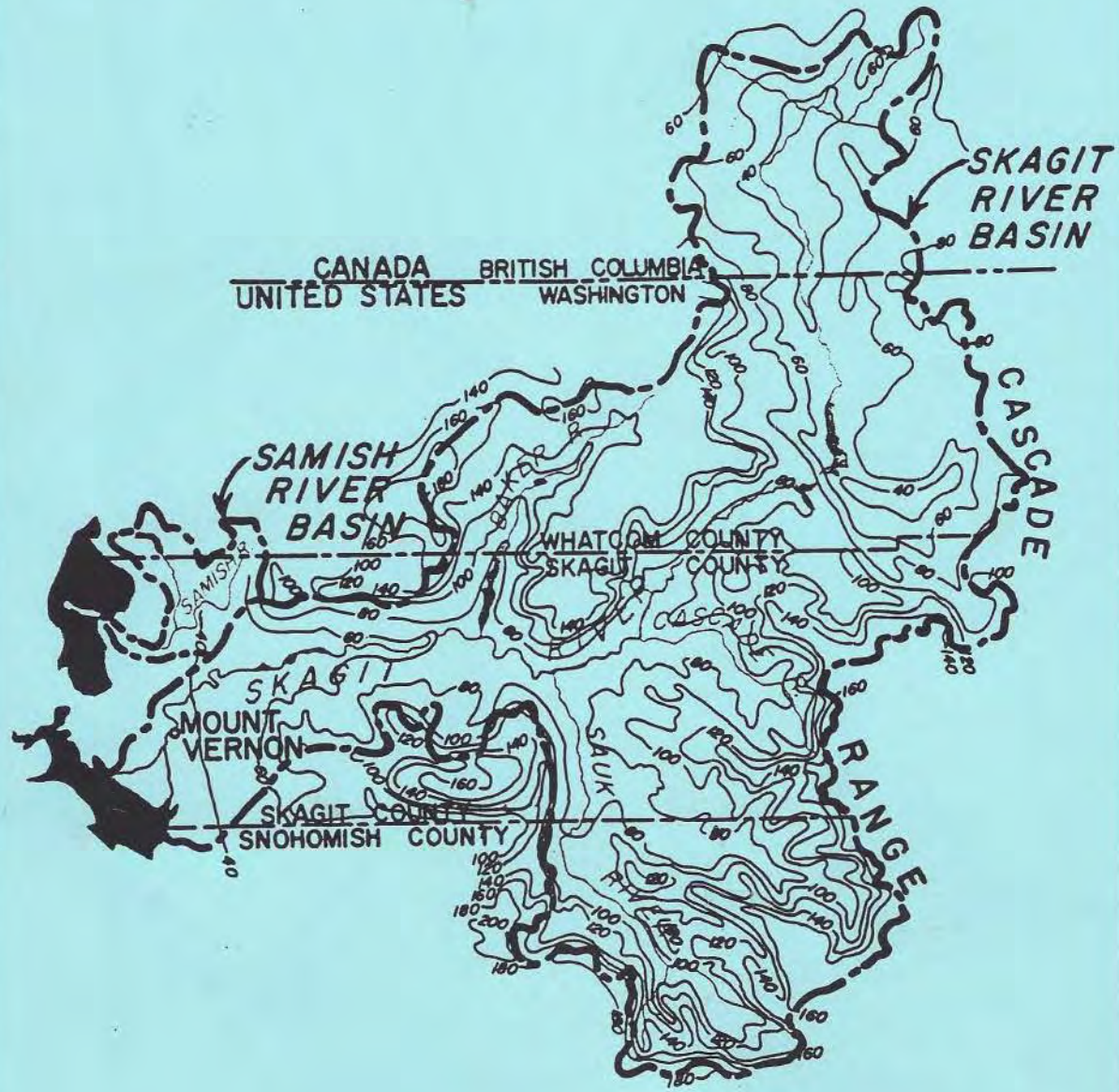
SKAGIT RIVER VALLEY



THE DISASTER WAITING TO HAPPEN

SKAGIT RIVER VALLEY

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DEDICATION

This book is dedicated to my wife Linda who has put up with my infatuation with "THE RIVER" for over ten years, and my two sons Josef and Jeffrey, and to their generations that will inherit the Skagit River Valley. May some day mankind realize that when Mother Nature speaks, we all should listen.

ACKNOWLEDGEMENTS

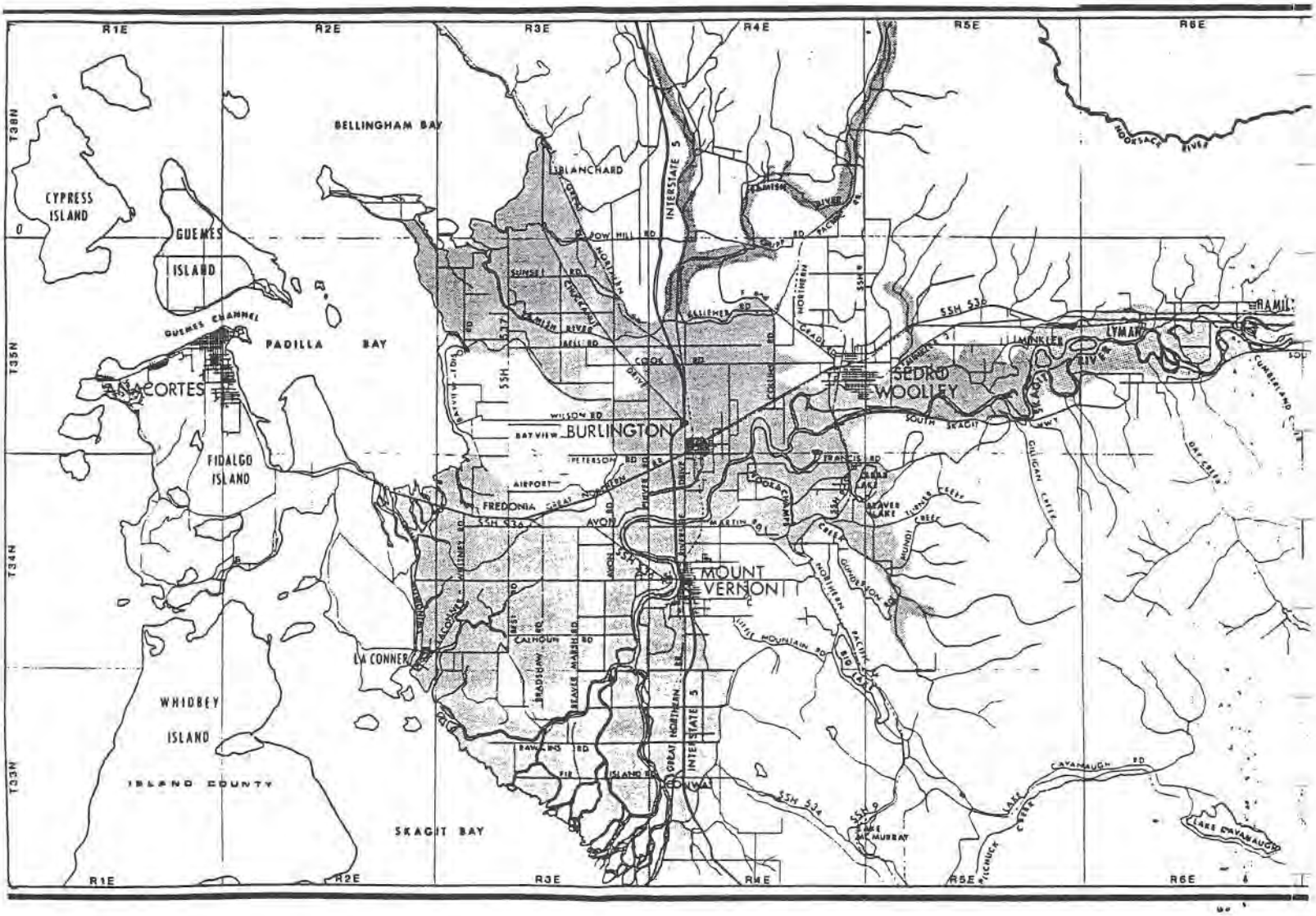
I would like to thank the U.S. Army Corps of Engineers, the Federal Emergency Management Agency, the U.S. Geological Survey, the State of Washington Department of Ecology, the Skagit Valley Herald, and the Skagit Argus for opening their files and providing over 95% of the information contained within these pages.

I would also like to thank all of the people that have tolerated me over the years talking about "THE RIVER". All of you have been contributors in one form or another, whether you were city councilmembers, county commissioners, government staff officials, citizen groups, reporters, friends or just plain folks. Thanks to all of you.

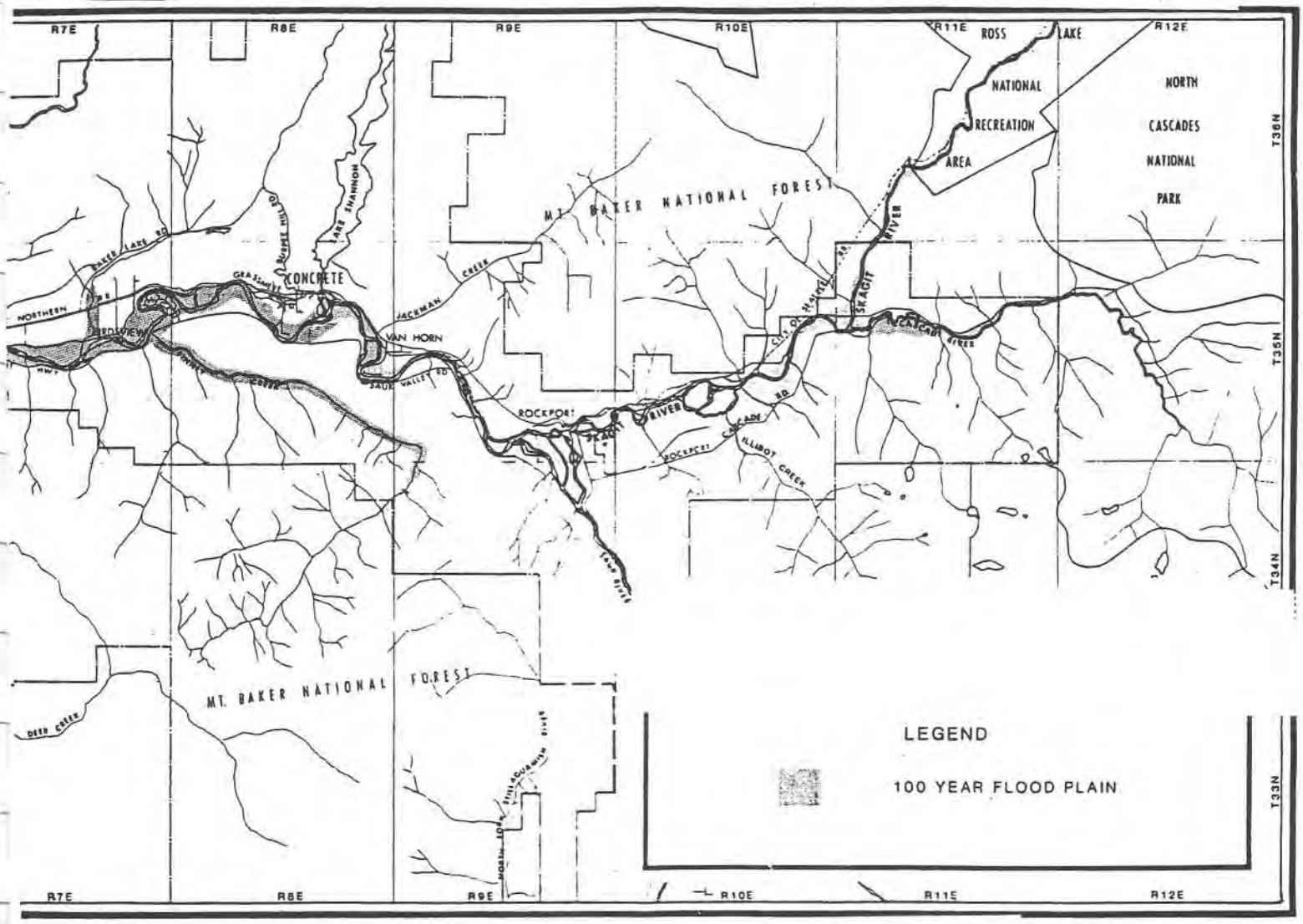
A special thank you to Mrs. Newell's 7th and 8th grade authors class, of Cascade Middle School in Sedro Woolley.

Also a special thank you to the Skagit County Historical Museum, which provided all of the photo's contained herein.

LOWER RIVER VALLEY MAP



UPPER RIVER VALLEY MAP



PREFACE

"When the white settlers first arrived in their covered wagons between the area of Lyman and Hamilton, they were met by the old Indian. They would ask the old Indian where should they homestead? Where was a safe place to build? The old Indian would reply, **"See mud on tree. Build higher."**

Testimony of Hamilton resident at public hearing regarding National Flood Insurance Program.

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PURPOSE

So much has been written about the Skagit River that it is a wonderment that so little has been accomplished and so much has been ignored. The early settlers began talking about the river almost as soon as they arrived in the late 1800's. The government became involved with the enactment of the 1936 Flood Control Act. With the exception of upriver storage provided by the Ross and Upper Baker Dams little if anything has changed with respect to the power of the mighty Skagit since 1936.

The purpose of this book was to assemble and organize all the known data about the effects of the flooding of the Skagit River, and then condense and present the material in an orderly manner. Hopefully this assemblage of information will assist the general public, elected officials, government staff, news media, and anyone who might have a vested interest in either interpreting the data or in trying to bring about responsible flood plain management or a responsible flood control project to the Skagit River Valley.

This book is intended to be a living document. As more information becomes available, new studies are conducted and as more floods happen (and happen they surely will), this book will be updated and republished. That is why I have included in the books title, Volume One, First Edition. If you would like to submit something for future publications of the book (ie photo's, comments, etc.) please feel free to forward the material to me at the address contained on the inside cover.

Feel free to copy this book as many times as you like. Give it to your friends, neighbors, developers, government and elected officials. It is this author's opinion that information is the cornerstone of education. The only stipulation that I impose on making copies is that no one be charged anything other then the cost of copying. It is this authors hope, that when enough people take the time to educate themselves about the Skagit River, then we will begin to learn how to cope with the awesome power of Mother Nature. Be fooled not by her beauty, for she carries with her the power of total destruction. Skagit Valley is indeed a disaster waiting to happen. **It is not a matter of if, but one of when.**

QUIPS AND QUOTES

SKAGIT RIVER FLOODING

"One cannot travel far within the boundaries of this county without coming in sight of the Skagit River. Usually, it is calm and placid, pleasing in its cold green movement from the mountains to the bay. But engineers and old-timers alike are unanimous in their pronouncement that sooner or later, the lazy Skagit will come boiling over its banks, engulfing dikes and soaking farmland, businesses and homes indiscriminately. ***Mary Pat Lorente, Argus staff writer, Skagit Valley Argus, 11/13/80***

"Anyone who has studied the Skagit River flood potential knows that we are sitting on a time bomb -- and sooner or later, we will have that 100-year flood that will make a shambles of our county unless we get this added protection." ***George M. Dynes, Skagit County Flood Control Coordinator, Skagit Valley Herald, 10/22/77.***

I can't even imagine what would happen at the shopping malls if water broke through or overtopped the dike ...

"So many things have happened in the county since the last major flood. The major food processing plants are in the flood plain, there is more residential development, bigger farming operations, more building. I can't even imagine what would happen at the shopping malls if water broke through or overtopped the dike above Mount Vernon." ***Frank Easter, Director Soil Conservation Service, Skagit Valley Herald, 12/6/78.***

"As long as I've lived in Skagit County, I've known we're living on borrowed time. I've realized for some time that the Skagit River system doesn't have the capacity to prevent large scale floods. That was brought home in 1975." ***Bob Hulbert, Soil Conservation District, Skagit Valley Herald, 4/25/79.***

As long as I've lived in Skagit County, I've known we're living on borrowed time.

"In this century alone, the Skagit River has flooded the Lower Valley 16 times. This is an average major flood about once every five and a half years. In the years of 1906, 1909, 1917 and 1921, all within the lifetime of many residents, the mighty Skagit has approached floods of 100-year frequency -- a term applied to about 200,000 cubic feet per second. Floods of this magnitude have catastrophic effect, wreaking tremendous damage on Skagit county and resulting in large scale loss of property and probably loss of life. Old timers said it was a miracle even in the comparatively mild flood of 1975 that some of the dikes didn't give way to the raging waters. . . .a 100-year

. . .a 100-year flood would rampage through the valley, destroy salt water dikes and roar through the town of LaConner.

flood would rampage through the valley, destroy salt water dikes and roar through the town of LaConner. Flood specialists have termed the Skagit River **"a disaster waiting to happen."** If. . .a major flood occurs, we will pay a cost almost beyond our present imagination. It will be a price we can ill afford." ***Editorial, Skagit Valley Herald, 10/31/79.***

"Many newcomers to the county don't realize the extent to which the Skagit River can flood. The only thing that will get support (for flood control) is if we have a major flood. Then people will become aware of the problem again." ***County Commissioner Howard Miller, Skagit Valley Herald, 11/21/79.***

Many newcomers to the county don't realize the extent to which the Skagit river can flood.

"A wall of water poured into the scenic town of Hamilton, submerging all but one of the homes there. Our near brush with disaster is a lesson in cooperation. It also is a lesson in humility for our safety, as we can so easily gauge from the rising water, hangs precariously on the whims of the river." ***Editorial, Skagit Valley Herald, 12/19/79.***

"Newcomers to this valley don't realize that the Skagit River likes to flood. The last really bad flood was in the 1950's--the floods of 1975 and 1979 were just spits in a bucket. But people around here tell me they doubt that the river will ever flood again. They are just ignorant. In 1909 there was a lot of snow in the mountains and a warm Chinook wind melted it and the valley was flooded all the way to Padilla Bay. And if it happened today, there would be a hell of a lot more wiped out than there was then. God help everybody if it happens again--a flood like that would be the ultimate disaster next to Mount Baker blowing up." ***Tim Helmer, Nookachamp-Clear Lake Resident, Skagit Valley Herald, 10/17/80***

"Someday there will be a 100-year flood out there and no one will be prepared. Oh, the County will be as prepared as it can be for that type of disaster, but the people out there, the ones who live in a flood plain, they just don't believe it could happen here and they won't be ready." ***Joe Cain, Director, Skagit County Emergency Services, Skagit Valley Herald, 10/17/80.***

Someday there will be a 100-year flood out there and no one will be prepared.

"There aren't many people around who remember how devastating that 1921 flood really was. People these days haven't experienced a major disaster, so they just don't understand what that kind of flood does to homes, property and lives. It's frightening and frustrating to me, and to other county officials, that people don't understand. It's a huge area to provide flood protection for, and the county would probably be powerless to prevent damage should a major flood occur." ***Don Nelson, Skagit County Engineer, Skagit Valley Herald, 10/17/80***

"The Skagit River is a time bomb. The floods of 1975 and 1979 were like small children causing a little water to overflow in a bathtub." ***Larry Kunzler, Nookachamp Farmer, Skagit Valley Herald, 4/1/80.***

The Skagit River is a timebomb.

"It's going to happen one day--nothing is going to stop it--and when it does, there won't be a dry acre in the whole flood plain." ***Tony Tronsdal, Commissioner, Dike District No. 3, Skagit Valley Argus, 11/13/80***

"The number one threat to our community is flooding from the Skagit River. It hangs over us like a brooding monster, poised and ready to sweep down from the mountains and wreak havoc within our valley. Because of the innumerable problems that high waters present, preventing a major flood is next to impossible. ***Editorial, Skagit Valley Herald, 8/19/81.***

"That city (Burlington) has a cocked gun at its head. You've got a hellacious problem there. Any fifth-grader could brand it as a flood area. How is flood water going to get over the highway (Interstate 5)? It's a terribly dangerous situation." **Chuck Steele, Chief of Natural and Technological Hazards Division, Federal Emergency Management Agency, Skagit Valley Herald, 2/4/84**

It's a terrible thing that river. I've seen it blow right down the main street of Burlington.

"It's a terrible thing, that river. I've seen it blow right down the main street of Burlington." ***Dean Benson, Longtime Burlington Resident, Skagit Valley Herald, 5/13/83***

FLOODING IN GENERAL

"There is no doubt that the foe is formidable. Flash floods -- those that come within a few hours of heavy rains **or perhaps levee failure** -- are the nations top weather disaster. In 1979 such floods killed 100 persons and caused an estimated $4 billion in property damage. During the 1970's according to the National Weather Service, an average of **200 people a year died** in flash floods, or triple the rate of the 1940's. **Decade by decade, the death and property toll is rising largely because more development is taking place on flood plains. "** ***AP Release, Skagit Valley Herald, 4/30/80***

"Flooding has been made much worse by years of inattention to floodway management, inability to curb development along the river valleys, and the accelerated logging of watersheds, according to more than a dozen experts interviewed by the Post-Intelligencer during the three weeks since the record floods hit. All parties who use the rivers are partly to blame for the chronic flood damage, experts said. And lessons from past floods went ignored. **Floods are, in fact, inevitable in this climate, advocates of tougher development controls say."** ***Angelo Bruscas, P-I Reporter, Seattle Post-Intelligencer, 12/27/90***

Decade by decade, the death and property toll is rising largely because more development is taking place on flood plains.

"The levee systems have given people a false sense of security. I look all over and see the levees are built right on top of the rivers. But you have to give the river room to move." ***Tom Bean, Senior Engineer, King County Surface Water Management Department, Seattle Post-Intelligencer, 12/27/90***

"I think the ultimate solution is you end up having to live with nature. There is a limited ability to impose structural solutions and quick fixes on a major natural phenomenon that may be beyond our ability to manage properly or even control. I think whatever we do we have to respect its ability to do what it will . . .That's the problem with structural solutions -- they can do a very good job of lulling you into a false sense of security." ***Bob Barnes, Senior Environmental Scientist, Puget Sound Power & Light Co., Skagit Valley Herald, 12/17/90***

The fundamental problem is our forefathers chose to live on a floodplain. That was a mistake.

"I'll be the first to admit there are probably an infinite number of solutions to this problem. But they don't solve the fundamental problem. The fundamental problem is our forefathers chose to live on a floodplain. That was a mistake." ***Robert Boudinot, former Burlington City Engineer, The Herald, 5/1/91***

SAUK RIVER DAM

"Until about a month ago, I thought we could get flood prevention, but our great senator has dropped the ball on the Sauk flood containment dam. Now we have no choice but to play catch-up. We can no longer fight for flood prevention. We must now settle for flood protection. We will take the water nature gives us but we won't take the water that other dikes would give us." ***Ken Johnson, Nookachamp's Farmer, Skagit Valley Herald, 12/19/78.***

"To hinge flood control on the Sauk flood containment dam is unrealistic. We have to decide on the trade-offs involved in other alternatives." ***Bob Hulbert, Soil Conservation District board member, Skagit Valley Herald, 1/3/79.***

"A dam on the Sauk would not be allowed because of the inclusion of the Skagit river and its tributaries in the federal Wild and Scenic Rivers system. ***Forest Brooks, Project Study Manager, U.S. Army Corps of Engineers, Skagit Valley Herald, 6/26/79.***

To hinge flood control on the Sauk flood containment dam is unrealistic.

"Numerous residents proposed a dam on the Sauk River because the river accounts for about 40 percent of the flood waters. But building a dam on the Sauk is illegal because the Sauk-Suiattle river system was designated a Wild and Scenic river two years ago. Dams are expensive, time-consuming to build and environmentally troublesome. It's 15 years before there are any benefits, and the environmental struggle to get one would be awesome." ***Don Nelson, Skagit County Flood Control Engineer, Bellingham Herald, 9/23/79.***

The cards remain heavily stacked against such a possibility. Such a project would require an amendment to the Wild and Scenic Rivers Act, federal legislation that currently prohibits dam construction on the Sauk River. In addition to that hurdle which would be virtually impossible to remove, remaining roadblocks include debate over potential disruption of fish runs and the proposals cost-benefit ratio. An educated guess on the cost of a Sauk River dam would be $400 million dollars. Local cost for a mixed use hydroelectric flood control dam could range from $20-60 million dollars. ***U.S. Representative Al Swift, Democrat, 2nd District, in interview with Steve Berentson, Staff Writer, Skagit Valley Herald, 8/14/81***

DREDGING

"Dredging the river would be a continuous process and would be entirely the county's cost after the first year. The Corps also cannot undertake a project which provides anything less than 100-year protection to cities and which does not return at least a one-to-one cost-benefit ratio." ***Gene Sampley, Skagit County Public Works Director, Skagit Valley Herald, 1/3/79.***

Dredging the river would be a continuous process and would be entirely the county's cost after the first year.

Dredging also is not feasible because of the high cost of maintenance. The channel would have to be dredged every year or two, and could have detrimental effects on the environment. ***Forest Brooks, Project Study Manager, U.S. Army Corps of Engineers, Skagit Valley Herald, 6/26/79.***

LEVEES

"The local community has done its work and stands ready to meet its future obligations regarding this project (1979 Levee Improvement). Now, we should act to help them provide Skagit Valley citizens with reliable protection from the ravages of floods." ***U. S. Representative Al Swift, Skagit Valley Herald, 3/13/79.***

"To the Nookachamps-Clear Lake area, this (raising the levees) can only do one thing, when you try to force the same amount of water through a smaller opening, it goes up. Somebody has got to pay for the right to flood the land. We can with some degree of certainty predict what will happen if the project is built. The local sponsor must acquire the right to do that." ***Vern Cook, Project Manager, Corps of Engineers, Skagit Valley Herald, 4/18/79.***

Somebody has got to pay for the right to flood the land.

We will take the water nature gives us but we won't take the water that other dikes would give us." ***Ken Johnson, Nookachamp's Farmer, Skagit Valley Herald, 12/19/78.***

"Flood protection in Skagit County is long overdue. We'd be the last to say the proposed project is a perfect solution to the problem. We realize there is no perfect solution. The opinion of the board is that the project as proposed is the best protection available at this point. ***Bud Norris, Chairman, Skagit County Commissioners, Skagit Valley Herald, 6/20/79.***

"If this is not the perfect plan, lets find the perfect plan. When everyone in Skagit County has to pay, then everyone should have benefits." ***Charlie Boon, Nookachamps Farmer, Skagit Valley Herald, 6/20/79.***

The Nookachamps area will act as a natural drainage basin.

"They complained (Nookachamp residents) because a levee on the north side of the river would increase flooding on the south side, endangering homes and dairy cattle. The Nookachamps area will act as a natural drainage basin." ***Don Nelson, Skagit County Flood Control Engineer, Bellingham Herald, 9/23/79.***

"In the early 1930's Diking District 12 with assistance from the county engineering department moved the dikes closer to the river thus forcing the water into the Nookachamp-Clear Lake area. By so doing they condemned the entire Nookachamp Valley floor to receive floodwaters that they otherwise would not have "naturally" experienced. None of what I've just stated is conjecture on my part. For at a meeting with the U.S. Army Corps of Engineers in Seattle on July 18, 1979 with Nookachamp-Samish farmers the Corps stated flatly that the severity of the flooding in the Nookachamp-Clear Lake area is "Directly attributable to the actions of Diking District 12. For the natural drainage for the Nookachamp area is in fact, the City of Burlington." For Mother Nature has never attempted to drain water uphill." ***Larry J. Kunzler, Nookachamp Farmer, Letter to the Editor, Skagit Valley Herald, 10/29/79.***

"We simply do not have the capacity in our diking system to take care of any more flood waters than we had in the recent December of 1975 flood, and we know from past floods that we must prepare for water in many places at least three feet higher on our dikes. Federal and state authorities recognize the seriousness of the threat. In the words of one agency, **"Skagit County is a disaster waiting to happen!"** ***Pete Walker, Chairman, Skagit Flood Control Council, Letter to the Editor, Skagit Valley Herald, 10/31/79.***

SKAGIT COUNTY IS A DISASTER WAITING TO HAPPEN.

"Local funding for a long-sought Skagit River flood control measure was washed away in no uncertain terms Tuesday by voters, who rejected the bond measure by a whopping 71.4 percent negative vote. The entire project must now go back to the drawing board in an attempt to find the next step forward. For we greatly doubt that Skagit county residents are willing to sit by and allow much of the valley to be hit by a raging flood. And believe it or not, the Skagit River, as we said earlier, is **"a disaster waiting to happen."** ***Editorial, Skagit Valley Herald, 11/8/79***

"A flood damage reduction plan might be the best approach now. This could include prohibiting construction in the flood plain, requiring flood plain insurance, removing some levees, and purchasing property in flood areas for conversion to recreational use. ***Vern Cook, Project Manager, U.S. Corps of Engineers, Skagit Valley Herald, 11/21/79.***

"The town of Hamilton cannot put up a dike because of the impact it would have on surrounding areas. Preliminary hydrology studies performed by the U.S. Army Corps of Engineers determined that construction of a levee around the town would simply not be feasible. Its construction would constrict the flow of water, raising the water level by more than 10 feet in surrounding areas." ***Rich Worthington, U.S. Army Corps of Engineers, Skagit Valley Herald, 4/9/80***

"The dikes aren't going to hold a 100-year flood. You might as well not have dikes in a 100 year flood, and in fact, you'd be better off without them. The dikes will only make things worse. The nearest Skagit County has ever come to a 100-year flood in recent history was in 1909. Flooding during the past four or five years has been at the 10 or 12 year level." ***Jerry Gardner, U.S. Army Corps of Engineers, Skagit Valley Herald, 3/25/81.***

You might as well not have dikes in a 100 year flood, and in fact, you'd be better off without them.

"Its unbelievable how fast a dike can unravel. 500 feet of dike could come down in a matter of minutes. If you're in front of one of those levees when it goes, you've had it. Burlington, with all its commercial development, is the danger zone in Skagit County." ***Don Nelson, County Flood Engineer, Skagit Argus, 3/16/82***

". . .work on 30 miles of dikes and levees continues -- little by little. Skagit County Flood Control Engineer Don Nelson has set a standard for dike repair to try to keep river dike districts equitable. "It's called the 50-year water profile which means every time we rebuild or repair, we do it to that level", he said recently. "That way everyone gets equal treatment." Nelson started the standard after flooding in 1975. "The profile doesn't give 50-year protection," he said. "The specifications allow two feet of freeboard. I estimate that gives dikes 25-year protection. Looking at what we had in November, I'd say we had a 25-year flood. Not a 100 or 50-year flood. The (1979) levee project would have done it all in one sweep and it failed, **so we are doing it this way**. We're getting it accomplished. We're miles ahead of where we would have been if we didn't do anything", he said. He estimates it will take five to 10 years for the whole dike system to get up to the 50-year water profile level. Those improvements not only make the dikes higher, but also stronger, in order to minimize seepage and blowouts. . . . Money also is available from the state Flood Control Assistance Account Program. That helps any agency with flood control. The grants encourage flood control work", he said. ***M. Sharon Baker, Staff Writer, Skagit Valley Herald, 12/20/90***

AVON BYPASS

The by-pass plan, formerly called the Avon Bypass proposal might not be the only way to prepare for a major flood, but it is among the more reasonable approaches. Serious talk of a bypass died 20 years ago because of difficulties in getting rights of way and easements from local property owners. ***Bill Spurlock, Chief of Flood Plain Management Services, U.S. Army Corps of Engineers, Skagit Valley Herald, 3/15/84***

...it is among the more reasonable approaches.

The river should have a space to go. And we should keep the cities out of the flood plain. ***Josef A. Kunzler, Age 8, 12/19/90***

FLOODWAYS

"The County, through court action, has had to become more restrictive in enforcing floodway regulation since January of 1976. If anything we're not being as restrictive as we should be." ***Paul Shelver, Skagit County Zoning Administrator, Skagit Valley Herald, 7/20/79.***

If anything we're not being as restrictive as we should be.

"Gages Slough, the meandering body of water which wanders through the Burlington area, also has historically acted as a floodway during high Skagit River flows." ***Jerry Smith, Washington State Department of Game, Skagit Valley Herald, 4/22/83***

"Another key effective flow area is the Gages Slough which is a floodwater conveyance system consisting of lower ground throughout the city and into the county." ***Charles L. Steele, Chief, Natural and Technical Hazards Division, Federal Emergency Management Agency, Letter dated 6/10/83***

"Gages Slough obviously carried the flood flow before and it would again. Local citizens have a false sense of security because local officials are denying there's any hazard associated with development around Gages Slough." ***Bill Spurlock, Chief of Flood Plain Management Services, U.S. Army Corps of Engineers, Skagit Valley Herald, 3/15/84***

SKAGIT COUNTY -- COMMUNITY DESCRIPTION

Skagit County, in northwestern Washington State, is bordered by Puget Sound on the west and the rugged Cascade Range, rising to 8,000 feet, on the east. It is surrounded by Whatcom County to the north, Okanogan and Chelan Counties to the east, Snohomish and Island Counties to the south, and San Juan County to the west. The County encompasses 1,735 square miles. The first permanent white settlers were established on Fidalgo Island in the late 1850's. Settlement of the tide flats on the mainland soon followed. Clearing and diking of the tide flats created rich farmlands which yielded fine crops of grains and vegetables. In the 1870's, there was a rapid influx of families to the region; schools, churches, farming, logging, and commercial fishing activities were well established. Skagit County was established in 1884 and named after the river and the Skagit Indian Tribe which lived along the riverbanks.[1]

The County encompasses 1,735 square miles.

THE SKAGIT RIVER 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 . . . Flood problems of the two streams are, therefore, closely related and both basins are treated as one large basin . . . [2]

The river drains an area of about 3,100 square miles.

[1] Flood Insurance Study, Federal Emergency Management Agency, October 17, 1984.

[2] Flood Plain Information Study, Skagit River Basin, Washington, Summary Report, U.S. Army Engineer District, Seattle, Washington, July 1966.

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.[3]

Potential flood damage in the Skagit River Basin is greatest in the flood plain.

Potential flood damage in the Skagit River Basin is greatest in the flood plain. The flood plain is primarily agricultural, but includes a large proportion of the county's urban and rural population, many manufacturing plants, and major transportation routes.[4]

THE SAMISH RIVER

The Samish River drains about 139 square miles between the Skagit River Basin on the south and the Nooksack on the north. The Samish River originates on a low divide south of Acme in Whatcom County, and its tributary, Friday Creek, originates in the hills south of Bellingham. The river has a very narrow flood plain and flows much of its 20-mile length in a southwesterly direction between steep and rugged mountains. It outlets into Samish Bay, near Edison.[5]

CLIMATOLOGY

The influence of the maritime air masses is pronounced in both the precipitation and temperature regimes, producing a mild but wet climate. During the winter the Skagit Basin, lying directly in the storm path of cyclonic disturbances from the Pacific, is subject to convective showers which are frequently rather heavy and may follow in quick succession. On the mountain slopes, storm precipitation is heavy and almost continuous as a result of the combination of frontal and oceanographic effects.[6]

Floods are, in fact, inevitable in this climate. . .

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[3] Ibid.

[4] Skagit County Comprehensive Flood Control Management Plan, Brown and Caldwell, April 1989.

[5] Ibid.

[6] Appendix to Report on Survey for Flood Control of Skagit River and Tributaries, Washington, Corps of Engineers, U.S. Army, February 21, 1952.

FLOOD CHARACTERISTICS

During the months of November through March when temperatures, particularly at higher elevations, are at or near the freezing point and much of the precipitation occurs as snow, a low base flow is maintained. However, frequent sharp rises resulting from concentrated 2 to 5 day storms or series of storms are experienced in this period. The intense storms when accompanied by warm winds and resultant snowmelt produce a rapid run-off. During and following these severe storms river discharges may increase from a relatively low base flow to a discharge of damaging magnitude within 24 to 30 hours. Near crest discharges may be maintained for a few hours, followed by a recession almost as rapid as the rise. Two or three such rises may be experienced within a period of 2 weeks. Not all rises reach flood stages, however, and these usually are more frequent and reach higher stages in late October, November, and December.[7]

Two or three such rises may be experienced within a period of 2 weeks.

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.[8]

Swollen creeks and streams quickly fill the main river channel to capacity.

[7] Appendix to Report on Survey for Flood Control of Skagit River and Tributaries, Washington, Corps of Engineers, U.S. Army, February 21, 1952.

[8] Flood Plain Information Study, Skagit River Basin, Washington, Summary Report, U.S. Army Engineer District, Seattle, Washington, July 1966.

The magnitude and intensity of a storm cannot always be used as an indexes of the resultant river discharge. Other factors, such as temperature sequence, degree of soil saturation, and moisture runoff produced by a particular storm. Conditions preceding a storm may be such that even a moderate storm could set in motion the related factors that, collectively, result in a flood. Conversely, conditions in the drainage basin may be such that a severe storm results in only minor high water.[9]

. . .the water rises until it spills over the roadway, creating a falls on the downstream side which may completely washout the road.

As the water moves toward Skagit, Padilla and Samish Bays, it may be blocked by a road fill with inadequate culvert openings.[10] When this happens, the water rises until it spills over the roadway, creating a falls on the downstream side which may completely wash out 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.[11]

HISTORICAL FLOODS

The first white people settled in the valley about 1869. High-water marks since then have been recorded from time to time, with increasing accuracy. Prior to that time the record of floods depends upon testimony and tradition of the Indians, upon certain direct and indirect evidence of high-water marks, and upon flood records elsewhere. Gaging stations have been established only since 1908, and the records therefrom are not, in general, continuous for any particular station.[12]

The Skagit River Valley has a long history of flooding.

The Skagit River Valley has a long history of flooding. Floodflows have been recorded intermittently since 1908. Flood damage begins when the flow measured at the Concrete gage exceeds 60,000 cubic feet per second (c.f.s.). In the leveed areas below Sedro Woolley, the maximum safe channel capacity (with 2 feet of freeboard) is 84,000 c.f.s.

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[9] Skagit County Comprehensive Flood Control Management Plan, Brown & Caldwell, April 1989.

[10] Authors Note: Interstate 5 actually serves as a weir. The only two places for the flood waters to cross is in the Gages Slough area and north of Burlington Edison High School to Cook Road (an estimated distance of 2 miles).

[11] Flood Plain Information Study, Skagit River Basin, Washington, Summary Report, U.S. Army Engineer District, Seattle, Washington, July 1966.

[12] Appendix to Report on Survey for Flood Control of Skagit River and Tributaries, Washington, Corps of Engineers, U.S. Army, February 21, 1952.

. . .if the peak flow continues for an extended time the discharge downstream can be greater due to downstream inflows and the reduced effectiveness of valley storage.

Freeboard is a factor of safety in the design of a levee. It is the height of the top of the levee above the water surface of the design river flow. Since 1908, during the winter flood season (October-March), 84,000 c.f.s. has been exceeded 19 times. . . .(I)n February 1951 (the river had) a peak discharge of 139,000 c.f.s. at Concrete; 150,000 c.f.s. at Sedro Woolley; and 144,000 c.f.s. at Mount Vernon. The flood remained near its peak for 6 hours at Mount Vernon, a fact which contributed significantly to the severity of the flood damages. During this flood, many dikes failed because they lacked sufficient height and width to withstand saturation. The December 1975 flood had a peak discharge of 122,000 c.f.s. at Concrete and 130,000 c.f.s. at Mount Vernon. The flood discharge was above 120,000 c.f.s. at Mount Vernon for about a day. During floods, the Nookachamps Creek area on the left bank between Mount Vernon and Sedro Woolley is a major source of valley storage and can reduce major floods peaks downstream from Sedro Woolley.[13] However, if the peak flow continues for an extended time the discharge downstream can be greater due to downstream inflows and the reduced effectiveness of valley storage.[14]

[15]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:

. . .at Sedro Woolley. . .about 10 feet of water in present business district. . .

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.

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[13]Authors Note: The storage in the Nookachamp Creek area is artificially created by the Burlington Diking District No. 12 and the constriction of the river created by the Burlington Northern bridge.

[14]Skagit River, Levee & Channel Improvements, Public Brochure, March 1978, Seattle District, Corps of Engineers

[15]Skagit River Flooding: An Overview, Skagit County Rural Development Committee, March 1976

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 25th 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.

. . .was the largest flood since the initiation of flood records.

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 hour 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.

. . .the second largest flood on record and caused a dike break. . .dumping 60,000 cubic feet per second (cfs) of water into the Samish River Delta area.

FEBRUARY 27, 1932: The mighty Skagit River, one of the largest in the west, went on a rampage over the weekend, crashed through the dikes in at least three places ..... A bad break in the dike south of Burlington sent a torrent of water westward down VARNEY

Water three and four feet deep covered the Pacific Highway (BURLINGTON BOULEVARD) in at least two places between the Riverside bridge and the Hanson Greenhouse.

SLOUGH[16], which overflowed, flooding some land. Water three and four feet deep covered the Pacific Highway (BURLINGTON BOULEVARD) in at least two places between the Riverside bridge and the Hanson Greenhouse. Traffic was cut off. The breaking of the dike caused a washout of the Great Northern railway tracks. The water from this break extended to north Avon and went as far as Whitney..... The river overflowed east of Burlington flooding scores of acres of land, but was prevented from entering Burlington by a high dike. VARNEY SLOUGH prevented water from entering Burlington on the south ..... Scores of men worked all night to save the dike which is southeast of the VARNEY SLOUGH (GAGES SLOUGH) bridge, but it was a losing battle. At about noon yesterday, the river tore a gap 200 feet long in the dike and within a few minutes the water was running westward in a raging torrent. It was not long until the Great Northern railway tracks were washed out for a short distance as the waters swept onward towards the Pacific Highway (BURLINGTON BOULEVARD) . As the water spread toward Burlington, it finally reached VARNEY SLOUGH (GAGES SLOUGH) and was diverted westward.[17]

. . .Burlington residents prepared to "move out". . .Hundreds gathered at VARNEY SLOUGH. . .to watch the water as it roared down the passage. . .

JANUARY 25, 1935: Excitement during the high water reached its peak, at about 3:30 Saturday afternoon when Burlington residents prepared to "move out" when it was learned that the dike had collapsed near the Cleveland ranch, northeast of Burlington. Hundreds gathered at VARNEY SLOUGH (GAGES SLOUGH), a short distance east of Burlington hospital, to watch the water as it roared down the passage..... The water reached within a few hundred feet of the hospital, but most of it raced down the SLOUGH, flooding a small section in the southern part of the town. It continued down VARNEY SLOUGH (GAGES SLOUGH) finally reaching the lowlands at North Avon.[18]

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

[16]Authors Note: Varney Slough is now called Gages Slough.

[17]Mount Vernon Daily Herald, 2/29/32

[18]Mount Vernon Daily Herald, 1/28/35

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.

. . .an example of a long duration flood.

The worst Skagit river flood since 1921 inundated thousands of acres of rich Skagit Valley farmlands over the weekend and left two county towns, Stanwood and Hamilton, standing in water ranging up to six feet deep. A break in the dike below Conway sent a raging river of muddy water through that town and spreading north over the flats on both sides of the Great Northern railroad tracks and Highway 99 to a point about a mile and a half south of the Mount Vernon city limits. Water from the Conway break spread over an estimated 4,480 acres, to a depth ranging from a few inches to several feet. Although the Fir Island dike did not break, water seeped through and spilled over to flood the western half of the island. . . The delta area west of Brown's Slough was flooded today by a smaller break or leak in the dike, with some 700 acres of farm land affected. The river broke through the railroad embankment east of Burlington, which acts as a dike, and tore through the Dollar road cutting the PUD 14-inch main serving Burlington. One of the most serious threats to the dike was in the river bend area west of the Riverside bridge, where leaks and boils in the road which parallels the dike caused concern throughout Saturday night and Sunday. Across the river, from the bridge to the Avon vicinity, the dike held but showed the same tendency toward seepage with water bubbling up in the road and adjoining fields until stopped by the sandbag treatment.[19]

The worst Skagit river flood since 1921. . .Stanwood and Hamilton, standing in water ranging up to six feet deep. . .The river broke through the railroad embankment east of Burlington. . .

[19] Mount Vernon Daily Herald, 2/12/51

NOVEMBER 30, 1975: 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 rise. Melting snow and rain water began 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 crested at 35.6 feet at the Riverside Bridge in Mount Vernon. Twenty-six feet[20] of water in the river at this point is considered flood stage by the Skagit County Engineers. Clear weather and cooler temperatures beginning Thursday affected immediate receding along the river as soon as the crest past. By Friday, December 5th, the water level was dropping and water receded at a remarkably rapid rate. The river lacked only 2,000[21] cubic feet per second of becoming a flood of the same magnitude as the 1951 flood which caused a major levee break near Conway.

Melting snow and rain water began swelling ditches, streams and the Skagit River. . .

DECEMBER 19, 1979: The river crested at 34 feet on the Riverside gauge, and, at 10 a.m. today, had receded to 33 feet. Parts of Skagit County, including Hamilton, Fir Island and areas of rural Sedro-Woolley and Conway, will remain underwater today according to county officials. Especially hard hit by the rising river was Hamilton, where almost every residence was flooded. A 30-foot break in the dike at Carpenter Creek near Conway occurred about 9 a.m. today. A log jam on the railroad bridge over the Skagit River between Mount Vernon and Burlington caused some concern Tuesday. County engineers feared that the huge pileup of logs and debris would eventually wipe out the Burlington-Northern bridge.[22] December served as a month of constant rain and rising water. Finally, the Skagit River crested seven feet over flood stage. The waters brought destruction to homes and property in the upriver town of Hamilton and panic to the communities in the lower valley.[23]

Especially hard hit by the rising river was Hamilton, where almost every residence was flooded.

[20] Authors note: This river level is now stated to be 28 feet.

[21] Authors Note: This figure should read 20,000 cfs. See chart on historical flood flows.

[22] Skagit Valley Herald, 12/19/79

[23] Skagit Valley Herald, 12/31/79.

DECEMBER 27, 1980: The Skagit River began rising in the early morning hours of December 26th, and before it crested at 41.1 feet in Concrete and at 34.2 feet in Mount Vernon Saturday, residents of Cape Horn, Hamilton, and West Mount Vernon had been forced to flee the rising waters.[24] Skagit County's belated Christmas present this year was a massive flood that did an estimated $4.5 million damage to homes, property, roads and dikes. Possibly the worst dike damage occurred at Cockerham Island between Lyman and Hamilton. The Corps following the 1979 flood, rebuilt a 300 foot section of the same dike and that rebuilt dike held during the flood. However, an older section of the same dike was washed out.[25]

Skagit County's belated Christmas present this year was a massive flood that did an estimated $4.5 million damage to homes, property, roads and dikes.

NOVEMBER 9-11, 1989: Most of the flooding was caused by swollen streams and creeks, rather than the Skagit River. The heaviest flooding appeared to be on Baker Lake Road, northwest of Concrete, and in the Samish River basin. Chuckanut Drive was blocked by a wall of mud, and a railroad bridge over Grandy Creek had to be partially dismantled after logs and debris created a dam behind it.[26]

DECEMBER 3-5, 1989: Warm winds and rain turned the Skagit River into a swollen, raging tributary on Dec. 3-5. The December flood caused less damage than the earlier flood, but it did force more than 500 people, including all the residents of Hamilton, to evacuate. A slide again closed Chuckanut Drive, and the revetment in downtown Mount Vernon was lined with sandbags in anticipation of a high flood level.[27]

NOVEMBER 11, 1990: (H)eavy rains and a high tide helped raise the river to 7 feet over flood stage, ripping a 250-foot hole in a dike on Fir Island, and forcing the evacuation of an estimated 500 people. Most of Fir Island, an 8,000-acre agricultural delta, was covered with up to 8 feet of water in the worst flooding to hit Skagit County in 40 years. Flooding over the Veterans Day weekend caused more than $40 million in damage in Skagit, Whatcom and Snohomish counties, including $24.5 million in Skagit County alone.[28]

. . .7 feet over flood stage, ripping a 250-foot hole in a dike on Fir Island. . .was covered with up to 8 feet of water

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[24] Mary Pat Lorente, Argus staff writer, Skagit Valley Argus, 1/1/81.

[25] Anne Gaynor, Staff Writer, Skagit Valley Herald, 12/30/80

[26] Skagit Valley Herald, 1/1/90

[27] Ibid.

[28] Tim Christie, Staff Writer, Skagit Valley Herald, 11/23/90

NOVEMBER 24, 1990: Hundreds of Skagit County residents remained homeless and damage cost continued to climb in the aftermath of the worst local flooding in at least 40 years. The Skagit River, swollen by torrential rains and a heavy snow melt, crested in Mount Vernon at 37.3 feet between 2 p.m. and 3 p.m. Sunday, 9.3 feet over flood stage and 2 feet higher than it was two weeks ago, according to the National Weather Service.

About 1,600 people were evacuated countywide, including 300 people living between Sedro-Woolley and Burlington, 300 who lived near Gages Slough and about 1,000 who lived within 100 to 200 feet of any Skagit River levee from Sedro-Woolley downstream. An unspecified number of people also were evacuated from the Riverbend Road area, northwest of downtown Mount Vernon. The town of Hamilton also was evacuated for a second time. The North Fork of the Skagit River smashed a temporary levee that was built to stop the flow of water onto Fir Island, wiping out $400,000 worth of work and inundating the agricultural delta that was just starting to recover from the previous flood. Other levees along either side of the Skagit River farther upstream were saturated to nearly the breaking point.[29]

About 1,600 people were evacuated countywide, including. . .300 who lived near Gages Slough and about 1,000 who lived within 100 to 200 feet of any Skagit River levee. . .

Flood Control regulation of the Skagit River is by Ross Dam and Upper Baker Dam. The storage projects helped control high runoff in the lower Skagit river valley and Mt. Vernon areas. Ross Dam filled to elevation 1600.4 feet, which is within 2.1 feet of normal full pool and 80% of allotted storage. Upper Baker Dam filled to elevation 720.7 feet which is within 3.3 feet of normal full pool and 79% of allotted storage. Peak inflow to Ross approached 36,000 cfs and at Upper Baker the peak inflow approached 28,000 cfs. Releases from both projects were limited to 5,000 cfs (minimum release required when Concrete gage is forecast to exceed 90,000 cfs). The maximum discharge was observed at Concrete at 146,000 cfs (39.89 ft) and observed at Mt. Vernon at 155,000 cfs (37.4 ft). Runoff stored at the two projects theoretically reduced flood levels by about 4½ feet at Concrete and 3½ feet at Mt. Vernon (assumes no levee failure or overtopping). Evacuation of floodwaters at both projects proceeds as rapidly as possible (as rapidly as downstream recession permits) to reestablish storage capacity in case of another flood event.[30]

AUTHORS NOTE: If the above interpretation of the amount of storage provided in the Thanksgiving Day flood is correct, then that flood was approximately the same as the 1921 flood (ie. 155,000 cfs + 54,000 cfs ((36,000 cfs - 5,000 cfs + 28,000 cfs - 5,000 cfs)) = 209,000 cfs) or an 80 to 90 year event if the dams were not in place.

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[29] Charles Siderius, Mick Boroughs, M. Sharon Baker and Tim Christie, Staff Writers, Skagit Valley Herald, 11/26/90

[30] Flooding in Western Washington from 21 to 26 November 1990, Memorandum for Record, U.S. Army Corps of Engineers, Seattle District, November 29, 1990.

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.

31

[31] Flood Plain Information Study, Skagit River Basin, Washington, Summary Report, U.S. Army Engineer District, Seattle, Washington, July 1966.

HISTORICAL FLOOD FLOWS OF THE SKAGIT RIVER[32]

DATE	C.F.S DISCHARGE SW	C.F.S. DISCHARGE MV	RIVER LEVEL MV[33]
1815	400,000		
1856	300,000		
11/16/1896	185,000		
11/18/1897	190,000		
11/16/06	180,000	180,000	37.0
11/30/09	220,000	N/A[34]	N/A
12/30/17	195,000	N/A	N/A
12/12/21	210,000	N/A	N/A
02/27/32	157,000	N/A	N/A
11/13/32	125,000	N/A	N/A
12/22/33	110,000	N/A	N/A
01/25/35	131,000 (at Concrete)	N/A	N/A
10/26/45	N/A	94,300	30.25
10/19/47	N/A	69,400	28.68
11/28/49	140,000	114,000	34.21
11/26/50	N/A	68,400	28.19
12/25/50	N/A	74,000	29.08
02/11/51	150,000	144,000	36.85
10/26/55	N/A	84,900	30.69
11/04/55	113,000	107,000	33.52
04/30/59	92,000	92,300	31.68
11/24/59	91,000	91,600	31.58
11/21/60	N/A	70,200	28.51
12/16/60	N/A	70,200	28.51
01/16/61	N/A	76,000	29.40
11/20/62	N/A	83,200	30.44
11/27/63	N/A	72,100	28.80
06/27/67	N/A	72,000	28.78
10/28/67	N/A	72,700	28.89
01/21/68	N/A	70,900	28.43

[32] Information obtained from Skagit River, Levee & Channel Improvements, Public Brochure, Seattle District, Corps of Engineers, December 20, 1978; Flood Plain Information Study, Skagit River Basin, Washington, Summary Report, U.S. Army Engineer District, Seattle, Washington, July 1966; Corps of Engineers, Seattle District and U.S. Geological Survey.

[33] Authors Note: Flood stage is at 28.0 feet.

[34] N/A = Not Available

DATE	C.F.S DISCHARGE SW	C.F.S. DISCHARGE MV	RIVER LEVEL MV[35]
06/03/68	N/A	68,800	28.09
01/31/71	N/A	70,300	28.52
07/13/72	N/A	80,600	30.07
01/16/74	N/A	77,600	29.64
12/04/75	121,000	130,000	35.66
12/19/79	N/A	112,000	33.99
12/27/80	N/A	114,000	34.16
12/04/82	N/A	71,600	28.65
01/05/84	N/A	88,200	31.14
01/19/86	N/A	72,800	28.84
11/24/86	N/A	70,700	28.49
11/11/89	N/A	88,220	31.14
12/05/89	N/A	95,480	32.10
11/11/90	N/A	124,300	35.20[36]
		142,000	36.60
11/24/90	N/A		37.30
		152,000	37.37

As of January 1, 1991, the Skagit River has reached flood stage 41 times since 1900 for an average of once every 2.2 years.

A 10 year flood will carry 132,000 c.f.s. 1909 - a 90 to 100 year flood; 1951 - a 20 year flood;
A 50 year flood will carry 200,000 c.f.s. 1917 - a 75 to 80 year flood; 1975 - a 12 year flood.[37]
A 100 year flood will carry 240,000 c.f.s. 1921 - a 80 to 90 year flood; 1990 - a 25 year flood.[38]
A 500 year flood will carry 321,000 c.f.s.[39]

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[35] Authors Note: Flood stage is at 28.0 feet.

[36] Authors Note: For the November 11th flood the figure of 35.2 feet is advanced by the National Weather Service and the figure of 36.6 is advanced by the U.S. Geological Survey (USGS). For the Thanksgiving day flood, the figure of 37.3 is advanced by the U.S. Weather Bureau, and the figure of 37.37 is advanced by the USGS. Based on independent investigation by this author, including interviewing flood plain residents and comparing historical data, it would appear that there is justification for the higher elevations. The higher elevations were justified by the USGS by on site survey levels taken of high water marks just two hours after the river crested on November 24th.

[37] Bellingham Herald, by Linda Hosek, 9/23/79

[38] Flooding in Western Washington from 21 to 26 November 1990, Memorandum for Record, U.S. Army Corps of Engineers, Seattle District, November 29, 1990

[39] Skagit County Flood Insurance Study, Final Coordination Meeting, June 14, 1984.

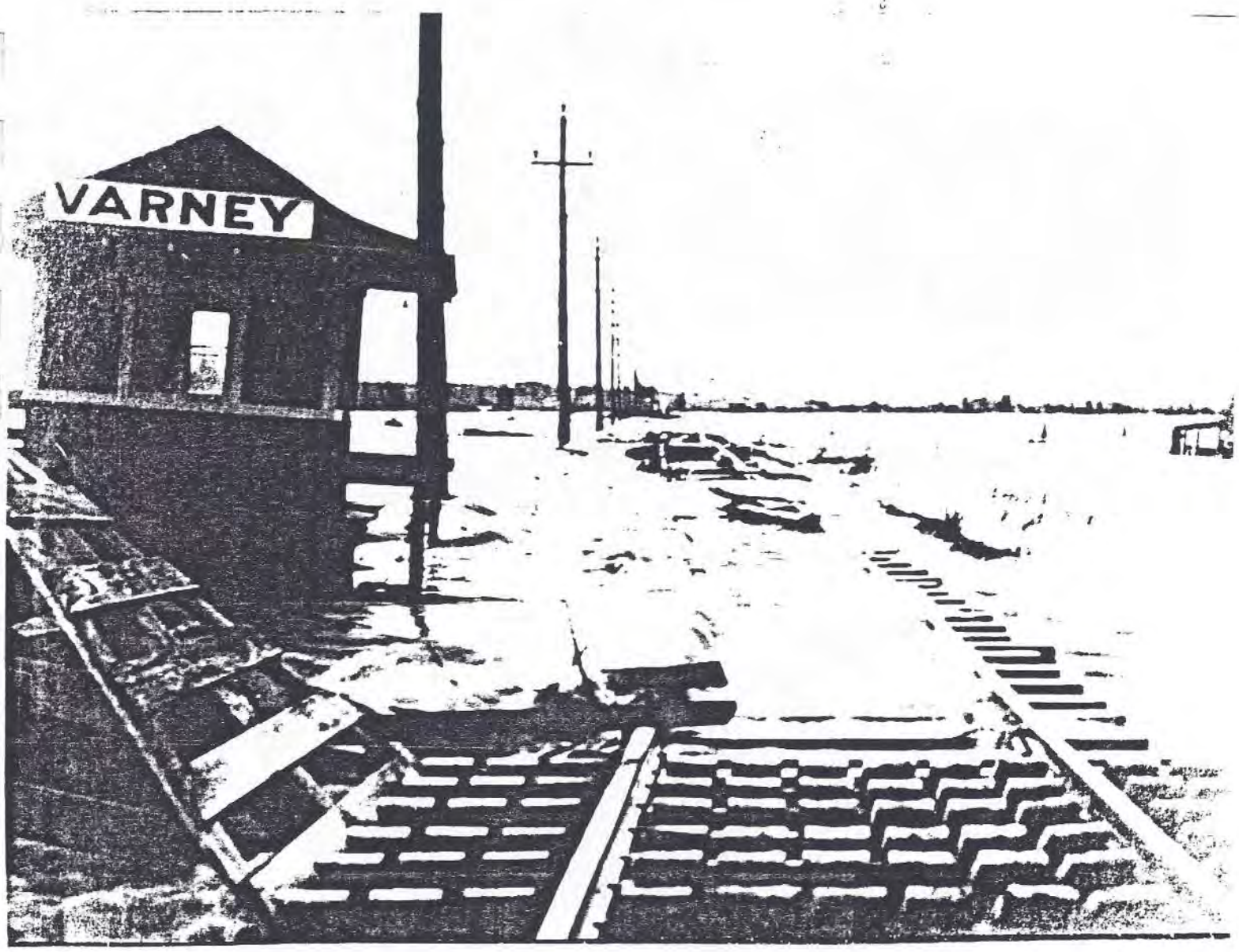
HISTORICAL FLOOD PHOTO'S

All photographs contained in this section were donated by the Skagit County Historical Museum.

AVON

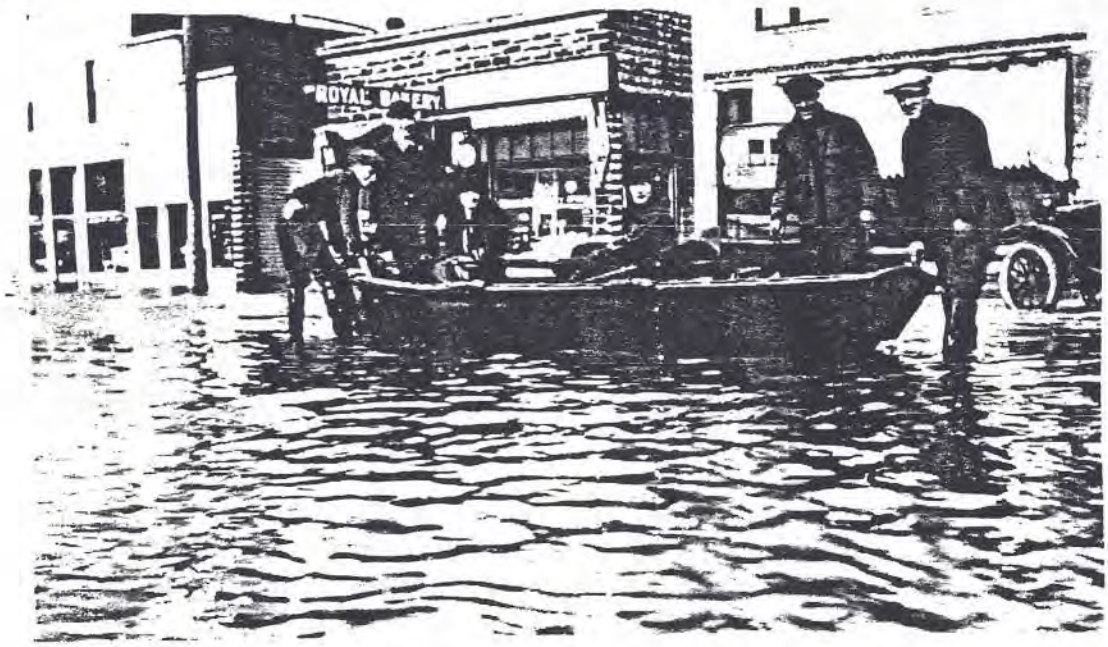
Nat Moore's house after the flood of 1909 which broke the dike between Mount Vernon and Avon. The house was located near the town of Avon.

BURLINGTON



Varney was a station on the interurban railroad between the Skagit River bridge and Burlington on Old Highway 99 (now called Burlington Boulevard in the general location of the Cascade shopping mall and the K-Mart mall). The floods in 1917 and 1921 broke the dikes below Sedro Woolley and washed out a large section of the track as it dug out Varney Slough (now called Gages Slough). This view is looking south towards Mount Vernon.

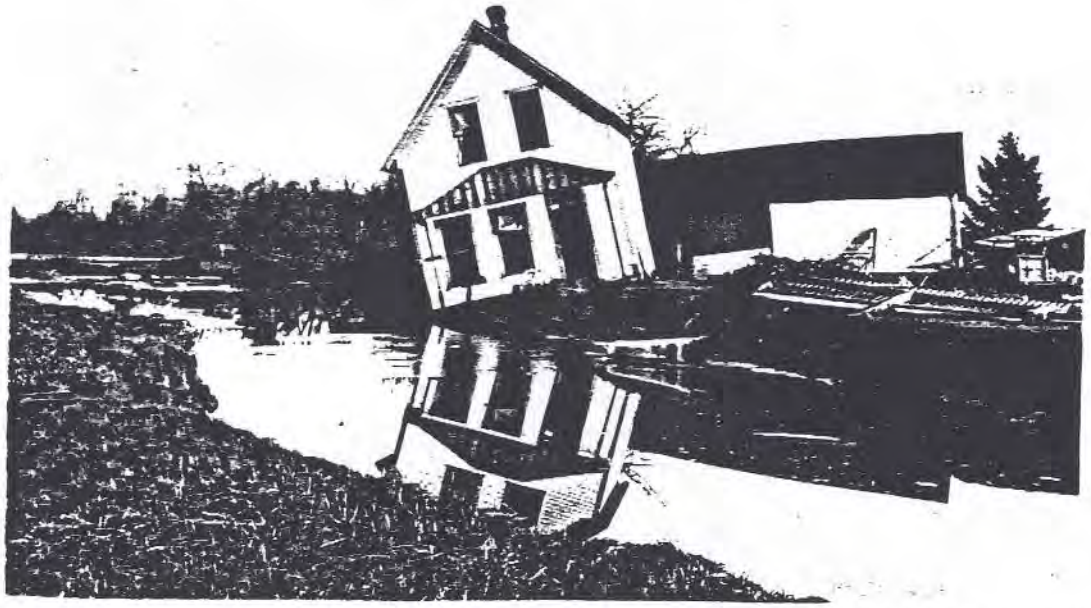
Downtown Burlington during 1917 flood. View is of Fairhaven Avenue looking East.



1917 flooding of downtown Burlington. This flood is an example of what happens during a long duration of the river remaining high. It was ranked as a 75 to 80 year event.

MORE 1917 PICTURES OF DOWNTOWN BURLINGTON

MORE 1917 BURLINGTON AREA FLOOD PICTURES



A classic example of what happens when you build structures next to conveyance areas. This house was located near what is now called Gages Slough.

Much of this once open field is now developed with commercial and residential structures.

CONWAY

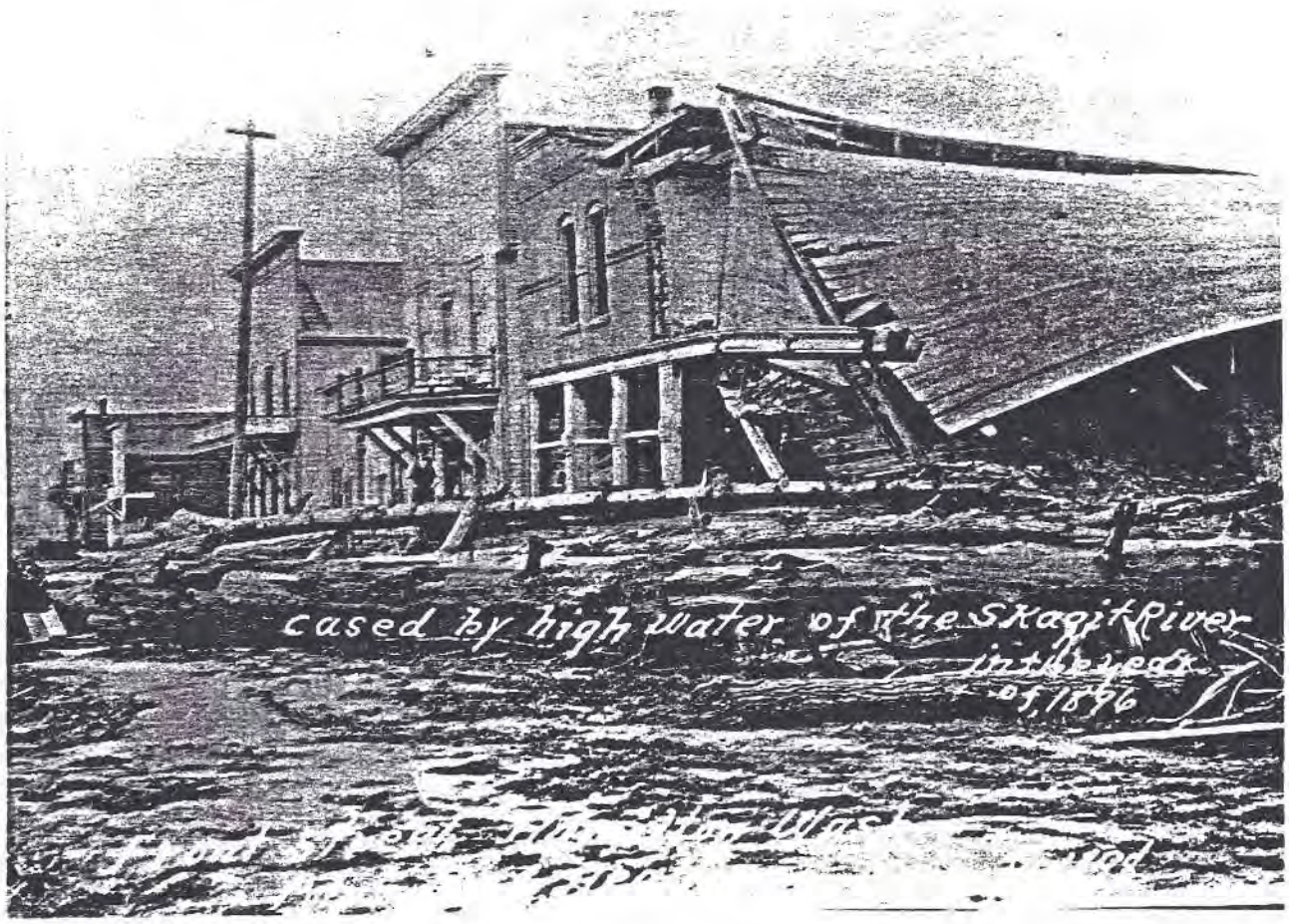
Main street of Conway. Presumed to be during the 1951 flood.

FIR ISLAND -- 1990

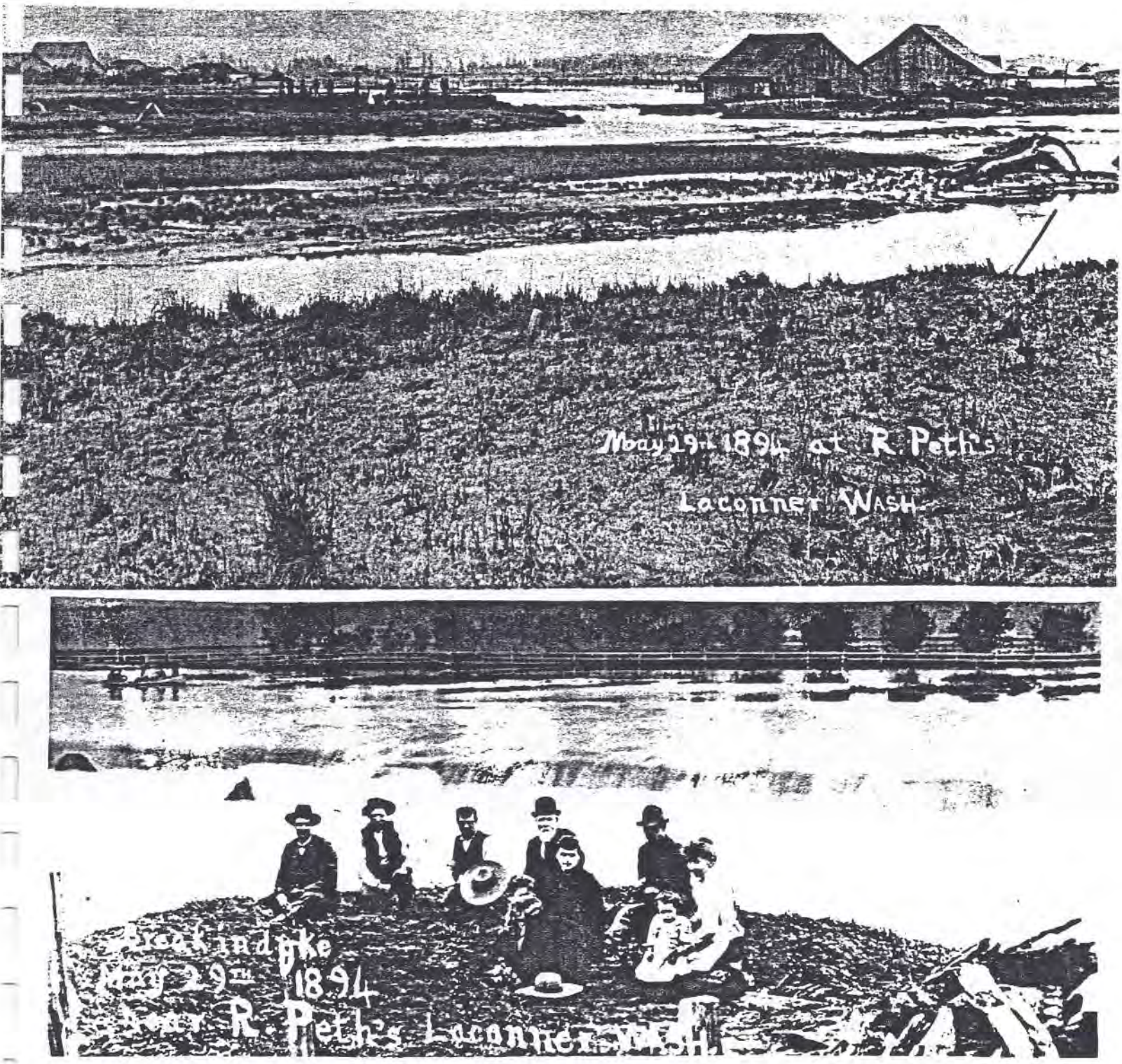
Break in the North Fork levee during the November 199● flood. Notice the slough, conveyance area, special flood risk zone immediately adjacent to the break in the levee.

FIR ISLAND -- 1990

HAMILTON

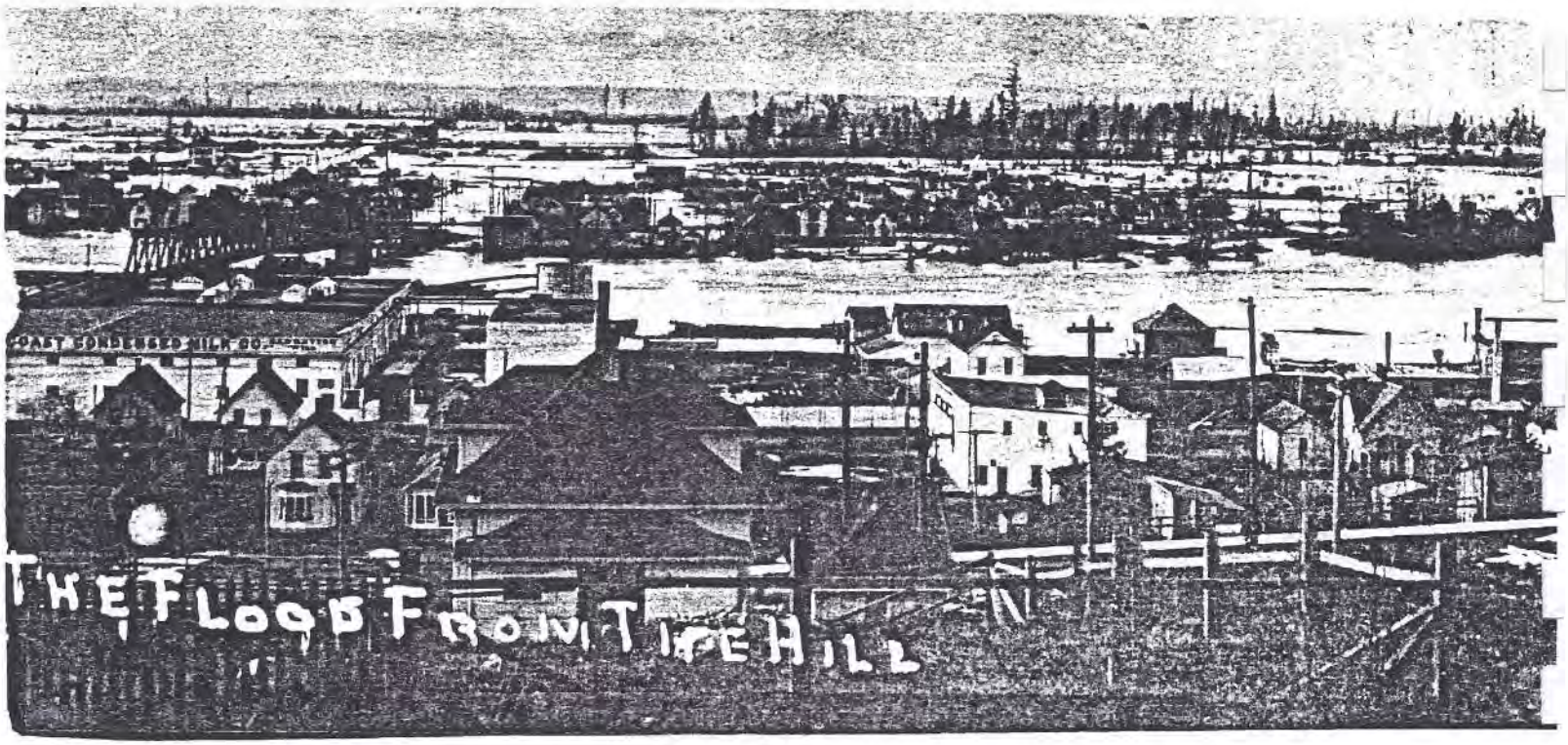


Front street after either the 1896 or 1898 flood. It has been reported that Hamilton begins to flood at a river level of approximately 30 feet. That level has been met or exceeded at least 8 times during the last 15 years.



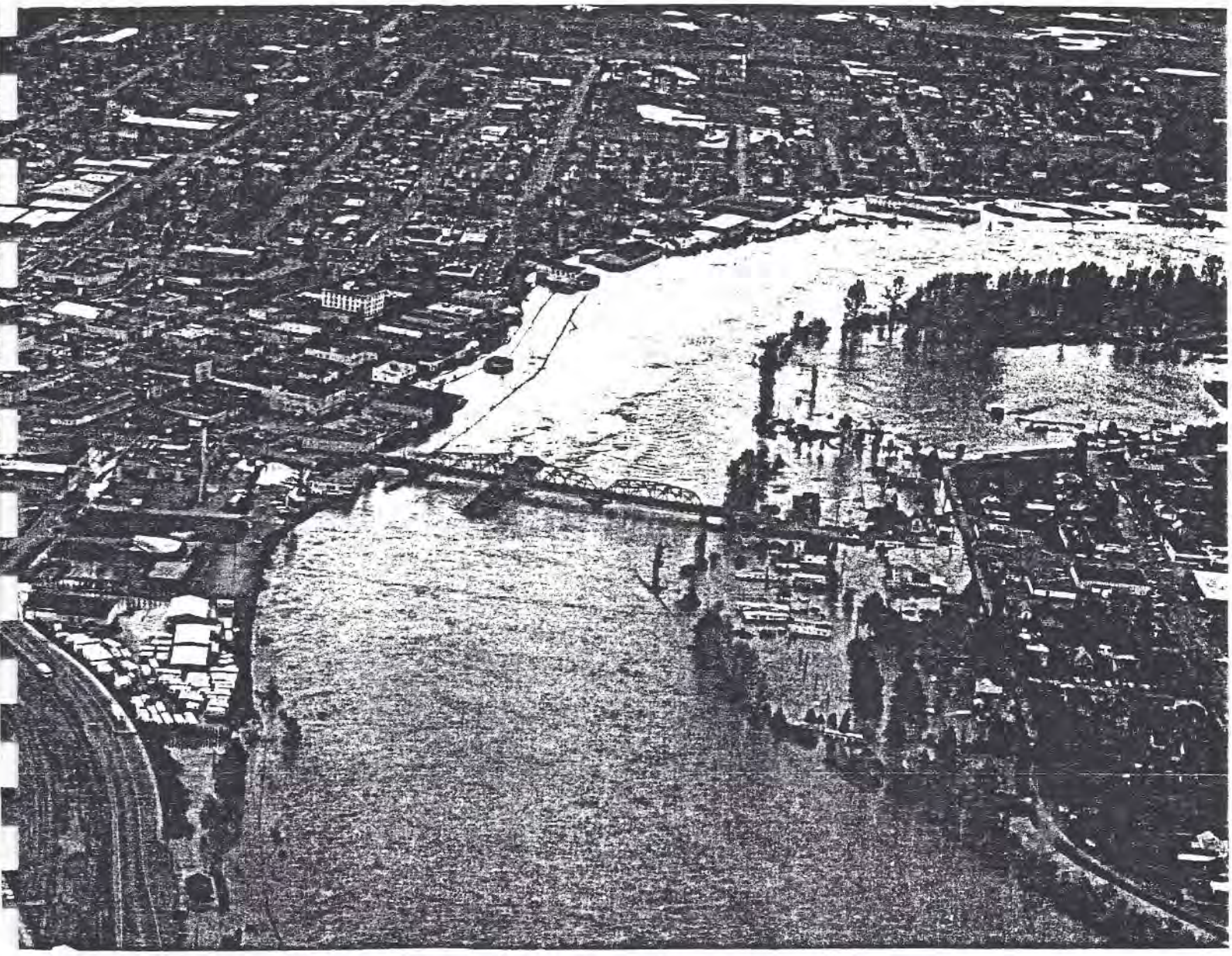
May 29th, 1894 flood at R. Peth's farm. The break is in the salt water dike. Current is water draining from land to the slough back into the bay. Notice there is no record of this flood provided by the federal government.

MOUNT VERNON



Reported to be the flood of 1909. The entire west Mount Vernon area went under water during the 1906 and 1909 floods. In 1909 the span of the bridge just west of the draw span was carried down river by the roots of a washed-out tree. It was possible in both these floods to take a row boat all the way from Mt. Vernon to LaConner across the fields.

MOUNT VERNON



City of Mount Vernon during the Thanksgiving Day flood of 199[illegible].

POTENTIAL FLOOD DAMAGE[40]

The potential for loss of life and monetary damage from a flood is great. Existing flood control measures mitigate potential flood damage somewhat, but the protection level differs throughout the County. The maximum protection achieved is for floods occurring at a frequency or once every 25 years, while other areas have little or no protection. Continuing residential and commercial development in the flood plain will increase the potential for damage.

The potential for loss of life and monetary damage from a flood is great.

The flooding problems discussed for each of the five different geographic areas cause considerable damage. The damage done by floods can be separated into three different categories. Physical damage is caused to structures, public and private, with losses in equipment, material, and furnishings. Financial loss results from decreased production, and the situation increases living expenses and operation cost. Cleanup, emergency, and relief activities require an enormous effort and expense. Each of these types of damage apply to the businesses, residences, and public utilities in the floodplain area.

RESIDENTIAL

Homes in the floodplain may be inundated, furniture waterlogged, basements filled with sediment and debris, heating facilities ruined. Yards, sidewalks, fences, and septic tanks are damaged. With greater depth and the force of flowing water, buildings may be moved off their foundations or undermined.

COMMERCIAL

Properties used in commerce, business, trade, services, and entertainment are affected. Land, buildings, equipment, supplies, merchandise, and raw material all can suffer loss or damage. Overhead expenses are increased for cleanup and inventorying. Normal operations costs increase and net profit is substantially reduced for the period.

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[40] Skagit County Comprehensive Flood Control Management Plan, Brown and Caldwell, April 1989

AGRICULTURE

Loss and destruction occurs to growing crops, land, barns, equipment, feed, livestock, and fences. The removal of debris, weed, and seed from affected land is time-consuming and costly. Siltation and saltwater can cause the soil to be less productive and fertile. Specialty horticulture such as bulbs and berries can be substantially damaged. Prolonged periods of high water are especially damaging. As agriculture is the major economic entity, extensive flood damage causes economic hardship to the entire county.

PUBLIC

Schools and roads are damaged and become unfit for use. Electric, water, telephone, and sewer utilities services can be interrupted, with additional problems if these services are needed for emergency purposes. Water rushing over roadways can potentially wash them out. Bridge foundations can be undermined when debris is trapped on piles and girders, causing an additional rise in the water surface.

"Flooding has been made much worse by years of inattention to floodway management, inability to curb development along the river valleys, and the accelerated logging of watersheds. . . ***Angelo Bruscas, P-I Reporter, Seattle Post-Intelligencer, 12/27/90***

EMERGENCY AID

The preservation of life and property are priority concerns during a pending flood. Flood emergency preparations are made. Evacuations are assisted. Additional police protection is needed. Rescue operations are performed. Mobilization of sandbagging teams of residents and military is needed. After the flood has passed, debris and wreckage is removed, and channels cleared. Private and public facilities are repaired or replaced. Damaged flood control works need restoration or repair.

COMPUTING THE FLOOD RISK[41]

Period (years)	Flood Frequency (year event) 10	25	50	100	500
1	10%	4%	2%	1%	.02%
10	65%	34%	18%	10%	2%
20	88%	56%	33%	18%	4%
25	93%	64%	40%	22%	5%
30	96%	71%	45%	26%	6%
50	99+%	87%	64%	39%	10%
100	99.99+%	98%	87%	63%	18%

The tabled values represent the probabilities, expressed in percentages, of one or more occurrences of a flood of given magnitude or larger within a specified number of years.

[41] Coordination during Flood Insurance Studies, Community Assistance Series, No.2, U.S. Department of Housing and Urban Development, Federal Insurance Administration

FLOOD CONTROL

There are five basic methods of handling flooding. These include: (1) do nothing, (2) institute flood plain regulations to restrict development and thus reduce flood damages, (3) create additional flood control storage on tributaries of the Skagit River, (4) divert flood flows away from the developed areas, or (5) protect selected areas with high levee systems.[42]

EXISTING CONDITIONS

LEVEES

Sixteen diking districts maintain approximately 56 miles of levees and 39 miles of sea dikes in the Skagit River delta. Additional levees protect farmland and residences elsewhere in the county, but none of the levees or dikes are adequate to protect against a 100-year tidal or riverine flood.[43]

. . .none of the levees or dikes are adequate to protect against a 100-year tidal or riverine 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 cubic feet per second is reached. Floods of these magnitudes are expected to recur at frequencies of 3 and 14 years, respectively.[44]

DAMS

Although the Skagit River basin has 5 hydroelectric dams, only two of them provide flood control storage, and the possibility of severe flooding in the basin remains. The three Seattle City Light dams on the Skagit River regulate river flows from about 31 percent of the Skagit drainage basin. Ross reservoir has a significant effect on flooding, but Gorge and Diablo have little storage and are used only for power generation. The two

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[42] Skagit River, Levee & Channel Improvements, Public Brochure, Seattle District, Corps of Engineers, March 1978

[43] Flood Insurance Study, Federal Emergency Management Agency, October 17, 1984.

[44] Flood Plain Information Study, Skagit River Basin, Washington, Summary Report, U.S. Army Engineer District, Seattle, Washington, July 1966.

Puget Sound Power and Light dams on the Baker river provide flood control for the Baker River basin which amounts to approximately 10 percent of the Skagit River drainage. Thus approximately 41 percent of the drainage basin is regulated by flood control dams. During the 1975 flood, the discharges from Ross and Upper Baker contributing to the flood peak of 122,000 c.f.s. at Concrete were 5,000 c.s.f. and 10,000 c.s.f., respectively. The Sauk River peaked at 65,300 c.f.s. and the inflow on the Skagit River below Ross and above Concrete was 42,000 c.f.s. Thus approximately 46 percent of the basin area (44% of the basin above Concrete) contributed 88 percent of the flood discharge at Concrete. . . . This flood has a recurrence interval of only about once every 10 years. . . . Thus, even with the existing flood control dams substantial amounts of flooding can and will occur in the future.[45]

. . .even with the existing flood control dams substantial amounts of flooding can and will occur in the future.

CONTINUE EXISTING CONDITIONS -- DO NOTHING

No new action would be taken for flood damage reduction through either structural or non-structural means. Development on the flood plain would be restricted through existing zoning. Flood proofing of future structures would be required as part of a flood insurance program that would indemnify property owners against losses. Undeveloped lands in the flood plain could be preserved for parks and open space. No new dams, levees, channel modifications, diversion structures, or other structural controls would be built for flood damage reduction purposes. Existing levee system and upstream flood control storage (120,000 ac. ft. at Ross, 74,000 ac. ft at Upper Baker) would be maintained. The existing flood warning system would provide forecasts of floods and give emergency information to flood plain residents.

Rivers would remain partially controlled by existing structural flood prevention measures. Existing average annual damages of about $4.5 million based on 1977 prices and conditions would continue. Some flood damage would be eliminated through floodproofing by individuals. Limiting flood plain development through zoning would reduce flood damage growth.

Flood plain residents would continue to be exposed to life and health threats and social disruption during flooding. Development on the flood plain would continue to be restricted by zoning, land use ordinances and building codes. Road, highway, and rail traffic would continue to be disrupted during floods.[46]

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[45] Skagit River, Levee & Channel Improvements, Public Brochure, March 1978, Seattle District, Corps of Engineers

[46] Ibid.

SAUK RIVER DAM

UPPER SITE

This site is about 9 miles upstream from Darrington and just below the confluence of Whitechuck and Sauk Rivers. Within the reservoir area are about 7 miles of secondary highway, a logging camp, and a logging railroad passing through the dam site to serve the camp, which is less than a mile from the dam site. (Total cost $47,600,000 -- 1951 dollars.) . . .the power benefits for this project would be $1,485,000. The annual costs would be about $2,380,000 and the project would not be feasible. This site is also objectionable to fisheries interests. The drainage area above this site is only 8 percent of the Skagit Basin area at Sedro Woolley and assignable flood control benefits would probably not exceed 15 percent. Such flood control benefits would have a negligible effect on the feasibility of the project.[47]

LOWER SITE

Few potential sites for upstream storage development are available in the Skagit River basin. A favorable site on the Sauk River six miles upstream from its confluence with the Skagit River appears to be the only location in the Skagit River basin at which major upstream storage is possible. Single-purpose flood control storage on the Sauk is not feasible; however, a dam at this site could develop approximately 700,000 acre-feet of multiple-purpose storage. About 250,000 acre-feet of storage would be usable for flood control. This amount of storage would increase the 35-year flood protection in the delta afforded by the Avon Bypass and downstream levee and channel improvements to more than a 100-year level of protection. Effective storage in the Sauk River reservoir, with the present level of flood protection, could control a 10-year flood at Mount Vernon to 91,000 c.f.s. corresponding to minimum capacities of downstream levees with minor sandbagging. The Sauk River storage, together with the levee and channel improvements, would yield 30-year frequency flood protection in the delta. Multi-purpose storage in the Sauk project could also provide hydroelectric power, irrigation, recreation, and low flow augmentation in addition to flood storage. The largest multiple-purpose benefit for the project would be hydroelectric power. ... The Sauk River has large migratory runs of salmon and steelhead which constitute a significant part of both the sports and commercial fishery of the region. Opposition can be

Few potential sites for upstream storage development are available in the Skagit River basin.

[47] Appendix to Report on Survey for Flood Control of Skagit River and Tributaries, Washington, Corps of Engineers, U.S. Army, February 21, 1952.

expected from fish and wildlife interests on any major storage project in the Skagit River basin. Such opposition is another reason that storage on the Sauk River should be considered only as a possible element of a future basin plan. Therefore the Avon Bypass and the channel and levee improvements in the delta would provide an immediate and very much needed first increment in a basin flood control plan.[48]

The Sauk site could provide 700,000 acre-feet of storage, of which 250,000 acre-feet are needed to increase the 30-year protection afforded by the Avon Bypass and by the improved levee system in the lower basin, to more than 100-year protection. The Sauk site has limitations on storage because of the overflow that would occur into the Stillaguamish River basin for a height of dam exceeding about 200 feet.[49] (Emphasis added.)

"The Lower Sauk Dam, . . ., is envisioned as a multiple purpose flood control/hydroelectric facility. It would utilize a dam in excess of 210 feet in height on the Lower Sauk River at about River Mile 5 . . . This dam would create an impoundment of 695,000 acre feet with a surface area at maximum pool elevation of approximately 6,700 acres. The impacts of such a project would be considerable. The impoundment would extend approximately fifteen miles upstream to the City of Darrington and would require the relocation of sixteen miles of SR 530 as well as many more miles of secondary roads, the replacement and/or relocation of two major highway bridges, relocation of ten miles of Seattle City Light's 230 kV lines, and require the displacement and in all likelihood the condemnation of several hundred residences and summer homes.

. . . a dual purpose project such as the Lower Sauk Dam invariably optimize neither flood control nor power production. Peak power capability, as well as energy production, during the high demand winter season is directly reduced in proportion to the flood control storage provided. The reduced power benefits combined with the greater costs of a high dam would seriously threaten the economic viability of such a project. In addition, in this particular case, the very significant sediment loads of the Sauk and Suiattle Rivers could result in serious reservoir sedimentation problems, cause excessive wear and tear on the turbines and could create serious water quality problems downstream of the facility.

The Sauk site has limitations on storage because of the overflow that would occur into the Stillaguamish River basin for a height of dam exceeding about 200 feet.

The Lower Sauk Dam, . . ., would utilize a dam in excess of 210 feet in height . . .

The anticipated impacts of such a project on the salmon and steelhead fisheries of the Skagit, Sauk and Suiattle Rivers and the costs of their mitigation would also be

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[48] Avon Bypass, Skagit River, Washington, Reactivation Report, U.S. Army, Corps of Engineers, November 1963.

[49] Ibid.

considerable and cannot be ignored. The problem of native American fishing rights would be certain to become a central issue. The uncertainty surrounding this issue alone was a major element in Seattle City Light's decision to drop the proposed Copper Creek Project on the Skagit River. It would be no less of an issue for a Lower Sauk Project. These fisheries issues, raised by the Tribes and the agencies, have been serious roadblocks to the development of even small scale hydro proposals.

From the legislative standpoint, the existing scenic and recreational river status of the Sauk-Suiattle River System under the Wild & Scenic Rivers Act could prove a most intractable problem even with the unified support of the State's congressional delegation and local citizens. At the December 7, 1982, meeting of the Skagit County Commissioners in Mount Vernon, the Corps publicly reiterated that, as a federal agency, they are prohibited from engaging in any engineering studies relative to a Lower Sauk Project without the express approval of Congress. Almost simultaneous with the Corps announcement, the U.S. Forest Service published their draft plan for the management of those reaches of the Skagit-Sauk-Suiattle System protected by the Wild & Scenic Rivers Act. It is quite clear that the Forest Service is prepared to manage the system as envisioned under terms of the Act and that those terms expressly prohibit such a development as the proposed Lower Sauk Dam."[50] (Emphasis added.)

The problem of native American fishing rights would be certain to become a central issue.

. . .the existing scenic and recreational river status of the Sauk-Suiattle River System under the Wild & Scenic Rivers Act could prove a most intractable problem...

AVON BY-PASS

The project was authorized by the Flood Control Act of 1936. At a public hearing on March 2, 1937, responsible County officials stated that county finances were such that it was then impossible for local interests to furnish the required local cooperation. No assurances of local cooperation were furnished and the project was subsequently classified inactive in 1952. The District Engineer in a survey report (submitted in February 1952) recommended that the Avon Bypass project be abandoned. Subsequently, the Chief of Engineers in a report dated June 16, 1956 to the Secretary of the Army concurred in the findings of the District Engineer's 1952 report. No action was taken by Congress on the recommendation. Studies initiated in 1961 showed that with present day development, improvement of the existing levee system downstream of the Avon By-

The river should have a space to go. And we should keep the cities out of the flood plain. *Josef A. Kunzler, Age 8, 12/19/90*

[50] John W. Ellis, President, Puget Power in a letter to George M. Dynes, Skagit River Flood Control Committee dated January 3, 1983.

Pass and construction of the Avon Bypass are the two most urgently needed projects for flood control in the Skagit River Basin and are well justified.

The proposed Avon Bypass project is a diversion channel and upstream right bank levee to divert excess flood flows from the Skagit River between Mt. Vernon and Burlington into Padilla Bay. The name "Avon By-Pass" was applied to the project in the original authorization and stems from the proximity of the town of Avon to the channel boundaries. The upstream end of the channel is on the Skagit River near Burlington, Washington. The channel passes through Gages Slough, follows the toe of Bayview Ridge, west of Burlington, and discharges into Padilla Bay. Other alinement for the bypass were investigated during early discussions with local interests. The most favorable alternate route was a channel with an intake at mile 15 near Avon, flowing westward to Padilla Bay and joining the proposed channel at about Station 500+00. This alinement results in a shorter channel and appears to be an obvious route. However, the alternate alinement would require expensive enlargement for more than three miles of the existing river channel and was found to cost $3,900,000 more than the proposed alinement. The alternate alinement would require the taking of expensive agricultural lands that are now being intensively farmed and would also require relocation of many residences in the path of the channel. The land required along the proposed route is largely slough, brush and marginal farm land.

The upstream end of the channel is on the Skagit River near Burlington...

The Bypass would substantially improve the degree of protection for urban areas by lowering water surface elevations during flood periods, and thereby provide a greater degree of protection. There would be no physical basis for a false sense of security as only minor levee improvements are planned in the immediate vicinity of urban areas. ... Encroachment on the 2-foot freeboard proposed for the Bypass project and the levee improvements could provide flood protection of up to 75-year frequency for the delta. Local interests would be required, as a part of local cooperation, to notify the public annually of the limited protection being provided so that all concerned would be knowledgeable.

...no physical basis for a false sense of security

Opposition to the Bypass project was expressed by representatives of Fire District No. 6 and Diking District No. 12, on the grounds that the Bypass cost would be excessive, would sever the Districts, and make access difficult. Several landowners along the path of the Bypass channel objected to the loss of farmland that would result from construction of the project. A petition signed by 740 persons was presented by a citizen's group that opposed the use of the Bypass on the following grounds:

a. The Bypass will not provide protection for major floods.
b. The Bypass will endanger a new area to flood hazard.
c. The Bypass will cause eventual silting-up of shallow Padilla Bay.

Letters to Congressmen from leading sponsors of this petition followed the public hearing. "To clarify some of the misunderstanding, a meeting was held on March 13, 1964 in the District office with leaders of the citizens opposing the project, most of whom are from the Bayview and Burlington areas. The group included Mrs. Edna Breazeale, Mr. John Swisher, Mr. Norman Dahlstedt, and others. Each of the foregoing arguments was considered in detail. The importance of the Bypass as a major element of flood control plan was explained. The broad width of levee berms in the Bypass, amounting to 50 feet or more, dispensed arguments that the Bypass would open up a new area to flood hazards. Regarding the statement that the Bypass would cause silting of shallow Padilla Bay, the group was advised that the Bypass would include provisions for a continuous diversion flow of about 100 c.f.s. to prevent stagnation. The diversion flow is less than one percent of the mean annual flow of the Skagit River, and much of it would occur during periods when the Skagit River is carrying little, if any, sediment load. Bed load in the river would be prevented from entering the channel by the ogee weir crest of the headwater which is about 20 feet above the river bottom. In addition, with the downstream levee and channel improvements, the Bypass would only be used once every four years for flood flows. The amount of flood discharge in the Bypass would vary from perhaps 10,000 c.f.s. once every 4 years to a maximum of 60,000 c.f.s. at 35-year intervals. The duration of this flood discharge would be from 24 to 48 hours. None of the foregoing operations would result in any sedimentation that would affect or even be noticeable in Padilla Bay.[51]

The Avon Bypass project would provide a clear, cold lake about 8 miles long . . . The accessibility of the Avon Bypass waters, coupled with the potential for excellent trout fishing, hunting and general recreation provide an outstanding attraction for recreational use. The U.S. Fish and Wildlife Service and Washington Department of Game have developed plans for a resident trout fishery within the Bypass. The project would be adapted for a fishery by construction of an additional intermediate collapsible weir to maintain a water level of about 10 feet throughout the channel. Inlet and outlet works would be screened to exclude non-game and migratory fish. A minimum flow of perhaps 100 c.f.s. would be required to maintain water quality and a water right for this flow would have to be obtained. Boat access could be provided to each section of the Bypass. The Fish and Wildlife Service estimates usage at 159,000 fisherman days annually if this program were established. In addition to the resident trout fishery, the Federal and State fishery agencies are studying the effect of the Avon Bypass on migratory fish. Consideration is being given to the use of the

The Avon Bypass project would provide a clear, cold lake about 8 miles long . . .

[51] Avon Bypass, Skagit River, Washington, Reactivation Report, U.S. Army, Corps of Engineers, November 1963.

lower section of the channel for a controlled natural rearing area for migratory fish.

The project would create about 340 acres of water surface and 440 acres of adjacent land available to the public for recreational pursuits. Forested lands near the midpoint of the channel have excellent potential for all purpose recreational development. A comparison with similar existing parks indicates that with recreational development, the Bypass would initially attract about 60,000 persons annually. Annual attendance could well reach 750,000 within 50 years.[52]

The project would create about 340 acres of water surface and 440 acres of adjacent land available to the public for recreational pursuits.

DREDGING THE RIVER

Deepening the Skagit River to carry flood flows is not feasible. Substantial deepening of the river to carry flood flows would undermine existing levees along the river banks. The Skagit River carries large quantities of bed sediment estimated at more than 500,000 cubic yards annually. An excavated channel of sufficient depth to carry flood flows would require annual dredging to remove deposited sediment and would be economically impracticable.[53]

Dredging also is not feasible because of the high cost of maintenance. The channel would have to be dredged every year or two, and could have detrimental effects on the environment. ***Forest Brooks, Project Study Manager, U.S. Army Corps of Engineers, Skagit Valley Herald, 6/26/79.***

Another problem with dredging is the potential for causing structural damage to the 30 miles of dikes along the river. Skagit County flood engineers say dredging could weaken the bed underneath the dikes, causing sloughing, with the dike eventually giving way from underneath.[54]

Investigations of dredging were conducted to sufficient level of detail to determine that the desired levels of flood protection could not be provided by dredging alone and that a combination of dredging and levee construction to provide desired levels is significantly more costly than levee construction alone. Also, dredging the Skagit River downstream of Sedro Woolley would cause major environmental impacts. Consequently, channel dredging was not considered a viable alternative for

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[52] Skagit River Washington, Plans for Flood Control and Recreation Improvements Including Fisheries as added purposes for Avon Bypass, Corps of Engineers, November 22, 1963.

[53] Avon Bypass, Skagit River, Washington, Reactivation Report, U.S. Army, Corps of Engineers, November 1963.

[54] Chad Hutson, Staff Writer, Skagit Valley Herald, 12/19/90

detailed study.[55]

LEVEES

> **"Its unbelievable how fast a dike can unravel. 500 feet of dike could come down in a matter of minutes. If you're in front of one of those levees when it goes, you've had it. Burlington, with all its commercial development, is the danger zone in Skagit County."** ***Don Nelson, County Flood Engineer, Skagit Argus, 3/16/82***

In 1978 the U.S. Army Corps of Engineers proposed a "Levee and Channel Improvement Project" for the Skagit River delta area. Five different proposals were presented, all with varying degrees of protection and adverse impacts. The proposal selected by the Corps and the County Commissioners was alternative 3E. Estimated cost of the project ... $55,000,000. The Corps stated at a December 20, 1978 public hearing that:

This alternative would involve improving the existing levee system to raise the level of protection for rural land to 50-year and for urban land (100-year protection), including Burlington, Avon, and west Mount Vernon on the right bank and Mount Vernon on the left bank. The levee design would include allowances for wave action, super-elevation, and future sedimentation. Rural levees would have a freeboard (factor of safety) of 2 feet and urban levees 3 feet. A weir would be built between Burlington and Sedro Woolley to limit 100-year Samish overflows to the same as under existing conditions. Drainage outlets would be modified as required. Flood plain management would still be required for areas outside the urban levees, including zoning, flood warning system, etc.

40,000 acres of land would be provided rural protection (50-year), and 11,800 acres of land would be provided urban protection (100-year). **The project would raise 100-year water surface elevations in the Nookachamps-Clear Lake area by <u>about</u> one foot.**[56] (Emphasis added.)

A draft environmental impact statement was prepared for the proposed project and released in the Spring of 1979. It stated in part:

Implementation of the proposed project will provide protection for the 50-year flood frequency from the mouth of the North and South Forks to below Mount Vernon. Protection for the 100-year flood frequency will be provided from below Mount Vernon to upstream of Burlington and then 50-year protection from upstream of Burlington to

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[55] <u>Draft Environmental Impact Statement, Skagit River, Washington, Levee Improvement Project</u>, U.S. Army Corps of Engineers, Seattle District, April, 1979

[56] <u>Skagit River, Levee & Channel Improvements, Public Brochure</u>, Seattle District, Corps of Engineers, December 20, 1978.

Sedro Woolley. Due to allowance in the project design for sedimentation over the 100-year economic life of the project, the level of protection at project year 1 will be something greater than 50 years for the rural areas and 100 years for the urban areas; however, this increased protection is temporary and would decrease in time to the level of protection for which the project is designed.

The concrete weir on the right overbank between Burlington and Sedro Woolley will regulate the Skagit River overflow into the Samish River Basin. The weir is designed to allow the same volume of Skagit River water to flood the Samish Valley as that which floods under existing conditions during the 100-year flood event. In so doing, approximately 50-year flood protection from Skagit River flooding is provided by the project to the Samish Valley.

The entire Skagit Delta is protected by the project except the natural flood storage area of the Nookachamps Creek drainage, which includes the community of Clear Lake on the left bank of the Skagit River, and south Sedro Woolley, Sterling, and west Mount Vernon on the right bank. The lower Samish River Basin will continue to experience periodic flooding from the Samish River.

Downstream from Mount Vernon, the 50-year flood frequency levee is designed to overflow in three areas at the confluence of the North and South Forks and Fir Island. Controlling the overbank flooding in these areas will result in all areas on the right and left banks of Fir Island flooding at approximately the same time during a flood event greater than the 50-year levee design. **This flooding would have a major effect on riverflow for some distance upstream.** (Emphasis added.)

Under with-project conditions, flooding in the study area will occur first in the unleveed portions, starting in the Nookachamps/Clear Lake area and then on the right bank Sedro Woolley and the unleveed area of west Mount Vernon. In the areas provided levee protection by the project, the right and left banks of the North and South Forks of the Skagit River along Fir Island are designed to overtop in a flood event greater than a 50-year frequency. At about the 50-year flood event, the Samish Valley will begin to experience flooding from the Skagit River via the proposed weir between Burlington and Sedro Woolley. As floodflows increase over the 100-year levee design in the urban areas, the next area designed to overflow is at Avon bend. Starting from the Avon area and moving upstream, the project is designed in a stepwise fashion to flood in sequence and thus to prevent the catastrophic effects of a flood event greater than 100 years on Burlington. The last area to experience flooding in a flood greater than 100 years will be Mount Vernon. (Emphasis added.)

> **"To the Nookachamps-Clear Lake area, this (raising the levees) can only do one thing, when you try to force the same amount of water through a smaller opening, it goes up. Somebody has got to pay for the right to flood the land. We can with some degree of certainty predict what will happen if the project is built. The local sponsor must acquire the right to do that."** ***Vern Cook, Project Manager, Corps of Engineers, Skagit Valley Herald, 4/18/79.***

The proposed action will produce long-term, adverse, secondary impacts as a result of increased annual flood damages in the four unleveed areas that will remain unprotected by the levee improvements. On the right bank near Sedro Woolley, the 50- and 100-year water surface profiles **will be raised by about 1 foot**. A total of 12 homes, one farm unit, and a log storage area within the existing 50-year and 100-year flood plains will be subject to increased flood depths from these events. The wastewater treatment plant in Sedro Woolley will be floodproofed to the with-project 100-year level. (Emphasis added.)

On the right bank at west Mount Vernon, the 50- and 100-year water surface profiles **will be raised by about 2½ feet for each event** and will raise the 500-year profile by an estimated 3 feet. Located in this area are 15 mobile homes, about 20 residences, and two commercial establishments. (Emphasis added.)

In the Sterling Road area east of Burlington, the 50- and 100-year water surface profiles **will be raised by about 1½ feet**, and the 500-year water surface profile will be raised less than 1 foot. One farm unit and 29 residences are located within this area. (Emphasis added.)

In the Nookachamps Creek/Clear Lake area, the 50- and 100-year water surface profiles **will be raised by an estimated 1½ feet**, and the 500-year water surface profile will be raised less than 1 foot. Within Clear Lake, there are approximately 140 homes, eight businesses, six churches, and two industrial establishments which could be affected by the increases in surface profiles caused by the proposed project. Outside the city limits, there are four farm units and 47 residences that could be affected.[57] (Emphasis added.)

In a legal memorandum dated May 18, 1979, copied to the Skagit County Public Works Department, the Corps attorney stated the following:

> The hydraulic analysis of the Skagit River system indicates that the additional depth of flooding resulting from the proposed levees in the unprotected areas will be as follows:
>
> **1/8-foot during the 5% recurrence frequency flood (20-year flood); 1½-foot during the 2% recurrence frequency flood (50-year flood); and 2 feet during the 1% recurrence frequency flood (100-year flood).**[58]

The attorney went on to state that impacted "...landowners may have a legal remedy in tort. In such case ... **any award for damages would be the responsibility of the County.**"[59] (Emphasis added.)

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[57] Draft Environmental Impact Statement, Skagit River, Washington, Levee Improvement Project, U.S. Army Corps of Engineers, Seattle District, April, 1979

[58] Memorandum For Record, JoAnn B. Johnson, General Attorney, May 18, 1979

[59] Ibid.

On November 6, 1979, the Skagit County voters overwhelmingly rejected the proposed project. The local editor of the Skagit Valley Herald commented as follows:

> "Local funding for a long-sought Skagit River flood control measure was washed away in no uncertain terms Tuesday by voters, who rejected the bond measure by a whopping 71.4 percent negative vote. The entire project must now go back to the drawing board in an attempt to find the next step forward. For we greatly doubt that Skagit county residents are willing to sit by and allow much of the valley to be hit by a raging flood. And believe it or not, the Skagit River, as we said earlier, is **"a disaster waiting to happen."** [60]

...impacted "...landowners may have a legal remedy in tort. In such case ... any award for damages would be the responsibility of the County."

FLOOD PLAIN MANAGEMENT
THE NON STRUCTURAL FLOOD CONTROL

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.

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.

Any development of the flood plain should be tempered by the fact that the flood plain can only be borrowed.

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 . . .

[60] Editorial, Skagit Valley Herald, 11/8/79

openings to pass flood flows without causing the water to back up excessively.[61]

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.[62]

The goal of flood plain management is to make wise choices among compatible land uses for both economic potential and the protection of natural resources. Land uses such as agriculture, recreation, and wildlife habitat are generally compatible with flood plain protection. A limited amount of urban development can also be compatible if properly planned.

If the flood plain's capacity to receive flood flows can be preserved, property damage and human suffering can be greatly reduced. Flooding is inevitable, but severe flood damage is not inevitable. It can be prevented if land use and flood risk are in harmony.[63] (Emphasis added.)

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[61] Authors Note: Unlike the condition created by the construction of Interstate 5 which serves as a weir backing up floodwaters into Burlington.

[62] Flood Plain Information Study, Skagit River Basin, Washington, Summary Report, U.S. Army Engineer District, Seattle, Washington, July 1966

[63] Flood plain management -- Why we need it., United States Department of Agriculture, Soil Conservation Service, Program Aid Number 1276

ZONING

In the absence of flood control, the most effective means of preventing flood damage is zoning. 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 increases in building and subdividing can affect all areas suitable for residential construction purposes.

In the absence of flood control, the most effective means of preventing flood damage is zoning.

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.[64]

REGULATORY FLOODWAY (DEFINITION)

For purposes of the National Flood Insurance Program (NFIP), a floodway is defined as the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment so that the 100-year flood can be carried without increasing the flood heights by more than 1.0 foot. This concept was designed for typical river valley situations, where the channel represents the lowest point in the flood plain and the most effective conveyance area is immediately adjacent to the channel.[65]

For purposes of administering the Washington State Shoreline Management Act, the Skagit County Shoreline Management Master Program (SMMP) defines floodways as: "...those portions of the area of a river valley lying streamward from the outer limits of a watercourse upon which flood waters are carried during periods of flooding that occur with reasonable regularity, although not necessarily annually, said floodway being identified, under normal condition, by changes in surface soil conditions or changes in types or quality of vegetative ground cover condition. The floodway shall not include those lands that can reasonably be expected to be protected from flood waters by flood

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[64] Flood Plain Information Study, Skagit River Basin, Washington, Summary Report, U.S. Army Engineer District, Seattle, Washington, July 1966

[65] Letter dated August 22, 1983, to Larry J. Kunzler, from Brian R. Mrazik, Ph.D., Chief, Engineering Branch, Natural Hazards Division, Federal Emergency Management Agency, Washington, D.C.

control devices maintained by or maintained under license from the federal government, the state, or political subdivision of the state".[66]

The City of Burlington defines floodways as: "the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the 100 year flood without cumulatively increasing the water surface elevation more than one foot. Floodways in Burlington consist of all areas riverward of the riverward toe of dikes and levees along the Skagit River."[67]

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.

Skagit County defines floodways as: "the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one (1) foot.[68]

Three types of regulatory floodways that are used in Washington State are: equal conveyance; density and zero rise.

EQUAL CONVEYANCE FLOODWAYS

This method of designating a floodway (sometimes referred to as the conventional method) involves determining the amount of area needed to keep the floodwaters from rising 1-foot and then dividing that area equally on both sides of the river channel. This method would have designated a large portion of south Burlington and almost, if not all of downtown Mt. Vernon.

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[66] Skagit County Shoreline Management Master Program, Skagit County Planning Department, Reprinted December 1983.

[67] Burlington Flood Plain Ordinance No. 1108, Adopted by the City Council August 13, 1987.

[68] Skagit County Flood Damage Prevention Ordinance No. 11888, Adopted December 28, 1988.

DENSITY FLOODWAYS[69]

Conventional floodways are not appropriate for the complex flow conditions in the Skagit River delta. A more suitable flood plain management technique is to limit the density of development. Development density is defined to be that portion of a lot that is raised above the 100-year flood elevation to accommodate new construction of landscaping. Increasing the development density on one lot produces a negligible increase in water-surface elevation caused by all new development in the flood plain can be substantial.

To make flood plain management regulations easier to enforce, a 10-percent density criterion for all flow paths and lot sizes is recommended.

The density criterion for flood plain management is the development density (measured in percent) that would result in a 1-foot increase in water-surface elevation if applied to every lot throughout the flood plain. Because the development density that causes water-surface elevations to increase 1 foot above present levels can be determined by hydraulic analysis, the density criterion provides an objective method of balancing benefits from flood plain development against flood losses.

The density criterion depends on lot size, average hydraulic depth, and average energy slope of the 100-year flood. . . .five separate flow paths were analyzed. The average hydraulic depth and energy slope was computed for each path. Graphs developed by the COE were used to determine the density criterion to be used for each flow path and lot size. Results are shown in Table 2.

AUTHORS NOTE: ***Flow Path 1 is through Burlington; Flow Path 2 is the area between Bayview Ridge and the Samish River Valley; Flow Path 3 is the area between Bayview Ridge, Avon and La Connor; Flow Path 4 is between Mt. Vernon south between I-5 and the Skagit River channel; and Flow Path 5 is Fir Island.***

TABLE 2. Density Criterion for Flood Plain Management (%)

Lot Size (Acres)	Path 1	Path 2	Path 3	Path 4	Path 5
0.25	5	7	8	7	5
0.50	7	8	10	9	6
1.00	8	9	12	10	7
3.00	9	10	13	12	9
5.00	10	11	14	13	10

[69] Analysis of Flooding in the Skagit River Delta Area; Submitted to Federal Emergency Management Agency Office of Natural and Technological Hazards, By Dames & Moore, December 1982

The density criterion varies from 5 percent to 14 percent depending on the flow path and the lot size. For example, suppose a land owner wishes to construct a building on a 1-acre lot in Flow Path 4. The table shows that the owner can raise a maximum of 10 percent (4356 square feet) of his property above the 100-year flood plain.

To make flood plain management regulations easier to enforce, a 10-percent density criterion for all flow paths and lot sizes is recommended.

ZERO RISE FLOODWAYS[70]

"Zero-rise floodway" means the channel of the stream and that portion of the adjoining floodplain which is necessary to contain and discharge the base flood flow without any measurable increase in flood heights. A measurable increase in base flood height means a calculated upward rise in the base flood elevation, equal to or greater than .01 foot, resulting from a comparison of existing conditions and changed conditions directly attributable to development in the floodplain. This definition is broader than that of the Federal Emergency Management Agency floodway, but would always include the FEMA floodway. The boundaries of the 100-year floodplain as shown on the Flood Insurance Study are considered the boundaries of the zero-rise floodway unless otherwise delineated by a special sensitive areas study.

Within a zero-rise floodway, no development activity shall reduce the effective storage volume of the floodplain, and no development proposal can cause any increase in base flood elevation unless: (1) FEMA Flood Insurance Rate Maps have been adopted to incorporate the increase in base flood elevation; and (2) Appropriate legal documents are prepared in which all property owners affected by the increased flood elevations consent to the impacts on their property. These documents shall be filed with the title of record for the affected properties.

Construction of new residential or non-residential structures is allowed in the zero-rise floodway subject to the following: (1) The structure is outside the FEMA floodway; (2) The structure must be on a lot legally in existence at the time the zero-rise floodway is designated; (3) The structure must be on a lot which contains less than 5,000 square feet of buildable land outside the zero-rise floodway; and the structure must be built on post and pier construction.

Appropriate legal documents are prepared in which all property owners affected by the increased flood elevations consent to the impacts on their property.

[70] King County Sensitive Areas Ordinance No. 9614, adopted August 29, 1990.

The following circumstances are exempt from the zero-rise requirements: (1) New construction when lots contain less than 5,000 square feet of buildable land outside the zero-rise floodway, provided the structures on the lot is less than 2,000 square feet; (2) Substantial improvement of an existing residential structure in the zero-rise floodway but outside the FEMA floodway.

Critical facilities (ie. schools, hospitals, police and fire stations and nursing homes) are not allowed to be constructed in the zero-rise floodway. Utilities are permitted only when there is no other alternative.

CONVEYANCE AREAS

Conveyance areas (when not man-made) are more often than not, old sloughs and channels of a watercourse. These areas traditionally carried heavy overflows of water during times of flooding, and until the arrival of mankind were completely unobstructed. In Skagit County, the delta area still has many remnants of the old sub-channels (Indian Slough, Gages Slough, Brown Slough, Dry Slough, Barney Slough, etc.). While the majority of the old sub-channels are cut off from the river by levees, during times of severe flooding when the levees are breached or destroyed, the old sub-channels will still serve to discharge floodwaters.

...these types of areas should be kept free of fill and other obstructions or otherwise managed as floodways...

[F]EMA recognizes that the majority of overbank flow occurs over Interstate 5 in the vicinity of the George Hopper Interchange between Gages Slough and the drive-in theater and from near Edison High School to just south of Cook road. Approximately 80 percent of the total overbank flow crosses the highway in these segments. Remaining flow will pass under the interstate at openings such as Gages Slough and other drainages and road underpasses. It is FEMA's opinion that these types of areas should be kept free of fill and other obstructions or otherwise managed as floodways, so that their conveyance characteristics are maintained.[71]

In 1983, a citizen's group tried to have the conveyance characteristics of Gages Slough recognized as a floodway under the State's Shoreline Management Act (SMA). The presentation before the Skagit County Planning Commission, on June 13, 1983, is republished in its entirety here for the readers perusal.

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[71] Letter to Honorable Raymond C. Henery, Mayor, City of Burlington, from Brian R. Mrazik, Ph.D., Chief, Risk Studies Division, Federal Insurance Administration, Federal Emergency Management Agency, dated February 1, 1984

GAGES SLOUGH
ANALYSIS OF THE FLOODWAY ISSUE

Mr. Chairman, members of the Planning Commission:

My name is Larry J. Kunzler. On behalf of the Citizens for Orderly Growth, I have been asked to address the issue of whether or not GAGES SLOUGH is a WETLAND by virtue of it being a FLOODWAY. Before one could pursue this train of thought we must first define FLOODWAY. I have taken the liberty of putting together a FLOODWAY Portfolio for each of the members of the planning commission as well as the Skagit County Planning Department Staff.

On the left hand side of your portfolio you will find copies of all the legal documents pertaining to the legal definitions of the term FLOODWAY. They include the Skagit County Shoreline Master Plan, the State of Washington Shoreline Management Act of 1971, Washington Administrative Code Chapter 173-22 titled Adoption of Designations of Wetlands Associated with Shorelines of the State, and lastly Chapter 508-60 Administration of Flood Control Zones again of the Washington Administrative Code.

After analyzing each legal definition one is left with a list of criteria questions. If GAGES SLOUGH meets the necessary criteria that the questions pose than GAGES SLOUGH is indeed a FLOODWAY and under the law all FLOODWAYS are automatic WETLANDS. I feel it also appropriate to point out that under the law all DRAINWAYS are considered to be and administered as FLOODWAYS.

For lack of a better name I have assigned the title, "THE FLOODWAY NINE" to the list of questions of criteria that one has to answer in order to justify calling GAGES SLOUGH a FLOODWAY. You will find those questions under the title page on the right hand side of your files along with all of the documentation needed for the FLOODWAY NINE answers.

For the benefit of the audience the FLOODWAY NINE questions are as follows:

THE FLOODWAY NINE

1. **IS THERE A CHANGE IN THE TYPES OR QUALITY OF VEGETATIVE GROUND COVER CONDITIONS?**

2. **IS THE GAGES SLOUGH AREA A WATERCOURSE THAT CARRIES FLOODWATERS?**

3. **DOES THE GAGES SLOUGH AREA SERVE AS A DRAINWAY?**

4. **IS THE GAGES SLOUGH AREA SUBJECT TO THE 100 YEAR FLOOD?**

5. **DO THE FLOODS HAPPEN WITH REASONABLE REGULARITY?**

6. **IS THE GAGES SLOUGH AREA REASONABLY PROTECTED FROM FLOODWATERS?**

7. **DOES GAGES SLOUGH INFLUENCE THE SKAGIT RIVER?**

8. **DOES THE SKAGIT RIVER INFLUENCE GAGES SLOUGH?**

9. **DO FLOODWATERS IN GAGES SLOUGH TRAVEL AT MORE THAN 0.5 MPH?**

Others in the audience tonight will address the wetlands, vegetative cover question.

In order to answer the FLOODWAY NINE we are going to take a look at a lot of historical, engineering and technological data that is available for review on the GAGES SLOUGH issue. In order to meet a self imposed time limitation on my presentation here tonight I'm only going to read to you very short excerpts from the evidence presented. It should be obvious that any one of the pieces of evidence could be used to justify answers to several of the questions.

Let us begin with the historical evidence.

I would like to submit to you several newspaper articles concerning past floods in GAGES SLOUGH. It is appropriate at this time to tell you that GAGES SLOUGH hasn't always been called GAGES. It used to be called VARNEY SLOUGH after the interurban railroad depot at Burlington next to the slough.

DEC 15, 1921 ... MT VERNON DAILY HERALD

At Mt Vernon Saturday, the fury of the waters caused alarm for the safety of the dikes and a close watch was kept over them. The first break occurred at McKays place in Burlington. The low lying land was soon covered with water. On Tuesday morning the scene north of the city (Mt Vernon) was one broad expanse of water, with dwelling houses, barns, hay stacks, fences and trees standing in it. From three to six feet of water was recorded in this section of the flood area, the lower floors of the houses being flooded, the inhabitants taking to the second story. The flood waters reached as far west as Avon ..... A number of houses between here and Burlington were reported to have been lifted from their foundations and otherwise damaged by the flood. The most serious one reported was that of Lee Davis, whose house floated off its foundation and broke in to. The family had been warned to seek safety but were slow in taking heed to the warning..... Travel was interrupted (on the interurban) by the washing out of a bridge just outside of city limits and damage to the bridge over VARNEY SLOUGH.

FEB 29, 1932 ... MT VERNON DAILY HERALD

The mighty Skagit River, one of the largest in the west, went on a rampage over the weekend, crashed through the dikes in at least three places ..... A bad break in the dike south of Burlington sent a torrent of water westward down VARNEY SLOUGH, which overflowed, flooding some land. Water three and four feet deep covered the Pacific Highway (GARL STREET) in at least two places between the Riverside bridge and the Hanson Greenhouse. Traffic was cut off. The breaking of the dike caused a washout of the Great Northern railway tracks. The water from this break extended to north Avon and went as far as Whitney..... The river overflowed east of Burlington flooding scores of acres of land, but was prevented from entering Burlington by a high dike. VARNEY SLOUGH prevented water from entering Burlington on the south ..... Scores of men worked all night to save the dike which is southeast of the VARNEY SLOUGH bridge, but it was a losing battle. At about noon yesterday, the river tore a gap 200 feet long in the dike and within a few minutes the water was running westward in a raging torrent. It was not long until the Great Northern railway tracks were washed out for a short distance as the waters swept onward towards the Pacific Highway (GARL STREET) . As the water spread toward Burlington, it finally reached VARNEY SLOUGH and was diverted westward.

JAN 28, 1935 ... MT VERNON DAILY HERALD

Excitement during the high water reached its peak, at about 3:30 Saturday afternoon when Burlington residents prepared to "move out" when it was learned that the dike had collapsed near the Cleveland ranch, northeast of Burlington. Hundreds gathered at VARNEY SLOUGH, a short distance east of Burlington hospital, to watch the water as it roared down the passage..... The water reached within a few hundred feet of the hospital, but most of it raced down the SLOUGH, flooding a small section in the southern part of the town. It continued down VARNEY SLOUGH finally reaching the lowlands at North Avon.

JAN 31, 1935 ... MT. VERNON ARGUS

The largest of the breaks occurred northeast of Burlington when a portion of the dike road gave way. The water found its way into VARNEY SLOUGH and was slowly carried off by way of North Avon into the bay without much damage.

Historically speaking there have been seven floods go through GAGES SLOUGH since 1906 for an average of once every 11 years. 1906, 1909, 1917, 1921, 1932, 1935, and 1951.[72]

Pictures from a local historical book called SKAGIT SETTLERS TRIALS AND TRIUMPHS 1890-1920, Page 173, the caption by the top picture reads:

> "VARNEY was a station on the interurban between the Skagit River bridge and Burlington. Floods in 1917 and in 1921 broke the dikes below Sedro Woolley and washed out a large section of the track as it dug out the SLOUGH just north of Willards Greenhouse, sometimes called GAGES SLOUGH and sometimes VARNEY SLOUGH. This view is looking south along the tracks.

As I mentioned earlier the historical data as well as the following engineering and technological data could be used to answer or applied to many of the FLOODWAY NINE questions. Again because of time limits self imposed I'm going to just grab the highlights of each piece of evidence and just apply it to one question.

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[72] **1990 UPDATE:** On November 25, 1990, the Skagit River crossed Highway 20 and began flowing into Gages Slough. This would increase the average occurrence to once every 10.5 years.

IS GAGES SLOUGH A WATERCOURSE THAT CARRIES FLOODWATERS?

Department of Ecology letter dated October 5th, 1979:

> . . .The Department of Ecology considers GAGES SLOUGH as a floodwater conveyance system. This means it would be used for floodwaters during 100 year frequency floods or less.

Federal Emergency Management Agency letter dated June 10, 1983:

> Another key effective flow area is the GAGES SLOUGH which is a floodwater conveyance system consisting of lower ground throughout the city and into the county.

DOES GAGES SLOUGH SERVE AS A DRAINWAY?

According to the front page of the Skagit Valley Herald dated May 13, 1983, the Burlington City Council believes the slough is a "drainage area". One quote in the article reads:

> "The city of Burlington and the adjacent property owners have used the SLOUGH as a DRAINAGEWAY for many years."

GAGES SLOUGH Public Hearing June 14, 1978 7:30 PM Skagit County Commissioners at Burlington:

Mr Johnson (county engineer):

> "GAGES SLOUGH has been asset for a long time. The city of Burlington uses the County uses it for drainage, the State uses it well as many individuals.

County Commissioner Howard Miller:

> "I can remember as a kid, four or five years old, down here by the hospital, my uncle lived there and I used to go down that SLOUGH and watch the river run through there. And I always talked to a man who said he remembered when he used to bring shingle boats through there.....

Mr Bob Hulbert representing the Soil Conservation District:

> "...I have seen the slough function as an emergency water course during floods exceeding 155,000 cfs at Sedro Woolley and receive runoff from the City of Burlington and surrounding lands.

GAGES SLOUGH Public Hearing 25 July 1978, Burlington Wash., conducted by the Skagit County Commissioners.

Mr Don Nelson, (Flood Control Section Manager):

> "Looking at the SLOUGH, its been pretty well neglected from a hydraulic standpoint; the DRAINAGEWAY itself has become clogged with weeds and growth. Also there seems to be NO JURISDICTION over the SLOUGH since it existed, I suppose. And as a consequence things are done to it that shouldn't be done to a DRAINAGEWAY of this type. A great deal of people use this SLOUGH for their DRAINAGEWAY..... (the slough) is a NATURAL DRAINAGEWAY created by the Skagit River many, many years ago."

IS GAGES SLOUGH SUBJECT TO THE 100 YEAR FLOOD?

Skagit County Storm Drainage Management Plan dated August 1982, commonly referred to as the Brown and Caldwell report:

> "The GAGES SLOUGH watershed is part of the Skagit River floodplain and includes the cities of Sedro-Woolley and Burlington.

DO THE FLOODS HAPPEN WITH REASONABLE REGULARITY? IS GAGES SLOUGH REASONABLY PROTECTED FROM FLOODWATERS?

Back to the GAGES SLOUGH Public Hearing on the 25th of July 1978 page 20. Mr Lee Lindamood:

> "...I lived down there at the tail end of GAGES SLOUGH for practically all my life ... And I've seen the floods of 1909 and 1917, 1921, 1932, and 1934. And I had to learn to swim in every one of them."

Skagit River, Wash. General Design Memorandum Levee Improvements Volume One July 1979:

> "...levees could withstand flows corresponding to floods with probable recurrence ranging from once in 3 years to once in 14 years...".

U.S. Dept of Agriculture, Forest Service, River Management Analysis of Skagit River Vol 1, page 42:

> "...Existing flood control measures and structures mitigate potential flood damage somewhat, but maximum protection is only achieved for floods occurring at a frequency of once every 14 years.

Comprehensive Land Use Planning Alternatives For The Skagit River Floodplain and Related Uplands, page 107:

> "...The levee capacity in the Burlington area is only 108,000 cfs which is considered to be below minimal protection for urban areas..... page 110, "...dikes only provide protection from flows below 91,000 cfs to 143,000 cfs or 3 to 14 year flood frequency."

Coordination during Flood Insurance Studies, Community Assistance Series #2, published by the Federal Insurance Administration page 11. The chart proves that GAGES SLOUGH stands approximately a 90% or more chance of being inundated by floodwaters in any 50 year period of time.

DOES GAGES SLOUGH INFLUENCE THE SKAGIT RIVER?
DOES THE SKAGIT RIVER INFLUENCE GAGES SLOUGH?

Floodplain Information Study, Skagit River Basin, a Technical Report prepared by the US Army Corp of Engineers, page 18:

> "...Water escaping from the same reach of levee that was breached above Burlington in 1909 would flow through the city, follow the general course of GAGES SLOUGH, and flood the entire area between Bayview and Pleasant Ridges."

DO FLOODWATERS IN SLOUGH TRAVEL AT >0.5 MPH?

The significance of this question is that in a floodplain an area is considered either FLOODWAY or floodway fringe. According to the definition provided by the Skagit County Shoreline Master Plan the floodway fringe is limited to flood-surge storage of water currents moving at a negligible velocity of less than 0.5 mph.

According to the Norman Report (a hydraulic investigation for a proposed development in the GAGES SLOUGH area) GAGES SLOUGH will carry under existing conditions 17,000 cfs. and have a flow of anywhere between 2.7 and 22.4 feet per second. That translates

to between 1.8 to 15 mph depending on where you're at on the SLOUGH. Now I might add that I personally am not endorsing the Norman Reports figures, for I feel the report grossly understates the significance the SLOUGH plays however if you accept that data than you must designate the SLOUGH as a FLOODWAY.

While we have the Norman Report before us I'd like to draw your attention to the map on the wall. The map was prepared by an engineering firm in Washington DC called Dames and Moore. The areas highlighted in green represent high ground. When you transpose the information from the Norman Report onto the Dames and Moore map you can begin to see the significance that the SLOUGH plays. By the way, is there anyone on the planning commission that knows how much water 17,000 cfs represents? Well according to a Flood Insurance Study page 21, 17,000 cfs is a little more than twice the amount of water that just flooded the Samish River Basin last January.

And to show you the effects of allowing landfill development in and adjacent to FLOODWAY areas, that one proposed development will move approximately 60,000 gallons of water per second into and south of GAGES SLOUGH. 60,000 gallons of water per second is approximately the same amount of water that flooded the Samish River Basin last January.

One last piece of evidence. The Draft Environmental Impact Statement for the Burlington Annexation and Sewer Extension dated August 3rd,1979, Page 23:

> **"GAGES SLOUGH ALSO SERVES AS A FLOODWAY IN ANY EVENT GREATER THAN 145,000 cfs."**

The sum total of the information gathered to support the answers to the FLOODWAY NINE questions, without any doubt, supports the statement: GAGES SLOUGH is a readily identifiable, easily recognizable, historically proven, FLOODWAY. Since GAGES SLOUGH is a FLOODWAY, and since GAGES SLOUGH is a DRAINWAY, and since GAGES SLOUGH supports a WETLAND, MARSHLIKE habitat, and since GAGES SLOUGH is within the Skagit River 100 year floodplain, then GAGES SLOUGH is and deserves the status of a WETLANDS designation as required by law under the State of Washington Shorelines Management Act of 1971.

Ladies and Gentlemen of the Skagit County Planning Commission, designation of GAGES SLOUGH as a WETLAND because it is a FLOODWAY is not a violation of property rights. It is simply a statement of admission of existing conditions. To call GAGES SLOUGH by any other name than a FLOODWAY is to display a degree of arrogance and ignorance for the powers of mother nature. GAGES SLOUGH is a natural hazard that if left unnoticed will become an natural disaster. Thank you very much for your time and attention.

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Subsequent to the foregoing presentation, the Skagit County Planning Commission, Skagit County Commissioners, Burlington City Council, and the State Shoreline Hearings Board refused to designate Gages Slough as an associated wetland by virtue of the floodway functions the slough performs.

As late as April 1989, the Skagit County Comprehensive Flood Control Management Plan, prepared by the engineering firm of Brown and Caldwell, on behalf of the Skagit County Public Works Department on page 2-14 sub-chapter Location and Identification of Problem Areas states the following:

> Area No. 11: Channel change near Burlington, Section 34, Township 35 North, Range 4 East--Sharp bend just upstream and east of Burlington could cause a major channel change should a large flood of considerable duration occur.[73]

Gages Slough flows directly from this bend in the river. The report then goes on to state the following:

> Area No. 12: Gages Slough blocked drainageway, Township 35 North, Range 4 East--Gages Slough is probably an old channel of the Skagit River. Floodwater will enter this slough as State Highway 20 is topped. The effectiveness of this slough to carry floodwater is in question due to neglect, abuse, and undersized culverts. It would serve to help remove floodwater from the City of Burlington once the flood started to recede. With considerable work, Gages Slough could be improved both as a drainageway and floodway.[74] (Emphasis added.)

During the Thanksgiving Day flood of 1990, the mighty Skagit River once again began flowing into Gages Slough. This despite the efforts to block its course by the use of fill material and sandbags. This despite the fact that Skagit County's flood ordinance prohibits the placement of fill within the channel of Gages Slough. The flood, as this report documents, was a 25 year event.

Both Skagit County and the City of Burlington have designated Gages Slough as a "Special Flood Risk Zone" (SFRZ). Skagit County defines the SFRZ as an area within 500 feet of the centerline of the slough having a ground elevation which is three feet or more below the 100 year floodplain elevation.[75]

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[73] Skagit County Comprehensive Flood Control Management Plan, Brown and Caldwell, April 1989

[74] Ibid.

[75] Skagit County Flood Damage Prevention Ordinance No. 11888, Adopted December 28, 1988

KEY RIVER LEVELS[76][77]
(As measured from the Mount Vernon gauge.)

25 feet -- backwater in Nookachamps Creek, flooding of low-lying farmland. No damage.

27.6 feet -- no damage.

28.1 feet – water up to Francis Road on north side. Water begins flowing over Swan Road in Nookachamp Valley.

28.5 feet -- continued flooding of Nookachamps Creek, water over the old highway between Lyman and Hamilton.

30 feet – water over Francis Road bridge in front of Johnson Dairy.

30.3 feet -- beginning of flooding of Hamilton. Water over the road to Sedro-Woolley via Clear Lake. Overland flow of water east of Burlington on Fairhaven and on the north side of the river between Burlington and Sedro-Woolley.

30.4 feet – south end of Francis Road in the Nookachamps goes underwater. All evacuation by vehicles must take place before this level is realized.

31.4 feet -- Nookachamps area under water, levees below Mount Vernon subject to failure. Levee patrol underway.

33.8 feet -- flooding of Hamilton. After 24 hours, levee failure or overtopping throughout the valley. All valley bottom roads closed to all but essential traffic. Preparation of evacuation procedures. Boats and rescue crews standing by.

36.6 feet -- flooding of all valley bottom. Probable breaching of right and left of dikes at Avon Bend.

38.1 feet -- Maximum flood fighting effort throughout the valley.

Under potential flood conditions, emergency public announcements would be made over the county emergency broadcast station, KBRC.

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[76] Skagit Valley Herald, 12/10/79

[77] *Authors Note: All information in italics were provided by the Author, a former Nookachamps resident.*

FLOOD FACTS

Since 1900 and as of January 1, 1991, the Skagit River has reached flood stage 41 times for an average of once every 2.2 years. This figure is representative of only the floods that have been documented by Federal agencies. As pictures show within this publication there is evidence that more floods have occurred in years past that have not been documented by the federal government.

The Skagit River Basin drains approximately 3,133 square miles of land area. That's almost twice the size of the whole County. The drainage basin includes portions of Canada, Whatcom County, Skagit County, and Snohomish County.

The **100 yr flood** is a flood having a 1 percent chance of happening in any given year. During any 100 year period of time the 100 year flood has a 63% chance of occurring. During a 30 year mortgage a homeowner living in the floodplain has a 26% chance of experiencing a 100 year event.

The Skagit River 100 year flood is estimated to carry between 220,000 and 240,000 c.f.s.

One cubic foot of water per second (c.f.s.) is equal to 7.5 gallons of water. During the November 24, 1990 flood the Skagit River was carrying approximately 1,140,000 gallons of water per second. The Skagit River 100 year flood will be carrying 1,800,000 gallons of water per second.

One c.f.s. flowing for a 24 hour period will cover 2 acres to a depth of one foot. 130,000 c.f.s. (the estimated overflow through Burlington into the Samish River Basin) will cover 260,000 acres in a 24 hour period to a depth of one foot. There are only 60,000 acres below Sedro Woolley. Conceivably the Samish Basin could be inundated to a depth of about 4 feet.

An adult could not stand up in three-foot deep water running three feet per second.

The traditional flood season in Skagit County is from November through March.

ONE PERSONS OPINION

Up until this point, over 95% of the material contained herein, has been quotations obtained from government documents, transcripts of public hearings, technical reports, newspaper articles, and correspondence. This chapter is devoted entirely to opinions of this author and individuals that have chosen to comment. The views are entirely those of their authors

The following letter was sent to the following individuals:

Jess Knutzen
1183 Avon Allen Road
Burlington, WA. 98233

Bob Hulbert, Sr.
1727 Hulbert Road
Mt. Vernon, WA 98273

Howard Miller
423 Talcott
Sedro Woolley, WA 98284

Jack Wylie
2155 Wylie Road
Mt. Vernon, WA 98273

Angelo Brucas, Reporter
Seattle Times
PO Box 1909
Seattle, WA 98111

Dan Berentson, Editor
The Skagit Argus
413 Gates
Mount Vernon, WA 98273

Kari Ranten, Nancy Erickson
& Carl Molesworth, Editors
Skagit Valley Herald
1000 East College Way
Mt. Vernon, WA 98273

Mayor Dave Pocock
Burlington City Hall
900 Fairhaven
PO Box 288
Burlington, WA 98233

Mayor Ray Reep
Mount Vernon City Hall
320 Broadway
Mount Vernon, WA 98273

Congressman Al Swift
1502 Longworth House Office Bldg
Washington, D.C. 20515

Senator Pat McMullen
401B Legislative Building
Olympia, WA 98504

Representative Rob Johnson
John L. O'Brien Building
Room 338
Olympia, WA. 98504

Christine O. Gregoire, Director
Dept of Ecology
MS-PV-11
Olympia, WA 98504-8711

Mr. Terry Williams, Director
Tulalip Department of Fisheries
3901 Totem Beach Road
Marysville, WA. 98270

Joseph R. Blum, Director
Department of Fisheries
115 General Admin. Bldg.
Olympia, WA 98504

Skagit County Commissioners
County Administration Building
Mount Vernon, WA 98273

Colonel Milton Hunter
COE Seattle District
PO Box C-3755
Seattle, WA 98124

Walter Bergstrom &
Gregory Hastings
2101 South 324th Street #98
Federal Way, WA 98003

Dr. Fred T. Darvill
809 South 15th
Mount Vernon, WA. 98273

Mr. Charles Steele
FEMA
Natural & Technological Hazards
Region X
Federal Regional Center
130 228th Street, SW
Bothell, Washington 98021-9796

RE: SKAGIT RIVER VALLEY -- THE DISASTER WAITING TO HAPPEN

Dear Recipient:

You have just received a Final Draft copy of the above referenced book. The book is a compilation & documentation of the historical and technical data regarding the flooding of the Skagit River. The purpose of the book is to bring together all the necessary data known about the Skagit River in order to help find a solution to the all to frequent and sometimes disastrous flooding the river presents us with.

The reason the book is still in draft form is because I am soliciting your help in writing the last chapter. That chapter is entitled, "One Man's Opinion". It will consist of sub-chapters composed of solicited letters from elected officials, government agencies, news media, Indian Tribes and my two favorite entities, the "Old Men of the River", and the "Future Generations of the Valley".

The sub-chapter, "Old Men of the River" will be composed of letters from Skagit Valley gentlemen that have dedicated a large portion of their lives to flood control. I feel

that it is very important to preserve their thoughts for the future. For the "Future Generations" sub-chapter, I have solicited comments from elementary through high school students.

I am not soliciting your comments on whether you think I have compiled a good book or a bad book. What I am interested in is; what do you think should be done with respect to the proper management of the Skagit River Valley with respect to the flooding of the Skagit River? For responding government agencies, feel free to address flood plains in general for much of the information contained herein could be applied to flood plains across the nation. For elected officials of towns or cities, feel free to present a letter on behalf of your community from your respective city councils.

You should address your letters to The Present and Future Residents of Skagit Valley. Your letters should be type written, dated, and should begin with words to the effect:

> I have reviewed the book, "Skagit River Valley -- The Disaster Waiting To Happen", and based on the materials contained therein, and my own personal experience I offer the following comments.

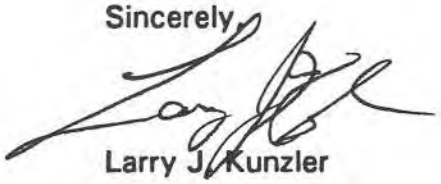
I give you my word that I will print your letters in their entirety with absolutely no editing whatsoever and you can consider this letter as a contractual agreement to that effect.

Currently I have no plans to charge anyone for this book. It will be made available, free of charge, to the general public, as a community service to the residents of Skagit Valley. If however, I am unable to achieve this goal, the only charge for the book will be those incurred in making copies. There will be no charge for my efforts or time. Tentatively, I plan on making 500 copies available. The book will also be donated to public libraries, public schools as well as government agencies from Skagit County, Olympia and Washington DC.

Please accept this letter as a formal request for your comments. As part of the "One Man's Opinion" chapter, I will publish this letter, along with the names of all those I have asked to comment, if all goes according to plan, by the end of March. Please have your letters back to me by the 15th of March. Please send them to Larry J. Kunzler, % Ferguson & Burdell, 1420 Fifth Avenue #3400, Seattle, WA. 98101-2339.

If you have any questions, please call me at 622-1711. I am looking forward to your reply.

Sincerely,



Larry J. Kunzler

PS. If you have any suggestions on how the book can be made better (additional information, different fonts, etc.), please address them under separate cover.

AUTHORS OPINION

May 1, 1991

To the Present and Future Residents of Skagit Valley:

The purpose of this book was to assemble all the known data about the Skagit River, present it in an orderly manner, and provide the reader with enough information necessary to formulate an opinion as to what must be done to address the destructive power that the Skagit River will, as sure as water is wet, one day again, as it has for over 13,000 years, unleash on the residents of Skagit Valley.

When one reviews all the material available about the Skagit River, one is immediately struck with a mountain of questions. Most important of which is, why. When you have local county commissioners, dike district commissioners, flood control committee members, editors of newspapers, local residents, and you have state and federal agencies, all stating in one form or another that the **SKAGIT RIVER IS A DISASTER WAITING TO HAPPEN**, why are we continuing to promote commercial, industrial and residential growth in such a hazardous/critical area? Why are we continuing to build in a flood plain that is susceptible to flooding once every 2.2 years?

The City of Burlington, currently zoned 34% commercial, 22% manufacturing, **32% single family and 12% multi-family residential**, has encouraged over five hundred new families to locate within their city with massive multi-family and single family housing projects within the last two years, with more on the drawing board. Burlington has also constructed large scale regional retail commercial projects, bringing in literally millions of cubic yards of fill material.

All but one of those projects lacked an Environmental Impact Statement (EIS) which could have analyzed flood flows. The one project EIS that did analyze flood flows (the Cascade Mall, located next to the well documented conveyance area, special flood risk zone, floodway called Gages Slough) stated that its project displaced over 8,000 cfs (60,000 gallons of water per second) into Gages Slough and to the land area to the south. Although I personally believe that analysis is much in dispute as to its accuracy, one can only wonder with the addition of so much landfill to support the additional commercial development to the south and east of the Cascade Mall, what has happened to the displaced water? Does it now flow through the center of town or does it now flow through the Bon Marche'? Has the impact of the land fill for the commercial development been to guarantee a channel change through the City of Burlington to the Samish River Basin as was referenced in the Skagit County Flood Control Management Plan (See page 65)? Have the existing land owners been adversely impacted by the commercial development as they have been by the construction of Interstate (Interwier) 5, in the form of receiving more flood waters in a greater velocity and depth then they would have without those developments? These types of questions beg legal and hydraulic analysis.

Legal Questions

Legal questions that must be answered in the immediate future include but are not limited to:

1. What is the legal responsibility of the Burlington City Council, Skagit County Commissioners, planning commissioners, city or county staff and dike district commissioners for allowing projects to be built in what has been labeled by the U.S. Army Corps of Engineers as the most potentially dangerous flood plain in the entire Pacific Northwest? Could they be held liable under the 1964 Civil Rights Act Section 1983?

2. If the course of the river is redirected by the artificial placement of fill material in the flood plain, does the City of Burlington, Skagit County, Department of Ecology, State Dept. of Transportation, dike districts, or the developers themselves, have any legal responsibility to impacted landowners?

3. If the answer to number 2 is yes then when would the statute of limitations begin to run? The day the projects were completed? The day the adverse effects were identified? Or the day after the flooding event?

4. Do the tenants of any of the commercial development have any legal responsibility for locating their businesses in projects that redirect flood flow paths?

5. During a flood fighting effort, if the City of Burlington or a state or county agency places sand bags or other fill material to stop the flood flows from traversing conveyance areas, thus keeping the Skagit River from its historical flow paths, do they have a legal responsibility to the property owners that suffer increased depths of water in their houses (ie Nookachamps, Clear Lake, Lafayette Road, Sterling Hill area residents)?

6. Has the state environmental policy act (SEPA) been violated by not taking into consideration the cumulative impacts of this landfill development? If so, who is liable? The state? The county? The City of Burlington? Or is it a combination of all of those?

7. If during a flood fighting effort, a high school student is taken to a levee and asked to stack sand bags over a seeping hole in the dike, and the dike breaks killing or injuring the student, is the dike district liable for damages?

8. Since the 1979 COE levee project identified the long term adverse impacts to certain areas within the Skagit River flood plain if the levees were raised, does the Skagit County Public Works Dept., Dike District 12 or the City of Burlington have any legal responsibility to those impacted land owners by allowing the levees to be built to the "50-year water profile level" (See page 8).

Hydraulic Questions

1. Will a two dimensional unsteady state hydraulic flow model of the lower valley give us any different information then was learned from the Dames & Moore 1982 study? If the answer is yes, what will that information provide and how could we apply it to potential development of the flood plain?

2. What is the hydraulic effect of blocking off Highway 20 on the communities of Clear Lake and Nookachamps? What is the effect of that action on the Burlington dikes?

3. If all levees in the lower valley are raised to the "50-year water profile level" what is the hydraulic effect on all the unleveed areas?

4. What effect has the commercial landfill in the Burlington area had on flood flows?

5. If the City of Burlington is allowed to "build out" to capacity, what effects on flood flows will that construction have if current building practices are followed?

6. If the State Dept. of Transportation is allowed to extend Highway 20, widen Interstate (Interwier) 5, and widen Highway 9, what will the cumulative effect of that construction have on flood flows?

7. If the dikes were removed from the edge of the river, how far would they have to be moved in order to provide 100-year, 50-year, 25-year flood protection?

8. Could certain dikes be removed/relocated (ie Fir Island, Cockerham Island, Riverbend Road) without significantly impacting the environment and at the same time provide greater flood protection to a majority of residents?

It is this authors opinion that all of these thought provoking questions deserve answers before any more construction takes place in the Skagit River flood plain.

As stated herein, "flooding is a fact of life in Western Washington". This fact, being accepted by this author, deserves looking in to what can be done on the Skagit River to prevent floods with flood control projects.

SAUK RIVER DAM

It is my opinion that there will never be a dam on the Sauk River, nor should there ever be. Besides being cost prohibitive, a legislative nightmare (its currently illegal), environmentally a disaster, simply put, it is impossible to build without flooding a large portion of Snohomish County and condemning hundreds of private residences. (See page 42). A fact that I doubt very seriously would seek much favor by Snohomish County residents. Any further study or discussion of this project is a complete waste of time. It should be summarily dismissed and we should move on.

DREDGING

For those that have not studied hydraulic principles of rivers, dredging offers the common sense approach to flood control. However, the truth of the matter is, dredging is to flood control what building sand castles below the high tide line is to affordable housing. While sand castles would provide a cheap means of affordable housing, every time the tide came in you would have to rebuild them. Dredging is along the same principle. While it would provide a level of protection the day you were done, the day after the next flood you would have to dredge it all over again.

Dredging for that reason is cost prohibitive, environmentally a disaster and will not work. Not to mention the relatively minor fact that dredging would undermine the existing levee system allowing the levees to fold into the river. No federal agency could provide funds for any dredging operation because you cannot dredge the river deep enough fast enough to provide 100 year protection for urban areas, a requirement of federal law. If dredging was allowed to any level of protection below that of 100 year protection it would only contribute to the false sense of security that is provided by the current system of levees.

Is the level of the bed of the Skagit River rising? You bet it is. Why is it rising? Because we have placed our dikes on the edge of the river thus not allowing the natural processes of silt distribution. That silt distribution is what built the 68,000 acres of the lower valley. It is my opinion that if the dikes were away from the edge of the river, the bed of the river would deepen by natural processes on its own.

LEVEES

Levees placed on the edge of a river are to flood control what school yard playgrounds built over hazardous waste dumps are to public safety. They provide nothing more than a public sense of false security. As was stated herein by one government official, during a 100 year flood we would be better off without the levees (See page 8). Dike districts over the years have created a monster that will some day claim human life in the lower valley.

The catastrophic effects of a dike break has been well documented by what happened on Fir Island during the 1990 flood or on Cockerham Island during the 1979 flood or by the picture showing Nat Moores house during the 1909 flood.

As documented herein, the levees cannot be raised without having long term adverse impacts in the form of additional depths of flooding on several areas within the Skagit River floodplain. Although I only reported in this book on the effects of what was known as project 3e there were other levee projects which would have raised the level of flood waters over 4 feet in the Nookachamp Clear Lake communities. Raising all the levees to the 100 year flood level is not the solution nor has it ever been.

AVON BY-BASS

In my opinion, this project is the only flood control project that warrants any merit of re-examination. As expressed by the words of my son, "We should give the river a place to go". It is the only project that is environmentally feasible for we would in effect be creating an 8 mile long lake with associated wetlands. Fish enhancement programs could be installed as part of the project.

It is the only project that would enhance the local economy (60,000 tourist a year would spend a lot of money) not to mention the effects of not having to worry about floods any longer. The by-pass is the only project that would treat farming, business, urban and rural communities as equals. Granted, it would do nothing for the upriver communities of Hamilton, Lyman or Concrete, but neither will any of the other projects. As one other person has stated within the confines of this book, what you end up with (in some areas) is having to live with mother nature. That statement is very applicable to the upriver communities. Simply stated, there are some areas where no human habitation should be allowed. "See mud on tree. Build higher." The simplicity of that statement is only matched by its truth.

The only drawback that I can see at this writing would be one of cost. Estimated at an educated guesstimate of around 150 million to 200 million dollars. I might also add, that after this project has its examination, the voters of Skagit County should be asked for their blessing before any elected official could commit to its construction. If the people of this valley want "FLOOD CONTROL" then in my opinion this is the only project that will work.

FLOOD PLAIN MANAGEMENT

In the alternative, if flood control is not feasible either because of cost, environmental concerns, or public acceptance, then flood plain management is the only feasible alternative left. This, again in my opinion, can only be accomplished with the performance of a two-dimensional, unsteady state flow model hydraulic analysis of the lower valley. It is my belief that such a study would identify flood flow paths and we then could justify strict zoning regulations which would prohibit certain types of construction (ie anything involving land fill) in those areas.

Once the study was completed we also, by using state of the art computer analysis, could determine areas that we could move the levees away from the edge of the river. Such areas would include but not limited to, the riverbend area in Mount Vernon, Fir Island, anywhere there is an open field in Burlington, and South Mount Vernon. While this approach may not stop the flooding (nothing is going to do that) it would certainly lessen the effects of the flooding. I believe as previously stated, it would also contribute to deepening the channel by natural processes.

CONCLUSION

For the record I would like to state that the labor I have expended on the writing of this book has indeed been a labor of love. It is a fine line between dedication and obsession. Sometimes it is hard to tell the difference. Having been a veteran of three flooding events, (1975, 1979 and 1980) I know first hand the traumatic effects of floods and emotional scars that they can leave you with. However, I also realize that we as mere mortals cannot stop the courses of nature. Trying to stop floods is like trying to stop Mt. Baker from erupting. All of our efforts in years past have only worsened the situation at hand. That old butter commercial that stated, "Its not nice to fool with mother nature" is very applicable to flood plains.

The following are my recommendations:

1. Conduct a two dimensional unsteady state hydraulic flow model of the lower valley. Use the results to formulate a comprehensive flood control management plan and begin to implement the plan immediately.

2. Re-examine the Avon By-Pass proposal.

3. Where feasible move the levees off the edge of the river. This would create natural areas for the deposition of silt material that could either be plowed into the ground or removed during summer months.

4. Quit spending money in areas that should be allowed to flood (ie Cockerham Island). Buy those people out and let it flood, it's going to anyway.

5. Put a new flood gauge on the Sedro Woolley bridge.

6. Adopt a zero rise floodway in the lower valley.

7. Dissolve/consolidate the dike districts and put the entire responsibility of river management under County authority.

Putting dams on rivers has depleted our salmon runs to the point of extinction. Putting levees on the edge of rivers is like putting a time bomb next to your bed and going to sleep. There is no doubt that the Skagit River is a ticking time bomb and most importantly, **A DISASTER WAITING TO HAPPEN**. The only thing that we can control is how bad the disaster will be. If we continue to ignore mother nature by building irresponsible commercial and residential development in our flood plains, we are not part of the solution, we are part of the problem.

Sincerely;

Larry J. Kunzler
Skagit County Resident

OLD MEN OF THE RIVER

The following individuals were asked to comment on the book and the flooding of the Skagit River in general:

Former County Commissioner Jess Knutzen **Member of the Flood Control Committee**	**FAILED TO RESPOND**
Bob Hulbert, Senior **Member of the Soil Conservation Service** **and the Flood Control Advisory Committee**	**FAILED TO RESPOND**
Former County Commissioner Jack Wylie	**FAILED TO RESPOND**
Former County Commissioner Howard Miller	**SEE ATTACHED LETTER**
Dr. Fred T. Darvill	**SEE ATTACHED LETTER**

In addition the Skagit County Flood Control Advisory Committee was asked verbally to comment. They **FAILED TO RESPOND.**

March 14, 1991

TO: The Present and Future Residents of Skagit Valley

FROM: Howard A. Miller

Re: Skagit River Valley - The Disaster Waiting to Happen

I have reviewed the book, "Skagit River Valley - The Disaster Waiting to Happen", and based on the materials contained therein, and my own personal experience, I offer the following comments:

I like your bobk. You have gathered all the available data in one book and made it easy to understand.

My thoughts on river management are: Heavy rock rip rap should be placed on the bends to keep the river in it's channel and stop the erosion. The levees should be made higher and stonger and they should be farther from the river to give it more room in flood times. Dredging is not feasible except gravel should be removed from the river by Highway 9 bridge and used for construction work, etc. This would help keep the lower river bed from rising. It would not harm fisheries if done correctly.

The Avon by-pass is not a good solution. It would be foolish to spend our tax money to try to solve the flood problem within 5 or 6 miles from the bay after the flood had damaged the whole upper valley.

Building should not be allowed in low areas.

Howard A. Miller

FRED T. DARVILL JR., M.D., F.A.C.P.
DIAGNOSIS AND INTERNAL MEDICINE
809 SOUTH 15TH STREET
MOUNT VERNON, WASHINGTON 98273

TELEPHONE - AREA CODE 206 - 424-0311

March 12, 1991

Present and Future Residents of Skagit Valley:

I have reviewed the book, "Skagit River Valley, The Disaster Waiting To Happen" and based on the materials contained therein and my own personal experience I offer the following comments:

The answer is clearly not flood control dams on the Sauk River or any other tributary of the Skagit. The cost would be prohibitive, the environmental destruction substantial, and it is most unlikely that Congress would remove any of the tributary rivers from Wild and Scenic River designation; dams are prohibited on Wild and Scenic Rivers.

Restricting clear-cut logging within the Skagit River drainage, particularly adjoining the river and its tributaries, will slow runoffs in times of heavy precipitation. Old growth forest is a sponge which soaks up water and releases it slowly. Logged areas release water rapidly, along with substantial amounts of silt and other debris.

Effective immediately, new residential and commercial construction within areas highly prone to flooding, such as Hamilton and Fir Island, should be prohibited. This could be accomplished by a change in County zoning. Funds currently used to protect these areas from the extraordinary flood (ie: 25 year or greater) should be used to buy out currently existing commercial and residential structures within these areas. Available funds could be better used for this purpose than to attempt to prevent damage to these areas from a major future flood; there probably is no way to do that!

With the removal of each structure from a area of inevitable future flooding, property loss would be pregressively minimized and the likelihood of flood caused death and injury would be significantly less.

I understand there is presently a proposal to tax the entire county for funds to be used for flood control measures. Whether it is fair to penalize the majority of us, who had the wisdom and foresight not to build businesses or residences in flood prone areas, with an additional tax burden is a question, I feel, that should be submitted to the voters for their approval or disapproval.

Sincerely yours,

Fred Darvill

F.T. Darvill, M.D.

FTD:ks

GOVERNMENT AGENCIES

The following government agencies were asked to respond:

Federal Emergency Management Agency	**SEE ATTACHED LETTER**
U. S. Army Corps of Engineers	**SEE ATTACHED LETTER**
Washington State Dept. of Ecology	**SEE ATTACHED LETTER**
Washington State Dept. of Fisheries	**SEE ATTACHED LETTER**

Federal Emergency Management Agency
Region X
Federal Regional Center
130 228th Street, S.W.
Bothell, WA 98021-9796

April 17, 1991

Mr. Larry J. Kunzler
Boyle and Gates
2 Union Square
601 Union Street
Seattle, Washington 98101

Dear Mr. Kunzler:

Thanks for the opportunity to review your publication **Skagit River Valley -- The Disaster Waiting to Happen**. This is a marvelous book about a difficult, most unusual piece of geography, one that deserves the kind of attention you have given it.

The main value of your book is that it pulls together so many thoughts and ideas from so many sources. To my knowledge, no document has as comprehensively related all that has happened on the subject of flooding in the Skagit Delta, as yours. While the book does not offer any absolute solutions, all the necessary thoughts are there, to assist the reader in formulating his or her own opinions.

It is clear in a reading of your book that the Skagit Delta is an extremely unique geographic place, one that defies conventional analysis. In fact, that is one of my major themes in writing this to you. During the Flood Insurance Study phase (that lasted from 1976 to 1984), trying to define flooding in the Delta through the only tools available to us in this business, was a constant source of frustration.

What we ended up with on the floodplain maps for the Lower Skagit, was nothing to plaster technical journals with. It was a compromise, between the need to assure a high enough level of awareness of the potential flooding danger almost everywhere in the Delta, and the need to be fair to those who live there and wish to continue to do so, such as by constructing new buildings.

In other words, the Skagit defied conventional floodplain definition. The compromise is depiction of a floodplain that is so large that one flood could not cover such an area, but flood elevations that are probably understated for those areas where breakouts will occur (like Fir Island), and floodwaters will want to reclaim. It was analyzed in this way because of the nature of this stream, that is perched in some places higher than its surrounding land, and where waters escape, not to return to their channel like normal floodwaters in normal rivers (analyzed through normal methods).

In summary, the floodplains we defined were as good as we thought we could do. With bigger budgets, methods that are perhaps better (such as two-dimensional modeling) could have been employed; but there is not consensus that the product would have looked any different, even with a vastly higher expenditure.

I would hope there could be a comprehensive analysis done in the Delta some day, that would factor in the many dynamic things we all know are happening; things like greatly increased urbanization, increased logging in the watershed, increased sedimentation in the channel, etc. Only a comprehensive look at these factors, coupled with a new look at floodplain delineation, would suffice for this most important and special area.

Again, my thanks for the opportunity to review this excellent document. It is very well written, has good graphic attraction and should be made available for all to read and learn about the potential hazards in the Delta. Your efforts to bring the many thoughts of those who have cared through the years, are deeply appreciated.

Sincerely,

Charles L. Steele, Chief
Natural and Technological
Hazards Division

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX -3755
SEATTLE, WASHINGTON 98124-2255

REPLY TO ATTENTION OF

APR 2 1991

Planning Branch

Mr. Larry Kunzler
c/o Ferguson & Burdell
1420 Fifth Avenue
#3400
Seattle, Washington 98101-2339

Dear Mr. Kunzler:

We have reviewed the book "Skagit River Valley - The Disaster Waiting to Happen" and offer the following comments.

Skagit River basin suffered considerable damage in the two floods occurring in November 1990. This office was involved as were many other agencies in providing assistance to prevent flood damages. The work of repairing levees damaged in these two floods continues to restore the level of protection previously afforded.

Your book contains an interesting and provocative collection of articles, quotes and data which suggests that more needs to be done to reduce the damage from flooding in Skagit County. I agree that more needs to be done. My staff and I are continuing to meet with elected officials and agency representatives to define an appropriate future course of action. This office strongly supports a comprehensive planning effort to define a responsible flood plain management and flood control project for the Skagit River Valley.

I appreciate the effort you have made in collecting and organizing the data on flooding in the Skagit River. I believe your effort will be instrumental in helping to focus attention on a serious problem that needs to be solved. Thank you for the opportunity to preview your book.

Sincerely,

Milton Hunter

Milton Hunter
Colonel, Corps of Engineers
District Engineer

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

Mail Stop PV-11 • Olympia, Washington 98504-8711 • (206) 459-6000

March 26, 1991

Dear Present and Future Residents of Skagit Valley:

Department of Ecology staff from the Floodplain Management Section have reviewed the book, "Skagit River Valley -- The Disaster Waiting to Happen." We offer the following comments:

This subject is particularly timely in 1991 since the state of Washington has recently experienced one of the most devastating floods in many years. This flooding affected not only the Skagit River Valley, but many other drainage basins across the state.

The topics covered in this book are thought provoking and address, in varying levels of details, many of the elements contained in a comprehensive floodplain management program.

The Department of Ecology, along with many other federal, state and local agencies, is making an increased effort to reduce flood damages in the state of Washington. One of the ways we feel this can be accomplished is through comprehensive planning.

This book and other documents that compile facts and information about flooding and flood damages serve as a framework for developing comprehensive plans.

We appreciate the opportunity to review this book and hope that it will contribute to the future reduction of flood damages in the Skagit River Valley.

Sincerely,

Carol Jolly

Carol Jolly
Assistant Director
Water and Shorelands

CJ:dll

JOSEPH R. BLUM
Director

STATE OF WASHINGTON
DEPARTMENT OF FISHERIES
115 General Administration Building, M.S. AX-11 • Olympia, Washington 98504 • (206) 753-6600 • (SCAN) 234-6600

July 1, 1991 -

Mr. Larry Kunzler
1420 Fifth Avenue, #3400
Seattle, Washington 98101-2339

Dear Mr. Kunzler:

Thank you for allowing us to review the draft copy of your book "Skagit River Valley - The Disaster Waiting To Happen". It is obvious this has been a labor of love for you and you have done an excellent job. You have gathered many historical documents from widely scattered sources which will aid in the review of whatever solutions are proposed for Skagit Valley flooding.

The November floods in 1989 and 1990 make it very clear many Skagit County residents live in harms way. People along the Sauk River, in Hamilton, Cape Horn, Thunderbird, Shangri-La, Cockerham Island, and Fir Island know that all too well. Many others in the lower valley who are "protected" by dikes may become complacent that their homes and businesses are safe. However, dike failures at Fir Island are a drastic reminder that being safe may not be possible on the Skagit River floodplain.

Yet, people continue to be allowed to build subdivisions, and shopping malls. Local governments control development, and the decision is clear in their mind that perceived benefits to the local economy outweigh the risks incurred in further building in the floodplain. As you discuss in your book, when, not if, the river breaks through upstream of Burlington, there will be damage which will make that which was suffered in the last two years seem small in comparison.

What is the solution to the Skagit flooding? Are more dams necessary? Is the river below SR 9 filling in with sediment? Should the river be dredged? Should all eroding banks be armored? Should a bypass be built? Should dikes be raised, moved further back, or built further upriver in places where none now exist? Are the flooding problems great enough to warrant major changes or structures? If the public is dissatisfied with how flooding occurs or how the river is managed, then a serious, comprehensive study is required to at least answer the questions raised. The

general reaction to a study is often, "We don't need any more studies, we just need to go do something!" To just go do something will involve potentially wasting tens to hundreds of millions of dollars of public money, potentially making flooding worse for others, and resulting in drastic, unnecessary damage to the public's fisheries resource. Any serious changes in river policy or structure will require an environmental review on the federal, state, and local level. The Washington Department of Fisheries will be deeply involved with this review, and with any subsequent permitting should major structural changes be proposed.

Again, thank you for the opportunity to review your book; your work is appreciated, and useful.

Sincerely,

Joseph R. Blum
Director

NSD:KB:dmm

NEWS MEDIA

The following news media entities were asked to comment:

Skagit Valley Herald	**SEE ATTACHED LETTER**
The Skagit Argus	**FAILED TO RESPOND**
The Seattle-Post Intellingencer	**FAILED TO RESPOND**

Skagit Valley Herald

1000 E. COLLEGE WAY POST OFFICE BOX 578 PHONE OR FAX: (206) 424-3251
MOUNT VERNON, WASHINGTON 98273 1-800-562-2010 IN WASHINGTON STATE

Leighton P. Wood, Publisher

March 12, 1991

Larry J. Kunzler
c/o Ferguson & Burdell
1420 Fifth Avenue #3400
Seattle, WA 98101-2339

Dear Mr. Kunzler:

Thanks for giving us the opportunity to see your draft of "Skagit River Valley: The Disaster Waiting to Happen." You've obviously spent a great deal of time and effort researching and writing this manuscript.

Though we applaud your dedication to this project, it would be inappropriate for us to participate with entries to include in the book. Neither would we be in a position to support its publication. I'm sure you'll understand that as a newspaper this is not our role.

Best of luck in your project.

Sincerely,

Nancy Erickson

Nancy Erickson
Executive Editor
The Skagit Valley Herald

NGE/lmb

ELECTED OFFICIALS

The following elected officials were asked to comment:

Mayor Dave Pocock — **FAILED TO RESPOND**
Burlington Mayor

Mayor Ray Reep — **FAILED TO RESPOND**
Mt. Vernon Mayor

U. S. Congressman Al Swift — **FAILED TO RESPOND**
Democrat

Senator Pat McMullen — **FAILED TO RESPOND**
Democrat

Representative Rob Johnson — **FAILED TO RESPOND**
Democrat

Skagit County Commissioner Ruth Wylie — **FAILED TO RESPOND**
Democrat

Skagit County Commissioner Robbie Robinson — **FAILED TO RESPOND**
Democrat

Skagit County Commissioner Bill Vaux — **FAILED TO RESPOND**
Republican

EPILOGUE

"THE SHINING WATER THAT MOVES IN THE STREAMS AND RIVERS IS NOT JUST WATER BUT THE BLOOD OF OUR ANCESTORS. IF WE SELL YOU OUR LAND, YOU MUST REMEMBER THAT IT IS SACRED, AND YOU MUST TEACH YOUR CHILDREN THAT IT IS SACRED, AND THAT EACH GHOSTLY REFLECTION IN THE CLEAR WATER OF THE LAKES TELLS OF EVENTS AND MEMORIES IN THE LIFE OF MY PEOPLE. THE WATER'S MURMUR IS THE VOICE OF MY FATHER'S FATHER. THE RIVERS ARE OUR BROTHERS, THEY QUENCH OUR THIRST. THE RIVERS CARRY OUR CANOES, AND FEED OUR CHILDREN. IF WE SELL YOU OUR LAND, YOU MUST REMEMBER, AND TEACH YOUR CHILDREN, THAT THE RIVERS ARE OUR BROTHERS, AND YOURS, AND YOU MUST HENCEFORTH GIVE THE RIVERS THE KINDNESS YOU WOULD GIVE ANY BROTHER."

CHIEF SEALTH'S PARTING WORDS

GLOSSARY OF TERMS[78]

100 yr flood. A flood having a 1 percent chance of occurring in any given year.

Channel. A natural or artificial watercourse of perceptible extent, with definite bed and banks to confine and conduct continuously or periodically flowing water.

Cold Front. The forward edge of a mass of cold air intruding into an area of warmer air. The cold front forces the warmer air aloft, where its moisture cools, condenses and forms rain.

Crest. The highest value of the stage or discharge attained by a flood; synonymous with Flood Peak, thus peak stage or peak discharge.

Cubic Feet Per Second (c.f.s.). A unit of measure for the rate of discharge of water. One cubic foot per second is the volume of water passing a given location in one second. One cubic foot of water is equal to 7.5 gallons of water.

Discharge. The volume of water passing along a stream per unit of time, such as cubic feet per second.

Divide. A ridge or hump dividing the direction of surface runoff.

Drainage Area. The area (acres, square miles, etc.) from which water is carried off by a drainage system.

Drainage Basin. That portion of the surface of the earth which is drained by a river and its tributaries, or which is occupied by a permanent body of water (lake, pond, reservoir) and all of its tributaries.

Duration. The period of time in minutes or hours in which rainfall of a certain intensity (inches per hour) occurs, or the period of time in which a river is above zero damage or major damage stage.

Fill. An earth embankment, i.e., a levee, highway, building foundation, or other raised area. The purpose of a fill may be to confine streamflow, raise ground surfaces above the waterline, or simplify transportation. **All fills on flood plains create obstructions to some degree.**

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[78]Sources used for the following definitions included the following: Flood Plain Information Study, Skagit River Basin, Washington, Technical Report, U.S. Army Engineer District, Seattle, Washington, April 1967; Skagit River, Levee & Channel Improvements, Public Brochure, Seattle District, Corps of Engineers, March 1978; Example Flood Damage Prevention Ordinance, Federal Emergency Management Agency, 1985; Skagit County Flood Damage Prevention Ordinance No. 11888, Adopted December 28, 1988; King County Sensitive Areas Ordinance No. 9614, adopted August 29, 1990

Flood. A flood is commonly interpreted as the temporary overflow of lands not normally covered by water, but which are used or usable by man when not inundated.

Flood Damages. Flood damages usually are classified as tangible or intangible. Tangible damages are the replacement costs or monetary loans resulting from the effects of floodwater and debris on crops, soil, buildings, furnishings, goods, roadways, utilities and levees; the added costs of protective efforts, evacuation and emergency care; and losses because of the interruption of commercial activities. Intangible damages are those which are difficult to measure in dollars, such as harm to life and health, inconvenience and discomfort.

Flood Damage Stage. Generally comparable to "flood stage", but may be somewhat higher or lower than official flood stage designations; refers to the stage in a stream at which damage becomes significant at any specified location, whether caused by overflow or other causes.

Flood Duration. Generally, the total length of time the stream is above "flood stage"; however, the term "flooding duration" may be used top designate the length of time a flood stage equals or exceeds any specified stage.

Flood Plain. The relatively flat, low lands adjoining a watercourse or other body of water subject to overflow.

Flood Plain Regulations. A general term applied to the full range of codes, ordinances and other regulations pertaining to land uses and construction within flood plains.

Flood of Record. This is the highest level or biggest flood over the period of record.

Flood Stage. A term commonly used by the U.S. Weather Bureau and others to designate the stage on a fixed river gage at which overflow of the natural stream banks begins to cause damage.

Flood Volume. The total volume of runoff during a flood, which is equal to the average rate of flow multiplied by time (flood duration). The term "inches runoff" is sometimes used to designate flood volume, which means that the flood volume would cover the drainage area above the point of measurement to a uniform depth equal to the number of inches specified.

Floodway. For purposes of the National Flood Insurance Program (NFIP), a floodway is defined as the channel of a stream, **plus any adjacent flood plain areas,** that must be kept free of encroachment so that the 100-year flood can be carried without increasing the flood heights by more than 1.0 foot. This concept was designed for typical river valley situations, where the channel represents the lowest point in the flood plain and the most effective conveyance area is immediately adjacent to the channel.

Freeboard. Additional height of a levee above the design height to provide a factor of safety in the design.

Hydraulics. The analysis of water or other liquid in motion, and its action.

Hydrology. The scientific analysis of rainfall and runoff, its properties, phenomena and distribution.

Left Bank. The land area to the left, adjacent to the river channel, looking downstream.

Levee. An embankment constructed on the flood plain for the purpose of confining large flows to a comparatively narrow floodway while protecting the remainder of the flood plain from inundation. Similar structures built to protect lowlands from high tides or to give partial protection to a portion of the flood plain are usually called "dikes".

Low Water Channel. That portion of a natural floodway within which a river is usually confined the greater part of the year, marked by definite banks and commonly referred to as the river channel or streambed. The low water channel is inadequate to carry the runoff from heavy rainfall or snowmelt.

Obstruction. An object or condition in a river channel or flood plain which retards or impedes the flow of water. All construction within the flood plain creates an obstruction to some degree. Examples, are fills for buildings, roadways or bridges, utility intakes or outlets and levees.

Right Bank. The land area to the right, adjacent to the river channel, looking downstream.

Runoff. Surface water resulting from rainfall or snowmelt that flows overland to streams, usually measured in acre-feet (the amount of water which would cover an acre one foot deep). Volume of runoff is frequently given in terms of inches of depth over the drainage area. One inch of runoff from one square mile equals 53.33 acre-feet.

Stage. The water-surface height of a stream, usually registered in feet and tenths of a float on a fixed staff gage.

Storage. Water naturally or artificially stored in surface or underground reservoirs.

Valley Storage. Natural storage of flood water in adjacent areas when a stream overflows its banks, measured in acre-feet.

Watershed. The area drained by a stream system.

Zero Damage Stage. Usually considered the same as bankfull stage, the height at which the river is just beginning to overtop its banks.

Zero-rise floodway. Means the channel of the stream and that portion of the adjoining floodplain which is necessary to contain and discharge the base flood flow without any measurable increase in flood heights. A measurable increase in base flood height means a calculated upward rise in the base flood elevation, equal to or greater than .01 foot, resulting from a comparison of existing conditions and changed conditions directly attributable to development in the floodplain. This definition is broader than that of the Federal Emergency Management Agency floodway, but would always include the FEMA floodway. The boundaries of the 100-year floodplain as shown on the Flood Insurance Study are considered the boundaries of the zero-rise floodway unless otherwise delineated by a special sensitive areas study.

Zoning. The division of an entire area, such as a county or municipality, into zones, with the type of construction and use allowable in each zone fixed by law. Zoning is carried out under the provisions of a State zoning enabling law.

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