SKAGIT RIVER · WASHINGTON

LEVEE IMPROVEMENT

PUBLIC BROCHURE
JUNE 1979
DRAFT 2

Forest Brooks, Study Manager 206-764-3621
Seattle District, U. S. Army Corps of Engineers
P. O. Box C-3755, Seattle, Wa. 98124

EXHIBIT 1

AGENCIES AND GROUPS PARTICIPATING IN STUDY

	Responded to March 1978 Brochure	Commented at March 1978 Meeting	Responded to December 1978 Studygram	Other Participation
LOCAL				
Skagit County				
Commissioners	X	X	X	X
Public Works	X	X	X	X
Planning				X
Conservation District			X	X
Farm Bureau		X		
Flood Control Council		X		X
Regional Planning Council		X		X
Public Utility District				X
Port		X		X
Whatcom County	X			
Snohomish County				X
Anacortes				X
Burlington		X		X
Concrete				
Hamilton	X			X
Lymen				
Mount Vernon		X		X
Sedro Woolley		X		X
Nooksack	X			
Puget Sound Air Pollution Control Agency				
Olympic Air Pollution Control Agency				
Northwest Air Pollution Control Agency				
Diking Districts	X	X	X	X
Drainage Districts	X	X	X	X
Granges				
STATE				
Senator Lowell Peterson				
Representative Duane Berentson				
Representative Jerry Vrooman		X		
Dept. of Agriculture				
Dept. of Commerce & Economic Development				
Dept. of Ecology				X
Dept. of Emergency Services			X	
Dept. of Fisheries				X
Dept. of Game				X
Dept. of Labor and Industries				
Dept of Natural Resources	X			X
Dept. of Social & Health Services				
Dept of Transportation	X		X	X
Ecological Commission				
Interagency Committee for Outdoor Recreation				
Office of Archeology and Historic Preservation				X
Office of Community Development				
Office of Indian Affairs				X
Office of Program Planning and Fiscal Management				

	Responded to March 1978 Brochure	Commented at March 1978 Meeting	Responded to December 1978 Studygram	Other Participation
ORGANIZATIONS AND FIRMS				
American Canoe Association	X			
Audubon Society				
Burlington Northern	X			X
Chamber of Commerce				X
Environmental Affiars Commission				
Evergreen Land Trust			X	
Evergreen Legal Services				X
Federation of Western Outdoor Clubs				
Friends of the Earth				
Izaak Walton League				
League of Women Voters				
Marine Construction & Dredging			X	
Milwaukee Road				
North Cascades Conservation Council				
Northwest Fisheries Association				
Northwest Steelheaders				
Pacific Northwest Trail Association	X		X	X
Pacific Northwest Travel Association				
Pacific Northwest Waterways Association			X	
Paddle Trails	X			
Puget Sound Power & Light Co.	X			X
Seattle City Light			X	X
Sierra Club				
Skagitonians Concerned About Nuclear Power		X		
Skagit System Cooperative				X
Small Tribes of Western Washington			X	
Steelhead Trout Club of Washington				
Stokley - Van Camp				
Swinomish Tribal community				X
University Canoe Club	X			
Upper Skagit Tribal Council				
Washington Environmental Council		X		X
Washington Kayak Club	X			
Washington Sportsmans Council				
Washington State Grange	X			
Washington State Historical Society			X	X
Wilderness Society				

COMMENTS AND QUESTIONS

The following questions and comments were received from individuals and groups in response to the previous public brochure and studygram, at the public meeting and the public workshop, and by letters or other means.

QUESTIONS AND COMMENTS	ANSWERS AND RESPONSES
General	
Correct public brochure to indicate that the Secretary of Agriculture has not made a decision on the impact of the Skagit Nuclear Power Plant on the Wild and Scenic River proposal (Puget Sound Power and Light).	A verbal correction was made at the March 1978 Public Meeting. Subsequently, the Secretary of Agriculture determined that the Nuclear Power Plant would not impact the Wild and Scenic River proposal if certain modifications were incorporated into the design.
Correct public brochure to indicate that during a flood the River District Office of the National Weather Service issues bulletins about impending flood flows to county officials and news media. (National Weather Service).	A verbal correction was made at the March 1978 Public Meeting.
Need careful cost-benefit analysis of alternatives with evaluation of impact to fisheries (Washington Environmental Council, Evergreen Legal Services). Provide average annual values so that alternatives can be compared (Seth Seigal). Need more details to make judgement (Skagitarians Concerned About Nuclear Power). Areas where flooding would be increased should be shown. Induced damages should be quantified.	Agree with comments. This information was developed as part of our studies.
One big problem with Diking District Commissioners is how much right-of-way will be required. (Skagit Co. Farm Bureau). Property owners can't afford to lose a large part of their property for minimal compensation (Eunice Summers)	We note your concerns. One of the criteria in designing the improved levee system was to utilize the existing levee system to the greatest extent feasible which will reduce the additional land required for the new levee.
Coordination should be maintained with the State (Representative Vrooman)	Coordination with the State has been continuous.
What are the choices regarding level of protection for a town?	Under Corps criteria the minimum level of protection appropriate for an urban town is 100-year. Higher levels of protection should be provided, up to a standard project flood, if justified by the benefits received.
Why isn't there a better flood warning system for the valley? (Helen Day)	Following this comment at the March 1978 Public Meeting, Skagit County refined their plan for flood emergencies and set up a special telephone number where residents can receive recently updated information during a flood.
I am very interested in flood control - in the last 3 years we have had to sandbag the levee twice. (Robert Lynch)	The proposed project will eliminate the need to sandbag the levee during most floods.
What is the funding outlook? (Richard Smith) Why spend Federal money for flood control when the County is permitting unwise practices - houses on top of dikes, logging to the stream edge, housing in minor flood areas, Burlington annexing and building in sensitive areas? (Margaret Yeoman)	Funds for construction are dependent upon inclusion by Congress in the annual budget.

W[illegible]ys for damage caused by raising the dike? [illegible]adbois)

As part of the tentatively selected alternative, structural and non-structural measures have been included to minimize or eliminate any induced damages which a resident would have incurred due to the project. This would include raising and/or floodproofing residential structures for a 100-year flood. The costs would be shared between the Federal government and the local sponsor 80% - 20%.

When is the final decision on the project?

For a project to be constructed, the County Commissioners must continue to support the plan. Congress must authorize modifications to the project authorized in 1966, and must appropriate money to carry out the construction.

Can Skagit County handle maintenance responsibilities (Burlington Northern). Who is going to raise the floodwalls during floods.

As part of the local cooperation requirements Skagit County must agree to operate and maintain the entire project. The County could set up agreements with the cities or diking districts for portions of the work, but the County would retain the responsibility to do it.

Tidal Effects - Dredging - Sedimentation

How far upstream does tide affect the water surface? (Allen Doss, Sophie Newhall) What good does it do to raise dikes, since at high tide the water can't get away? (Allen Doss)

The tidal effect extends to about the Forks of the Skagit River.

L[illegible] dredge the river mouth and make more farm-[illegible]ith the dredged material - like in Holland ([illegible]atta Pearson). Dredging the lower river and delta channels would eliminate need for more levees on Fir Island (Duke Hayduk). Why can't mouth of river be dredged? (Henriatta Pearson) Why can't you dredge out the river after floods? (Clara Soler) You should create a 200' wide dike right-of-way along both banks where material dredged from the river can be used to form dikes. By placing the roads on top, access would be improved during floods. Further benefit could be improved channelization through dredging. (Marine Const - Ken Youngman). Corps should study river mouth - not 2 miles upstream. Consider the bottlenecks to the bridge and mouth. (Eunice Summers)

Dredging was considered during the study and dredging of comparable scope to the improved levee system was found to be more expensive than levee construction as well as having potentially much more serious environmental impacts. Tri-annual maintenance dredging would be required with location of suitable disposal sites a problem.

In 1975, water stacked up at North Fork bridge. What is the river width at the bridge? (Eunice Summers). Couldn't flood water surface be lowered by widening river at the bridges? (Darrel Young).

The low water channel at the North Fork bridge is about 240 feet wide and the high water channel about 560 feet wide. The water surface could be lowered by channel widening at the bridges but this generally is not cost effective and has potentially serious environmental impacts.

Has Corps seriously considered removing jetty between McGlinn and Goat Islands? (Gary Jones)

The jetty between McGlinn and Goat Islands was built as part of the Swinomish Channel Navigation Project. Removal of the jetty would have a negligible effect on the 50-year water surface in the leveed reach of Skagit River. Removal of the jetty would cause rapid shoaling of the Swinomish Channel.

If the channel is deepened 2 feet, will flood water surface be lowered 2 feet? (John Roosen)

No, the relationship is not direct. The amount of water passing a given point is the product of the areas times the velocity. The velocity is generally higher at the water surface than at the bottom of the channel and the width of a two foot slice of the river is much greater at the surface than at the bottom. Thus, lowering the channel bottom 2 feet will lower the water surface much less than 2 feet.

Who dredges Swinomish Channel? Since Corps does it for navigation, Why not for flood control?

The Corps dredges the Swimomish Channel to a depth of 12 feet as part of an authorized navigation project. The evaluation of navigation and flood control benefits are much different and suitable alternatives exist for flood control whereas dredging is often the only way to maintain navigation.

What provisions are made for silt removal at dams in the basin? (John Roosen)

Generally dams are designed with a certain amount of "dead storage" which is not used for beneficial purposes. The dead storage is designed for the expected sedimentation during the life of the dam.

Where does all the silt in the river go? (John Roosen)
Building levees only postpones the problem because over time sedimentation fills in the river channel. What is the answer for flood control when this occurs? Do we have to raise the levees a foot every 100-years?

Riverbed material ranges from 1/4" to 3/4" gravel at Mount Vernon to medium and fine sand near mouth. Finer grained sediments, silt, are carried into Skagit Bay and deposited in the river delta.

Nookachamps Creek - Clear Lake

Can the Corps study Nookachamps flooding problem? (Lloyd Johnson). Clear Lake and Big Lake areas could be used to store water. Nookachamps Creek could be dammed and the dam opened during floods to allow waters to flow up the creek and reduce the Skagit flood. Salmon runs in these streams could be reestablished (Laurence Boettcher). Diking Nookachamps would be useless because the area would flood from interior runoff alone. Cost would be prohibitive (Paul Wilcox). Nookachamps flooding extends way into Clear Lake and past Beaver Lake.

After the December 20, 1978 Public Workshop the Skagit County Commissioners requested the Corps to study in more detail the flooding problems of the Nookachamps. The Corps conducted additional studies and has included structural and non-structural measures for improvements in the Nookachamps-Clear Lake areas as well as the other areas riverward of the improved levee system to not only compensate for the increased water but also provide flood damage reduction.

What is the storage capacity of Nookachamps-Clear Lake area? (Laurence Boettcher)

The storage capacity of the Nookachamps-Clear Lake area during the 1975 flood was 35,000 acre feet.

What would be the water levels in the Nookachamps Creek area for the 1975, 20-year, 50-year, and 100-year floods with and without project? (Dan and Barbara Astin). Urban levees would increase flooding in the Nookachamps (Larry Kungler, Burlington Northern, Charles Boon).

Water levels at the Johnson Dairy Farm on Francis Road

	Without project	With project
1975	39.4	39.4
20 year	40.8	41.3
50 year	41.4	42.9
100 year	42.5	44.0

What are the gage readings at Mount Vernon and Sedro Woolley for the above floods? (Dan and Barbara Austin)

	Mount Vernon Gage		Sedro Woolley Gage	
	w/o proj	w/proj	w/o proj	w/proj
1975	35.7	35.7	26.1	26.1
20 year	36.8	37.6	26.8	27.3
50 year	37.2	39.3	27.8	28.9
100 year	37.7	40.6	28.9	30.2

Why was the river higher in Mount Vernon than in Sedro Woolley during the 1975 flood? (Dan and Barbara Austin)

Storage capability for flows that pass through Sedro Woolley exists in both the Nookachamps and Samish basins. Normally, this capacity fills as the peak passes between Sedro Woolley and Mount Vernon, resulting in a lesser peak at Mount Vernon even after inflow between the two measurement points is added. However, in 1975, a series of heavy precipitation periods, about 24 hours apart, caused the crest to remain near maximum for an unusually long period of time permitting the storage to remain full. With inflows then contributing to main stem flow, the peak at Mount Vernon, (130,000 cfs) exceeded that at Sedro

Woolley(121,000 cfs). Another factor to be considered is the integrity of measuring techniques. Limitations on equipment and methodology may be responsible for part of the apparent (9,000 cfs) differential. Our recent studies indicate that inflow between Sedro Woolley and Mount Vernon were probably considerably less than 9,000 cfs during the 1975 Skagit River peak.

Major trouble in Nookachamps is gravel from hills filling in ditches and creek causing overflow. (Paul Wilcox). Has runoff from hills been included in analysis of flooding? How much is it? (Dan and Barbara Austin)

The coincident inflow from Nookachamps Creek basin was considered in the modeling for the 100-year Skagit River event. Nookachamps inflow resulted in approximately a 0.2-foot increase in the Skagit River water surface profile, with project conditions, above what that profile would have been without inclusion of Nookachamps Creek flows.

Can we expect 1 1/2 feet of additional water per 10,000 cfs up to 50-year flood over 1975 level? (Dan and Barbara Austin)

No, the increase in water surface due to the project will range from 0.9 feet to 1.4 feet as the river flow varies from 130,000 cfs to 160,000 cfs. (Clear Lake-Beaver Lake area)

Buildings and improvements in the Nookachamps Creek area were built based on past floods. Any increase in water surface would have a disasterous impact on many individuals. Any plans that increase the water level in the Nookachamps-Clear Lake area are unacceptable and should not be considered. (Clark McKee, Dean Flaig, Ken Johnson, Seth Siegel, Dan & Barbara Austin) Both levee and highway projects would increase flooding in Nookachamps. Does anyone have the right to sacrifice the holdings of one for the benefit of another? (Barbara McNair) It's not right that the Nookachamps suffers for the good of the towns. Only areas in county subject to dangerous flooding are Nookachamps and Hamilton flood plains. Levees would raise water in these areas. We do not need more water on our farms. (Ruth and Ed Lipsey)

Your concerns have been considered, and improvements in the unleveed areas will be raised to accommodate the increased water levels and higher.

Nookachamps residents require raising and/or floodproofing of mounds and buildings (Lawrence Boettcher)

This has been included as part of alternative 3E.

How will sedimentation affect the 100-year flood water surface over the life of the project? (Charles Boon)

In 100 years the bottom of Skagit River at the confluence of Nookachamps Creek will be about 1 foot higher in elevation than now exists. That 1 foot, in the bottom of Skagit River, will have an insignificant influence on the elevation of the 100-year flood plain because the loss of carrying capability due to sediment in the river is so very small in relation to the holding capability of the 100-year flood plain. However, because sedimentation downstream of the Nookachamps Creek area will tend to back up water upstream, the water surface for a 100-year flood will be about 1/2 foot higher a 100 years from now than it would be today in the Nookachamps.

COMBINATION OF NEW HIGHWAY AND LEVEE

If the southerly route for Highway 20 were chosen, opportunity would exist for joint development of levee and highway (St. Dept of Transportation). Could the new highway planned for the north side of the river between Burlington and Sedro Woolley be used as part of the levee system? (Elden Bowen, Elwood Lenvog). How much additional water could be expected in the Nookachamps Creek area if SR 20 is built as a dike? (Dan & Barbara Austin)

The road and levee could be combined into one project. However, if that project used a continuous fill and prevented overflow to the Samish valley, it would raise the water surface about 4 to 5 feet higher than under existing conditions. During discussions with the Dept of Transportation, we indicated that their alinement along the river should probably include a causeway to permit overflow to the Samish valley.

Could the state build the road along the river and ruin your plan?

Before the State could build the road, they would conduct studies to determine their project costs and effects, prepare an environmental impact statement, conduct public hearings, and obtain necessary permits from State and Federal agencies, one of which is the Corps of Engineers. There would be considerable coordination and opportunity to modify the highway to reduce its adverse impacts.

UPRIVER PROBLEMS

Flood damages and erosion also occur east of Sedro Woolley in the upriver area. (Sophie Neble) What are you going to do upriver from Sedro Woolley? Will you dredge the river or creeks flowing into the river from Lyman east? (Mrs Marie Hodgin) Can the Corps study the flooding problem in Hamilton? (Lloyd Johnson)

As part of this study, the Corps is not considering the flooding problems upriver from Sedro Woolley. However, studies could be done concerning those flood problems by the Corps if officials of Skagit County or the towns involved formally requested such studies under authority of Section 205 of the 1948 Flood Control Act.

How much will the project increase flooding in Hamilton? How deep is the flood in Hamilton?

The project would have no effect on the flooding in Hamilton. The elevation of the 100 year flood in Hamilton is about 100 to 102 feet above Mean Sea Level. The floodwater depths for that flood would range from 3 to 10 feet deep.

What additional flood protection would be provided by High Ross Dam?

If Ross Dam is raised 121 feet as contemplated by Seattle City Light no increase in the flood control storage capability of the project would be provided.

SAUK DAM

Any proposal to dam Sauk River should consider (1) dam cost vs. cost to buy protected land, (2) problems posed by earthquakes causing dam failure, and (3) adverse environmental impacts. (Noel Cimino) Sauk Dam would cause loss of spawning and rearing habitat for steelhead and summer chinook salmon. (Evergreen Legal Services) We are concerned about a Sauk Dam because it would be very expensive in money and environmental costs (farm & timber land, fisheries, scenery, recreation). (American Canoe Association, Paddle Trails, Washington Canoe Club, University Canoe Club). Sauk Dam could help people throughout the valley (Einer Knutzen). Lets get Sauk Dam- remember Burlington, Mount Vernon, and downstream areas aren't the only sufferers in a flood. (Grace Jones) Something like Sauk Dam should be done to protect land riverward of the levee (Mrs. Greg Jones) Isn't the Sauk the best answer for flood control?

Your concerns have been noted.

Where would a dam be built on the Sauk? (Charles Toepke)

No detailed studies have been done. The most advantageous site based on preliminary studies in the 1960's was near river mile 5, about halfway between the Skagit and Suiattle Rivers.

Would Avon Bypass handle 40% of the runoff from the Sauk? (Larry Kunzler)

The most recent design of the Avon Bypass used a 60,000 cfs diversion channel with 120,000 cfs in the Skagit River (total capacity of 180,000 cfs, about an 87 year flood at Mount Vernon). The 100-year flood of the Sauk River near the mouth is 94,000 cfs.

Would a dam on the Sauk River which would help us not be scenic and Seattle City Light dams are scenic? (Ruth & Ed Lipsey)

Under the definitions set up for National Wild and Scenic River System, a "scenic" river or section of river is free of impoundments with shorelines or watersheds still largely primative and shorelines largely undeveloped but accessible in places by roads. Thus a "scenic" designation and a dam are exclusive. Seattle City Light's dams may be scenic but could not be "scenic". They are located in the Ross Lake National Recreation area which is operated under different criteria than the Wild and Scenic River System.

What was the basis for your preliminary cost estimate for Sauk Dam? Corps should be authorized to study a free flowing emergency control structure-not a high multipurpose dam on the Sauk. What is Corps experience with such a structure? (Skagit Co. Conservation District - Robert Hilbert)

The cost estimate for the Sauk River dam was based on preliminary studies in the 1960's updated to current price levels. Mud Mountain Dam in the White River, completed in 1948, is a single purpose flood control dam that is dry much of the time and stores water during floods. It has provided cumulative flood damage reduction benefits of over $12 million from past floods to the lower White and Puyallup valleys. The reservoir is raised every year after flood season to collect debris that does not pass through the "Emergency control structure". A minimum fish flow thru the structure could be necessary which might require summer impoundment of water.

PROJECT DESIGN

Dikes cause greater disaster when they break and give people a false sense of security. (Burlington Northern, Evergreen Land Trust) If levees are r[illegible] and then wash out heavy damage will be [illegible]ed by property adjacent to the levee. I[illegible]sing levee height raises water surface so when flooding occurs floating debris damages bridges. (Burlington Northern)

Skagit County, as part of the local cooperation requirements, must annually inform the public about the limited flood protection provided by the project. There is always the danger of floods greater than the project design. The project includes segments of levee with reduced freeboard so that the area of overtopping in floods beyond project design is known and land use controls can prohibit future development adjacent to these areas. The effect of debris on bridges has been considered in the project design.

How good is your levee design? Will water seep under it? What assurances are there that the dikes will be "hard core"? (Grace Jones) How do levees usually fail?

The levee design is based on current engineering practice regarding earthern embankments and floodwalls. The dikes will not be "hard core" in the sense that no seepage is permitted. Seepage will occur but the levee is designed to maintain its integrity. Levees generally fail from seepage and blowout rather than overtoping.

Rural residents are opposed to using the Samish valley as a release valve for the entire project (Skagit Conservation District)

We recognize their concern and have designed the levee system so that the Samish residents will experience no change from existing conditions and, in fact, are helped some in the 50 to 100 year flooding range.

Levee design should be modified to let nature chose where the river will overtop the dike. (Skagit Conservation District)

This would not be good engineering practice since it would spread the risk uniformly regardless of the potential damage. This could create a very hazardous situation since the levee could break in an area of concentrated development with danger to life rather than an area of farmland.

Corps should study effects of overflow from Skagit to Samish valley northeast of Burlington. Obstructions to the flow of Joe Leary Slough should be considered. (Laurence Boettcher) Will water passing over the weir cause problems at the hospital? Will it cause problems at I-5?

The Corps has considered the effects of the overflow to the Samish valley. Project features have been modified to insure that the overflow will not occur unless a greater than 50 year flood occurs and to insure that in a 100-year flood the overflow to the Samish will be no worse than under existing conditions. Modifications to the levee provide 100 year protection to the hospital. Interstate Highway 5 will act as a long crested weir during major floods.

Will the dike be tied to Burlington Hill? (Einer Knutzen)

The overflow levee north of Burlington will tie into Burlington Hill.

Including freeboard, how high are you planning to raise the dike?

The total amount that the existing levees will be raised varies by location from one to seven feet above the existing levee.

What will be channel capacity at Mount Vernon after dikes are raised?

The channel capacity at Mount Vernon with 3 feet of freeboard is 185,000 cfs which is a 100-year flood.

Where do Rural Levees start?

The Rural Levees start on the east side about 500 feet downstream from the Mount Vernon Sewage Plant and on the west side about 500 feet south of the intersection of Penn and Behvens Road.

Where will earth fill come from? How much will come from the river?

The earth fill will come from borrow sources off the flood plain. There are sufficient public or private pits and quarries within an eight mile radius of Mount Vernon. No borrow will be taken from the river. Topsoil from the construction right-of-way will be stockpiled for use on the levee slopes.

In west Mount Vernon, why not run levee along the river bank? (Bill Murdock)

We have considered several alinements in west Mount Vernon, one of which was on the river bank. The project was modified to move the levee one block east from Ball to Front Street. Movement of the levee further riverward would have reduced the channel capacity at the Mount Vernon bridge and required higher levees for the same level of protection.

FUTURE DEVELOPMENT IN FLOOD PLAIN

When the river is overprotected, artificial building sites are encouraged. Building should not occur in flood zones or high water areas. This reduces quality of life and increases development. People should not build in flood plains. (Evergreen Land Trust) There would be serious economic impact if 100-year protection were provided large areas of lower valley - this would encourage commercial development and ruin the rural character of area (Noel Chimino)

The project by itself will not directly change existing zoning that limits residential construction in agricultural areas. Secondarily, there may be an increase in pressure to develop more intensively the agricultural areas unavoidably provided 100 years protection and to some extent in the Samish Valley and areas downstream of Mount Vernon where 50 year protection is provided to agricultural land. The only practical alternative for reducing flood damages to existing development is the improvement of the levee system and retention of the present land use regulations by the cities and Skagit County. The extent of development in areas provided a higher level of protection will be dependent upon local land use regulations.

RECREATION

Recreational use of the shoreline should be considered in the planning process. The Pacific Northwest Trail Association would like to be able to use the riverside down to Mount Vernon as part of the proposed National Trail (PNTA - Ron Strickland)

Recreational use of the shoreline has been considered during the planning process. At this time there is no recreational development planned as part of the project. However, authority exists for inclusion of justifiable recreation on project lands at some time in the future. However, this development w ould probably be confined within city limits and at existing public access sites.

Against public recreation on all dikes because of damage, vandalism, and garbage that would occur. Hunters now are a problem. (Eunice Summers) Against recreation in agricultural areas because city people misuse farmland (Sophie Neble) Against recreation on dike or private land on the bank because of past unhappy experiences (Elsie Larsen) We don't want recreation - we need more farmland (Henriatta Larson)

We recognize your concern about mixing farming and recreation.

CHOICE OF ALTERNATIVE

Support clearing debris, raising levees to 75-year flood level, establishing settling basins for silt, and dredgeing direct route for river to Skagit Bay at mouth of Forks. Look to long-term solution - don't be concerned with only 10-15 year protection. (Port of Skagit County)

Remove dikes to limit destructive force of floodwaters (Noel Chimino) Let water go where nature intends. If not, someday our dikes will be like Mississippi with bottom of channel higher than protected land. (Zell Young)

Between our bridge and Burlington, our embankment serves as a levee - we have had problems here during past floods. We oppose raising the levees because it would endanger our bridges and embankments. Upstream storage is acceptable (Burlington Northern)

Do nothing on lower Skagit (Allen Doas)

Alternative 1 or 2 should be considered (Seth Siegel)

Favor alternative 2 with removal of jetty and opening mouth of North Fork. Against Avon Bypass since it requires too much farmland (Elsie Larsen)

We have considered all your concerns and have tentatively selected an alternative which provides the maximum feasible amount of flood damage reduction while minimizing adverse environmental and social impacts.

Alternative 3 is attractive but alternative 2 is much less expensive. (Skagit Co. Farm Bureau) Alternative 2 or 3 would provide flood protection without impacting Wild and Scenic River. (Washington Environmental Council) Support alternative 3 with levee extension to Sedro Woolley but it costs too much. Suggest alternative 2 withextention to Sedro Woolley at cost of $21 million for short term. Since Sauk Dam has been precluded, then go for enlarged Avon Bypass to provide 100-year protection (George Dynes). Low levees should be combined with upstream storage on Avon Bypass (Ken Johnson)

Support alternative 3 for early construction as a minimum measure but would like alternatives 4, 5, and 6 retained as options for future additional flood protection (Skagit Co. Comm., Skagit Co, Flood Control Council, Skagit Co. Public Works, Skagit Regional Plng Council. Burlington, Mount Vernon, Sedro Woolley) Modify alternative 3 to provide 100-year protection for West Mount Vernon. Areas between dikes should be used for recreation (Mount Vernon). Extend the dikes around the Sterling area. (Laurence Boettcher). Modify alternative 3 to provide 100-year protection to the south side of Sedro Woolley (Sedro Woolley, George Dynes, Laurence Boettcher) Levees from the mouth to Sedro Woolley should be improved. (Skagit Co. Conservation District).

Alternative 3 is the best choice since alternatives 4 and 6 would only provide additional margin al protection to agricultural or non urban areas (American Canoe Assoc., Paddle Trails, Washington Canoe Club, University Canoe Club).

Alternative 3C is a practical solution but consideration should be given to upstream storage and to those who would sustain additional damages in the Nookachamps - Clear Lake area. Alternative 3E with improvements in the Nookachamps area should be further modified:to provide 100-year protection to the cities, the United General Hospital and the Convalescent Center and 50-year protection for Fir Island, The Avon Bend and Sterling areas; to remove the weir; and, in greater than 50-year floods, to let nature chose where the river will overtop the dike (Skagit Co. Conservation District) Alternative 3A thru 3E increase the flooding in the Nookachamps which is unacceptable (Ken Johnson, Larry Kunzler) The Nookachamps area needs protection also - alternatives should be explored that aid the entire valley. (Don & Barbara Austin) Since a dam in the Sauk can't happen because of the Scenic River designation, the Avon Bypass should be built along with the diking of the Nookachamps area.

I object to a plan that protects me at the expense of others. Would not object if flooding were minor and those affected adequately compensated. Cannot be sympathetic with people who build outside levee and then demand flood protection. Cannot support flood protection which will lead to increased detremental development. (Seth Siegel) I oppose Sauk Dam and support the Wild and Scenic River System (Dennis Walker, Margaret Yeoman) Best alternative for flood control is #4 - Sauk Dam, Rural and Urban Levees (Ruth & Ed Lipsey) I am against any alternative which includes Avon Bypass (Neil Williams, Henrietta Pearson) Alternative 6 or some other that does a complete job should be chosen (E. B. Olmsted)

GLOSSARY

Acre Feet (ac.ft.) - A unit for measuring the volume of water or sediment. It is equal to the amount of water needed to cover one acre of land with water one foot deep. One acre foot equals 43,560 cubic feet or 325,851 gallons.

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 rate of flow of a stream with a cross section of one square foot which is flowing at one foot per second. It is equal to 448.8 gallons per minute.

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

Flood - Any relatively high streamflow or overflow that comes from a river or other body of water.

100-year Flood - A flood which is expected to recur on an average of once every 100 years, or a flood which has a 1 percent chance of occurring in any given year. It is based on statistical analysis of rainfall and runoff characteristics in the watershed. At Sedro Woolley, the 100-year flood on the Skagit River is estimated to be equal to a streamflow of 230,000 c.f.s.

Standard Project Flood - A flood which would be expected to occur from the most severe combination of weather (meteorological) and runoff (hydrological) conditions that are considered reasonably characteristic of the Skagit River basin. At Sedro Woolley the standard project flood is estimated to be equal to a streamflow of 397,000 c.f.s.

Flood Plain - The area adjoining a watercourse (river, stream, lake, etc.) which has been or may be covered by floodwaters. Flood plains are often defined for a flood of a particular magnitude; e.g., "100-year flood."

Floodway - Ordinarily means those portions of the flood plain adjoining the watercourse which are reasonably required to carry and discharge floodwaters.

Freeboard - The height of the top of the levee above the water surface of the design river flow is called freeboard. It is a factor of safety in levee design.

Runoff - That part of precipitation that appears in surface streams. This is the streamflow before it is affected by artificial diversion, reservoirs, or other man-made changes in or on stream channels.

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

Valley Storage - Natural storage of floodwater in adjacent areas when a river overflows its banks.

Appendix C: Wildlife Species Occurring in the Project Vicinity at the Skagit Wildlife Recreation Area. 1/

BIRDS

Common Name	Scientific Name	Occurrence
Common loon	Gavia immer	Common winter visitor
Arctic loon	G. arctica	Common winter visitor
**Red-throated loon	G. stellata	Common winter visitor
Red-necked grebe	Podiceps grisegena	Common winter visitor
Horned grebe	P. auritus	Common winter visitor
Eared grebe	P. caspicus	Common migrant spring & fall
**Western grebe	Aechmophorous occidentalis	Common migrant spring & fall
Pied-billed grebe	Podylimbus podiceps	Resident common
**Fork-tailed petrel	Ocanodroma furcata	Uncommon
**White pelican	Pelecanus erythrorynchos	Rare or uncommon
**Double-crested cormorant	Phalacrocorax auritus	Common resident
Brandt's cormorant	P. penicillatus	Common resident
Baird's pelagic cormorant	P. pelagicus	Common resident
**Great blue heron	Ardea herodias	Common resident
Anthony green heron	Butorides virescens	Uncommon resident
Cattle egret	Bubulcus ibis	Fall migrant
Common egret	Casmerodius albus	Fall migrant
American bittern	Botaurus lentiginosus	Common summer visitor
Whistling swan	Olorcolumbianus	Uncommon migrant
Trumpeter swan	Olor buccinator	Uncommon winter visitor
Canada goose	Branta canadensis	Common migrant
Black brant	B. nigricans	Common migrant
Emporer goose	Philacte canagica	Rare winter visitor
White-fronted goose	Anser albifrons	Uncommon migrant
Lesser snow goose	Chen hyperborea	Common migrant
Mallard	Anas platyrynchos	Common resident (nests)
Black duck	A. rubripes	Fall (scarce)
Gadwall	A. strepera	Common migrant (nests)
Pintail	A. acuta	Common migrant (nests)
Green-winged teal	A. carolinensis	Common migrant (nests)
Blue-winged teal	A. discors	Common migrant (nests)
Cinnamon teal	A. cyanoptera	Common migrant (nests)
European widgeon	Mareca penelope	Rare winter migrant
American widgeon	M. americana	Common winter (nests)
Shoveller	Spatula clypeata	Migrant common (nests)
Wood duck	Aix sponsa	Uncommon resident (nests)
Redhead	Aythya americana	Common migrant (nests)
Ring-necked duck	A. collaris	Common migrant (nests)
Canvasback	A. valisineria	Common migrant (nests)
Greater scaup	A. marila	Uncommon freshwater
Lesser scaup	A. affinis	Common migrant (nests)
American goldeneye	Bucephela clangula	Common migrant

Common Name	Scientific Name	Occurrence
Burrow's goldeneye	B. islandica	Common migrant (nests)
Bufflehead	B. ulbeola	Common migrant
Oldsquaw	Clangula hyemalis	Uncommon migrant
White-winged scoter	Melanitta deglandi	Common saltwater migrant
Surf scoter	M. perspicillata	Common saltwater migrant
Common scoter	Oidemia nigra	Uncommon migrant
Ruddy duck	Olyura jamaicensis	Common resident
Hooded merganser	Lophodytes cucullatus	Uncommon resident
American merganser	Mergus merganser	Uncommon resident
Red-breasted merganser	M. serrator	Rare freshwater migrant
Turkey vulture	Cathartes aura	Summer visitor
Goshawk	Accipiter gentilis	Resident uncommon
**Sharp-shinned hawk	A. striatus	Resident uncommon
**Cooper's hawk	A. cooperii	Resident uncommon
Red-tailed hawk	Buteo jamaicensis	Common resident
**Swainson's hawk	B. swainsoni	Summer visitor
Golden eagle	Aquila chrysoetos	Uncommon resident
*Bald eagle	Haliacetus leucocephalus	Common resident
**Marsh hawk	Circus cyaneus	Common resident
**Osprey	Pandion haliaetus	Uncommon resident
*American peregrine falcon	Falco peregrinus anatum	Rare migrant
Peale's peregrine falcon	Falco peregrinus pealei	Rare migrant
**Pigeon hawk	F. colymbarius	Uncommon resident
**Sparrow hawk	F. sarvarius	Common resident
Ruffed grouse	Bonasa umbellus	Common resident
California valley quail	Lophortyx californicus	Common resident
Hungarian partridge	Perdix perdix	Uncommon resident
Ring-necked pheasant	Phasianus colchicus	Common resident
Sandhill crane	Grus canadensis	Uncommon migrant
Virginia rail	Rallus limicola	Common resident
Sora rail	Porzana carolina	Common summer visitor
Coot	Fulica americana	Common resident
Semipalmated plover	Charadrius semipalmatus	Common migrant
Killdeer	C. vociferous	Common resident
Black-bellied plover	Squatarola squatarola	Common migrant
Wilson snipe	Capella gallinago	Migrant common
Long-billed curlew	Numenius americanus	Rare migrant
Hudsonian curlew (whimbrel)	N. phaeopus	Common migrant
Spotted sandpiper	Actitis macularia	Common migrant
Greater yellowlegs	Totanus melanoleucus	Common migrant
Lesser yellowlegs	T. flavipes	Common migrant
Pectoral sandpiper	Erolia melanotos	Common (fall only)
Red-backed dunlin	E. alpina	Common (winter)
Dowitcher	Limnodromus griseus	Common migrant

Appendix C: Wildlife Species Occurring in the Project Vicinity at the Skagit Wildlife Recreation Area. (Cont'd)

Common Name	Scientific Name	Occurrence
Western sandpiper	Ereunetes mauri	Common migrant
Northern phalarope	Lobipes lobatus	Common migrant
Parasitic jaeger	Stercorarius parasiticus	Common migrant
Glaucous-winged gull	Larus glaucescens	Common resident
Western gull	L. occidentalis	Common resident
Herring gull	L. argentatus	Common migrant
California gull	L. californicus	Common migrant
Ring-billed gull	L. delewarensis	Common freshwater migrant
Bonaparte's gull	L. philadelphia	Common migrant
Caspian tern	Hydroprogne caspia	Uncommon summer visitor
Common murre	Uria aaige	Common resident
Band-tailed pigeon	Columba fasciata	Common resident
Mourning dove	Zenaidura macroura	Common summer visitor
Rock dove	Columba livia	Common resident
**Barn owl	Tyto alba	Resident
Screech owl	Otus asio	Common resident
Great horned owl	Bubo virginianus	Common resident
Snowy owl	Nyetea scandiaca	Rare winter visitor
Pygmy owl	Glaucidium gnoma	Uncommon resident
Long-eared owl	Asio otus	Uncommon winter visitor
Short-eared owl	A. flamneus	Resident
Saw-whet owl	Aegulius acadicus	Common winter visitor
Great gray owl	Strix nebulosa	Rare resident
Nighthawk	Chordeiles minor	Summer visitor
Black swift	Cypseloides niger	Summer visitor (nests)
Vaux's swift	Chaetura vauxi	Summer visitor (nests)
Rufous hummingbird	Selasphorus rufus	Summer visitor (nests)
Belted kingfisher	Megaceryle alcyon	Common resident
Yellow-shafted flicker	Colampes auritus	Common resident
Red-shafted flicker	Colaptes cafer	Common resident
Pileated woodpecker	Dryocopus pileatus	Uncommon resident
Lewis' woodpecker	Asyndesmus lewis	Common resident
Yellow-bellied sapsucker	Sphyrapicus varius	Common resident
Hairy woodpecker	Dendrocopos villosus	Common resident
Downy woodpecker	D. pubescens	Common resident
Eastern kingbird	Tyrannus tyrannus	Summer visitor (nests)
Traill's flycatcher	Empidonax traillii	Summer visitor (nests)
Western flycatcher	E. difficilis	Migrant (nests)
Olive-sided flycatcher	Nuttallornis borealis	Summer visitor (nests)
Horned lark	Eremophila alpestris	Resident (nesting)
Violet-green swallow	Tachycineta thalassina	Summer visitor (nests)
Tree swallow	Iridoprocne bicolor	Summer visitor (nests)
Bank swallow	Riparia riparia	Migrant (nests)
Rough-winged swallow	Stelgidopteryx ruficollis	Summer visitor (nests)
Barn swallow	Hirundo rustica	Summer visitor (nests)
Cliff swallow	Petrochelidon pyrrhonota	Summer visitor (nests)

Appendix C: Wildlife Species Occurring in the Project Vicinity at the Skagit Wildlife Recreation Area. (Cont'd)

Common Name	Scientific Name	Occurrence
Purple martin	Progne subis	Uncommon-summer visitor (nests
Steller's jay	Cyanocitta stelleri	Common resident
Black-billed magpie	Pica pica	Uncommon migrant
Raven	Corvus corax	Common resident
Crow	C. brachyrhynchos	Common resident
Black-capped chickadee	Parus atricapillus	Common resident
Chestnut-backed chickadee	P. rufescens	Common resident
Bushtit	Psaltriparus minimus	Common resident
House wren	Troglodytes aedon	Summer visitor (nests)
Winter wren	T. troglodytes	Common resident
**Bewick's wren	Thryomanes bewickii	Common resident
Marsh wren	Telmatodytes palustris	Common resident
Robin	Turdus migratorius	Common resident
Varied thrush	Ixoreus naevius	Common resident
Hermit thrush	Hylocichla guttata	Common migrant
Swainson's thrush	H. ustulata	Common summer visitor
Mountain bluebird	Sialia currucoides	Uncommon winter visitor
Townsend's solitaire	Myadostes townsendi	Common winter visitor
Golden-crowned kinglet	Regulus satrapa	Common resident
Ruby-crowned kinglet	R. calendula	Common winter visitor
Water pipit	Anthus spinoletta	Common winter visitor
Bohemian waxwing	Bombycilla garrulus	Uncommon winter visitor
Cedar waxwing	B. cedrorum	Common summer visitor
Northern shrike	Lanuis excubitor	Uncommon winter visitor
Starling	Sturnus vulgaris	Common resident
Red-eyed vireo	Vireo olivaceus	Common summer visitor
Yellow warbler	Dendroica petechia	Common summer visitor
Myrtle warbler	D. coronata	Common summer visitor
MacGillivray's warbler	Oporornis tolmiei	Common summer visitor
Yellowthroat	Geothlypis trichas	Common summer visitor
English sparrow	Passer domesticus	Common resident
Meadowlark	Sturnella neglecta	Common resident
Yellow-headed blackbird	Xanthocephalus xanthocephalus	Common migrant
Redwing blackbird	Agelaius phoenicues	Common resident
Bullock's oriole	Icterus bullockii	Common summer visitor
Brewer's blackbird	Euphagus cyanocephalus	Common resident
Brown-headed cowbird	Molothrus ater	Common summer visitor
Western tanager	Piranga ludoviciana	Common summer visitor
Black-headed grosbeak	Pheuticus melanocephalus	Common summer visitor
Evening grosbeak	Hesperiphona vespertina	Common resident
Purple finch	Carpodacus purpureus	Common resident
Pine grosbeak	Pinicola enucleator	Uncommon winter visitor
Gray-crowned rosy finch	Leucosticte tephrocotis	Uncommon winter visitor
Pine siskin	Spinus pinus	Common resident
Goldfinch	S. tristis	Common resident
Spotted (rufous-sided) towhee	Pipilo erythrophthalmus	Common resident

City of

MOUNT VERNON

Washington

JACK D. MILLER, MAYOR
RICHARD M. WHITE, CLERK TREASURER
KENNETH J. EVANS, CITY ATTORNEY
JACK PITTIS, CITY ENGINEER

TELEPHONE 336-6585
POST OFFICE BOX 809

98273

March 21, 1978

Mr. Forest Brooks, Study Manager
Seattle District, Corps. of Engineers
P. O. Box C-3755
Seattle, Washington 98124

Dear Mr. Brooks:

The City of Mount Vernon is very interested in the levee and channel improvement study being conducted by the Corps of Engineers in Skagit County. Our interest, as can be expected, is primarily directed to the protection of the retail sales areas and commercial areas in the River-bend or Riverside shopping centers, the Downtown area and the West side of the City of Mount Vernon.

At a minimum, the urban area of the City of Mount Vernon should be provided with assurance that it is protected against a 100 year flood. It is understood that to accomplish this, it will be necessary that the river channel or levees of the Skagit River be improved through the Cit of Mount Vernon.

Having reviewed the alternatives published in the Skagit River Levee an Channel Improvements public brochure dated March, 1978, we would recomm that alternative 3-Levee and Channel Improvements and Urban Levees woul adequately provide a 100 year flood protection we seek for the urban ar of Mount Vernon. We also concur that some of the area between the dike should be utilized for recreational opportunities and possible future parks. It is important for us to continue to recognize the historical, scenic and recreational aspects of the Skagit River as well as retainin a practical outlook of solving the potential flooding dangers associate with the River.

Very truly yours,

Jack N. Pittis, P.E.
City Engineer

Jack D. Miller
Mayor

EXHIBIT 4
(Page 1 of 1)

CITY OF BURLINGTON
BURLINGTON, WASHINGTON 98233

OFFICE OF TH
MAYOR
Raymond C.

March 22, 1978

Corps of Engineers

Gentlemen:

The Burlington City Council and I express our thanks and appreciation for the Skagit River Levee and Channel Improvement study and the information provided.

Referring to draft No. 1, dated March 1978, we urge that, as a minimum, the Corps recommend to the Federal Congress the adoption of Alternate 3. We actually hope that the final conclusions will justify Alternate 4 and possibly Alternate 6.

Should the study not recommend Alternates 4 or 6 we hope they will be retained in a status which would permit prompt reconsideration if circumstances change.

The lower Skagit River Delta has been developed into a very valuable piece of real estate, providing a most attractive environment in which to live. Neglecting to provide reasonable protection for this investment, and this environment, could only be considered gross negligence.

With reference to the alternates requiring adjustments to the river environment upstream, it seems the gain in protection for the environment downstream, when considering the comparative value, fully justifies the adjustments. We need only remind ourselves that Skagit County is valued, for tax purposes, over one billion dollars, a large part of which is subject to flood damage, and that the City of Burlington is valued, for tax purposes, over fifty-five million dollars all of which is subject to flood damage.

Thank you,

Raymond C. Henery

Raymond C. Henery
Mayor

RCH:bd

EXHIBIT 5
(Page 1 of 1)

SKAGIT COUNTY FLOOD CONTROL COUNCIL

COPY

Skagit River Levee Project

Statement to the U.S. Army Corps of Engineers concerning the Skagit River Levee Project:

Colonel John A. Poteat:

The Skagit County Flood Control Council comprised of all the Dike and Drainage District Commissioners of Skagit County, the Commissioners of the Conservation District of Skagit County, and representatives of the Skagit County Engineer's Office, have long recognized the vital need for additional flood protection for the Skagit Valley, realizing that levee improvement is the last viable option to obtain this flood protection, enthusiastically support this Flood Control Project presented by the Army Corps of Engineers.

The members of the Skagit County Flood Control Council believe that the modified Flood Control Project Plan, known as Alternate Plan 3e, will provide the most flood protection obtainable, by a levee system, at the least cost and adversely impact fewer persons than any plan thus far presented. The Council feels Alternate Plan 3e closely meets the request of the majority of Skagit County citizens testifying at the Army Corps of Engineers preliminary hearing on this project held on March 22, 1978.

Thus the Skagit County Flood Control Council supports the Army Corps of Engineer's Skagit River Levee Project, Alternate Plan 3e, and request the Army Corps of Engineers to continue and pursue its early construction and completion.

Signed the Officers and Directors of the Skagit County Flood Control Council.

President – PETE WALKER – Peter R. Walker
Vic Pres. – Owen Thronsdel – Owen Thronsdel
Secretary – Donald Nelson – Donald E. Nelson
Directors – Oscar Hulde
Alfred Tellesbo – Alfred Tellesbo
Bonnie Anderson – Bonnie Anderson
Lawrence Hoffman – Lawrence Hoffman
Earl Hanson
Robert Hulbert

EXHIBIT 8
(Page 1 of 1)

JERRY L. MANSFIELD
FIRST DISTRICT

BUD NORRIS
SECOND DISTRICT

HOWARD MILLER
THIRD DISTRICT

SKAGIT COUNTY
BOARD OF COMMISSIONERS
Mount Vernon, Washington 98273
(206) 336-9300

July 17, 1979

District Engineer
Seattle District
Corps of Engineers
P. O. Box C-3755
Seattle, WA 98124

Dear Sir:

This is to advise you that Skagit County, Washington, understands that the following two sets of conditions are required by the Corps of Engineers with a proposed Skagit River Flood Control Project in Skagit County, Washington. Please be advised that Skagit County has no objection to either of the two sets of conditions and expresses its support to continue with the project at this time. It is further understood, however, that the brief listing of conditions refers to the type of conditions only and is not the contract language which the County would expect to sign in conjunction with a project of this magnitude.

CONDITION I.

A. Provide as cash or in-kind contribution, an estimated $11,000,000.00 which is 20 percent of the estimated first cost of construction.

B. Hold and save the United States free from damages due to construction, operation and maintenance of the Project, except for damages due to the fault or negligence of the United States or its contractors.

C. Maintain and operate the project after completion in accordance with regulations prescribed by the Secretary of the Army.

D. Prescribe and enforce regulations to prevent obstruction or encroachment on channels, levees and interior ponding areas which would reduce their flood carrying capacity or hinder maintenance and operation, and control development in the project area to prevent an undue increase in the flood damage potential.

E. Publicize flood plain management information in the areas concerned and provide this information to zoning and other regulatory agencies for their guidance and leadership in preventing unwise future development in the flood plain and in adopting such regulations as may be necessary to ensure compatibility between future development and protection levels provided by the project.

F. At least annually inform affected interests regarding the limitations of the protection afforded by the project.

G. With respect to recreational facilities, provide cash, equivalent work, or lands so that the non-Federal share shall be at least 50 percent of the total first cost of the development and assure public access for all on equal terms.

CONDITION II.

A. Provide without cost to the United States all lands, easements, and rights-of-way, including interior ponding areas, borrow areas, and excavated material disposal areas determined suitable by the Chief of Engineers and necessary for the construction of the project.

B. Hold and save the United States free from damages due to construction, operation and maintenance of the Project, except for damages due to the fault or negligence of the United States or its contractors.

C. Maintain and operate the project after completion in accordance with regulations prescribed by the Secretary of the Army.

D. Provide without cost to the United States all relocations of buildings and utilities, roads, sewers, related and special facilities necessary for construction of the projects.

E. Prescribe and enforce regulations to prevent obstruction or encroachment on channels, levees, and interior ponding areas which would reduce their flood carrying capacity or hinder maintenance and operation, and control development in the project area to prevent an undue increase in the flood damage potential.

F. Publicize flood plain management information in the areas concerned and provide this information to zoning and other regulatory agencies for their guidance and leadership in preventing unwise future development in the flood plain and in adopting such regulations as may be necessary to ensure compatibility between future development and protection levels provided by the project.

G. At lease annually inform affected interests regarding the limitations of the protection afforded by the project.

H. With respect to recreational facilities, provide cash, equivalent work, or lands so that the non-Federal share shall be at least 50 percent of the total first cost of the development and assure public access for all on equal terms.

I. Provide a share of the costs of all nonstructural measures (acquisition, relocations, flood proofing, flowage easements, etc.) in accordance with cost-sharing provisions contained in Section 73(b) of the Water Resources Development Act of 1974.

We understand the first set of the above conditions are in accordance with the President's proposed cost-sharing policies, while the second set is the conditions that have been discussed with us during the past years regarding this Project. While we express our willingness to meet either set of conditions, we prefer the second set.

While the Board of County Commissioners herein have reemphasized their recognition for the need for such an important flood control project, we shall continue to work with the Corps, the County's staff and the citizens of the County during the advance design stage to examine all possibilities of avoiding any adverse effects resulting from the proposed project and further improving the flood damage reduction measures for all the unleveed areas.

Skagit County, Washington, possesses the authority and the capability under the Washington State Constitution and other law to furnish the non-Federal cooperation required by the Federal legislation that authorizes the Project.

In carrying out the specified non-Federal responsibilities for the Skagit River Flood Control Project in Skagit County, Washington, Skagit County further agrees to comply with the provisions of the "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970", Public Law 91-646, approved 2 January 1971; and Section 221 of the Flood Control Act of 1970, Public Law 91-611, approved 31 December 1970, as amended.

Respectfully,

BOARD OF COUNTY COMMISSIONERS
SKAGIT COUNTY, WASHINGTON

BUD NORRIS, Chairman

HOWARD MILLER, Commissioner

JERRY L. MANSFIELD, Commissioner

APPROVED AS TO FORM:

PAT MCMULLEN,
Prosecuting Attorney
Skagit County, Washington

DEN:bjs

EXHIBIT 11

APPENDIX D. ENGINEERING DESIGN AND COST ESTIMATES

(3) Nookachamps Creek. Nookachamps Creek lies east of Mount Vernon and south of the Skagit River, and is the largest tributary to the Skagit River downstream of Sedro Woolley, draining approximately 81 square miles. Nookachamps Creek is formed by the confluence of the East and West Forks near Barney Lake and flows about 2 miles through the Nookachamps Valley to the mouth. Flooding in the low-lying Nookachamps Valley is dominated by flood conditions on the Skagit River and flooding extends upstream into the East and West Forks.

The West Fork Basin lies in nearly a south-to-north alignment, bordered by Carpenter Creek to the west and the East Fork to the east. West Fork drainage covers about 35 miles of moderately sloped, lowland hills ranging in elevation from 30 feet to about 1,450 feet above sea level. Most of the area is rural or in native vegetation underlain by a variety of soil groups typically hydrologically well drained and fine textured.

The East Fork Basin drains approximately 41 square miles of the western slopes and foothills of the Cultus Mountains. Basin elevations range from about 30 feet to over 4,000 feet above sea level. Ground cover and underlying soils are similar to the West Fork Basin; however, runoff response is more rapid due to the generally steeper drainage course. Runoff from about 7 square miles of the basin flows through Clear Lake and Beaver Lake before joining the East Fork just upstream of Highway 9 bridge. Flooding of the lowland areas around Beaver Lake and the community of Clear Lake is also dominated by Skagit River flood conditions. During major flood events, Skagit River backwater passes under the Highway 9 bridge flooding the lowlands in the East Fork Nookachamps area from the south.

(4) Urban Areas. The urban areas of Mount Vernon and Burlington occupy about 6.2 square miles. These areas are well developed with little natural vegetation.

(a) Mount Vernon. About 50 percent of Mount Vernon is serviced by a storm sewer system. This system has four pump facilities with a total capacity of about 30 c.f.s. (shown as F2, F3, F5, and F6 on plate D-21). During local freshets, however, effluent from the sanitary sewer system is diverted, mixed with storm runoff, and pumped directly into the river at pumphouse F6. Although most of Mount Vernon is serviced by storm drains, the system is overtaxed during major storms and most of the runoff flows overland and down paved roads.

(b) Burlington. Nearly the entire runoff from the town of Burlington drains into Gages Slough. The storm sewer system follows natural drainage patterns and also discharges into Gages Slough. A gravity drain connects Gages Slough with the Skagit River, and a flap gate prevents backflooding during high Skagit River stages. Underlying soils are well drained, gradually sloped, and similar in composition to the adjacent agricultural areas.

2.03 Flooding Analysis.

a. Existing Conditions. Water surface profile computations were made for the study reach between the mouths of the North and South Forks and Sedro Woolley. During the 1975 flood, the peak tide elevation at Skagit Bay was 6 feet NGVD. MHHW at Skagit Bay is approximately 5 feet NGVD. The assumption was made that similar tidal conditions would exist during any future floods, so peak tide elevation of 6 feet NGVD was used for all flood simulations.

The hydraulic parameters, such as vegetal cover, friction factors, slope, locations of contractions and expansions, and debris used to generate water surface profiles, were collected in the field during and after the 1975 flood. Hydraulic conditions were observed along the levee face and overbank. Following the 1975 flood, minor levee rehabilitation was undertaken, but did not measurably change vegetation or slope of existing levees. The levee restoration work consisted mainly of repairing damaged areas and strengthening the weak locations; however, at various locations the levee height was increased.

Field investigations of the river system, including the extent and conditions of the existing levees, have been made. Much of the levee system is in satisfactory condition, but various reaches could be described as unsatisfactory. These unsatisfactory reaches are located throughout the existing levee system. At many locations, considerable brush and small trees are growing on the levee embankment, along with larger trees having trunks exceeding 10 to 12 inches. Riprap is generally placed on riverbanks rather than levees, on slopes that are quite irregular and, in many cases, steeper than desirable for stability. Serious displacement of levee embankment has occurred at many locations due to the trampling action of cattle grazing along the top and sides of the existing levees. Only extensive flood fighting enabled the levee system to contain the 1975 flood which was a 12-year frequency event (130,000 c.f.s. at Mount Vernon). Based on evaluation of the 1975 flood, and guidance from EM 1110-2-1601 and Civil Works Engineering Bulletin 54-14, the flooding analysis was based on the existing levees remaining safe only when the water level was 2 feet below the top of levee. Whenever the water encroaches on this 2 feet of freeboard, seepage, erosion, scour, and boils will threaten levee integrity and start overland flooding. Total levee failure was assumed to occur when the water level reached 1 foot from the top of levee. Length of levee failure is dependent on initial length of low levee reach and duration of stage above natural ground. Levee erosion will continue until the river stage has receded to a level equal to the water stage in the overbank. Using these levee failure assumptions, zero damage discharge for the following locations was computed. The failure sequence and corresponding zero damage discharge during the 50-year, 100-year, and SPF hydrographs at Mount Vernon gaging station are presented in table D2-1 for existing conditions. Figure D2-1 illustrates locations of failures with sequence numbers. Discharge values are very similar for respective sequence numbers but could vary significantly depending on slope and direction of the flood hydrograph. The discharge values tabulated are only for the hydrographs analyzed.

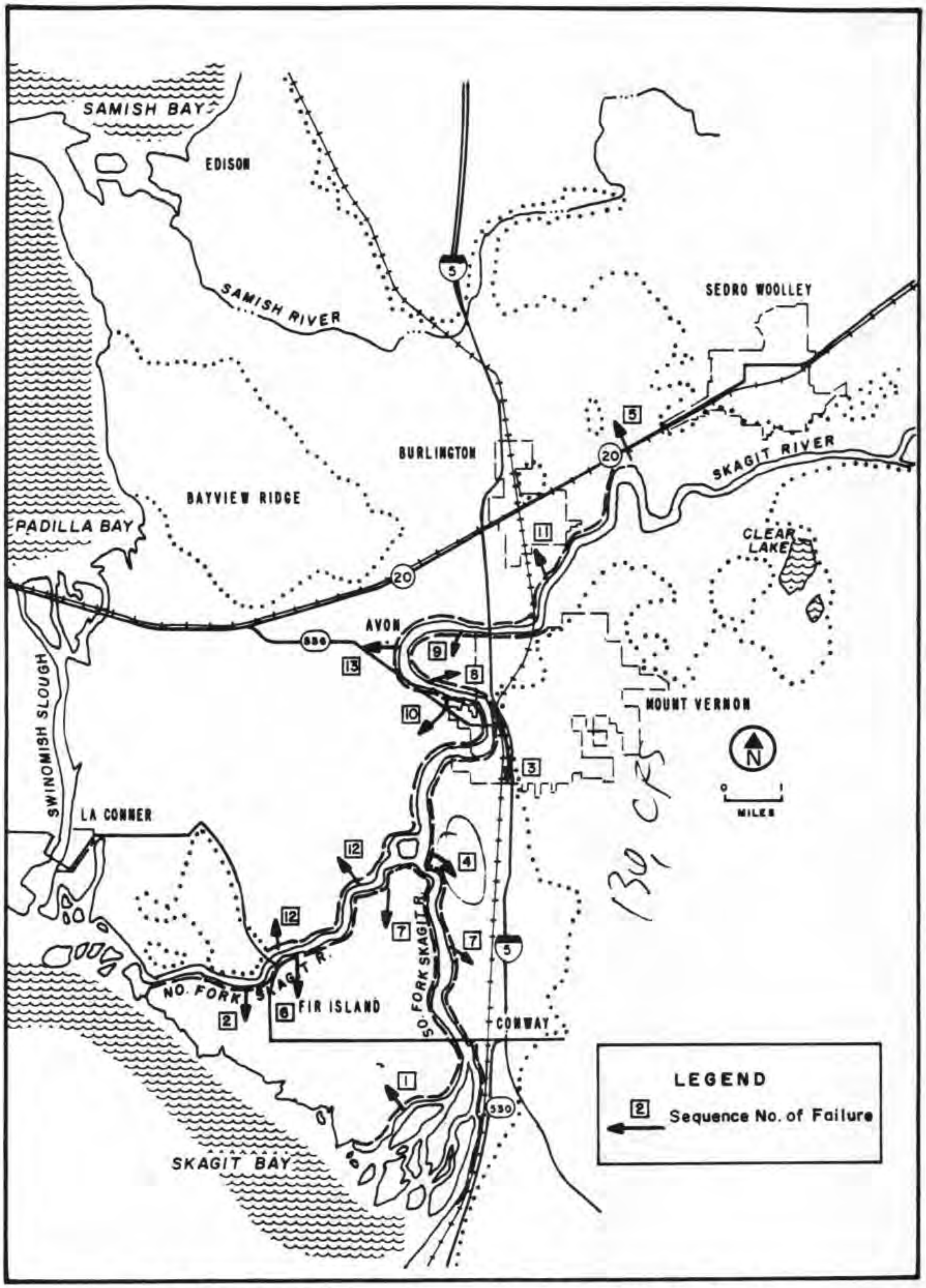
TABLE D2-1

ZERO DAMAGE
EXISTING CONDITIONS

Sequence Number	Mount Vernon c.f.s (1,000's) 50-year	100-year	SPF
1	106	130	131
2	125	131	132
3	126	132	133
4	130	134	134
5	134	137	135
6	136	139	137
7	138	141	139
8	142	144	141
9	145	146	142
10	146	145	143
11	149	150	145
12	--	151	150
13	--	152	153

Utilizing all the above conditions and assumptions, channel flood profiles were computed using the computer model for the 10-, 50-, 100-, and 500-year frequency flood discharge hydrographs (see plates D-23, D24 and D25)

Flows through levee failures were computed by the energy equation and coupled to the computer model to establish overland flooding conditions. Extent and depth of overbank flooding resulting from assumed failures were computed on the basis of the area which could be flooded and volume of water available. Natural land characteristics were utilized to compute overland flow patterns and pondage areas. Inundation limits for any flood greater than 50-year flood cover the entire area below Sedro Woolley (see figure D2-2). For larger floods, only the depth of water increases. The sea dikes were assumed to prevent overbank floodwaters from escaping to Skagit Bay until elevation 8 feet NGVD was reached. One critical feature is Interstate Highway 5 which runs north and south through the delta



FAILURE LOCATIONS WITH EXISTING LEVEES

FIGURE D2-1

TABLE D2-2

ZERO DAMAGE

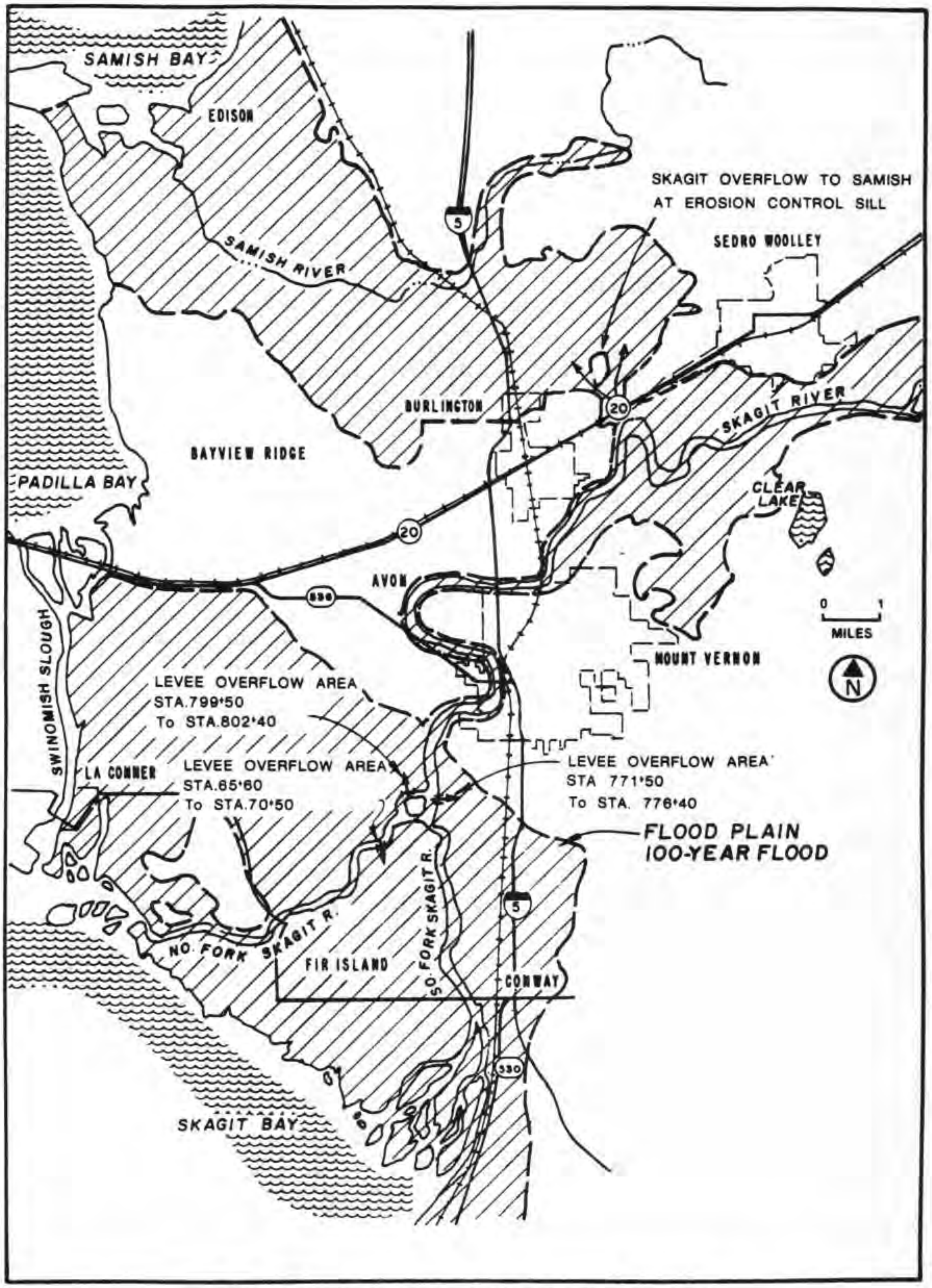
PROPOSED CONDITIONS

Sequence Number	Mount Vernon c.f.s. (1,000's) 50-year	100-year	SPF
1	none	163	163
2	none	167	178
3a, 3b, 3c	none	none	183
4	none	none	199
5	none	none	200

being discharged to Samish Valley. The west bank of Gages Slough and the west side of District Line Road will be leveed, forming a corridor to the sill and providing 100-year protection for Burlington and the area east of the District Line Road. Flood water will enter the corridor during events with a recurrence interval of about 20 years or greater. The area, including buildings between the sill and the railroad embankment, will be subjected to high velocities and rapid inundation. For the purpose of the Phase I urban levee studies, a cost estimate was prepared for removing some buildings and floodproofing the remainder. During future feature design memorandum studies, alinement of the levees, details of the sill, and the need for floodproofing or relocation will be reviewed.

The flood plain for a 50-year frequency event, with-project condition, is shown in figure D2-5. The entire Skagit Delta is protected from Skagit River flows, except for a portion of the Nookachamps Creek area and three unprotected areas on the right bank. The project will raise the water level, on the average, by about 1.5 feet on the left bank upstream from Mount Vernon, including portions of the Nookachamps area and a small area just south of the erosion control sill on the right bank. No overflow will occur into the Samish River Basin. However, the lower Samish River Basin will continue to experience periodic flooding from the Samish River.

The flood plain for the 100-year frequency event, with-project condition, is shown in figure D2-6. Samish Valley flooding remains the same as under existing conditions. Essentially all of Burlington, Avon, Mount Vernon, and Clear Lake would be provided 100-year flood protection. The Nookachamps Creek and South Sterling areas would continue to flood and, with the proposed project, would suffer an increase in flood stage of approximately 1.5 feet during a 100-year frequency flood. The water surface increase shown on plates D-24 and D-25 indicates a 3- to 4-foot increase in the 100-year frequency flood



WITH PROJECT 100-YEAR FLOODING

FIGURE D2-6

• Thickness will be increased by 50 percent where topographic features require the armored embankment slope to be steeper than 1 vertical to 2 horizontal.

Both buried and weighted revetment toes have been used on this project. The buried toe is used wherever the levee is set back and riverbank stability permits. The setback criteria, used to determine where to use the buried toe, and the toe design are shown in figure D2-13. The weighted toe is used wherever riprap is required and the buried toe criteria cannot be met. The weighted toe design is shown in figure D2-14.

n. Bridge Encroachment. Of the six bridges shown on table D2-6, only one bridge encroaches into the levee freeboard. This bridge is the Burlington Northern railroad bridge. The low steel on the three main bays of the Burlington Northern railroad bridge appears to be about one foot below the top of the levee. The four bays on the north end of the bridge appear to be about one foot above the top of the levee. The apparent encroachment of the bridge into the levee freeboard will be the object of detailed studies during preparation of the feature design memorandum. The exact bridge configuration, encroachment, and channel section will be determined. Removal of a natural bench on the north side of the river will be investigated to determine how much of the material can be removed, the resulting reduction in water surface, and at what cost. Preliminary findings indicate that the water surface could be lowered about one-half foot without changing the levee alinement or becoming involved in significant bridge modifications.

2.04 Clear Lake/East Fork Nookachamps Creek. The 1975 flood resulted in flooding to approximately elevation 40.0 feet NGVD in the Clear Lake area. A 100-year flood, occurring today, would cause flooding to approximately elevation 43.0 feet; and a 100-year flood, occurring after construction of the project, would cause flooding to approximately elevation 45.0 feet. To control flooding in the Clear Lake area, a levee will be constructed near the railroad embankment west of Clear Lake, and a control structure will be constructed on the East Fork Nookachamps Creek to prohibit backflooding for floods less than the 100-year event (see plates 16A and 16B). Some flooding of the Clear Lake area will occur with the proposed structure. This is due to the coincident East Fork Nookachamps inflow which would be stored behind the structure. During the 100-year event on the Skagit River, this East Fork Nookachamps storage will pond to approximately elevation 36.0 feet. Review of topographic maps indicated that interior flooding to elevation 36.0 feet will not affect existing residences. The control structure will consist of three box culverts, with flap gates and positive-closure slide gates, through a short length of levee. Freeboard on this levee will be 2 feet. When encroachment into this freeboard reaches 1 foot, backflooding through the culverts into the Clear Lake community will be accomplished. This prevents catastrophic flooding which would occur if the Clear Lake levee breached.

a. Waterway Opening. Waterway opening of the structure will consist of one 6-foot by 6-foot and two 9-foot by 9-foot box culverts. The 6-foot culvert invert will be 1.0 foot lower than the larger openings to insure sufficient waterflow for fish passage during low-flow periods. The structure is designed to pass a 100-year event on East Fork Nookachamps Creek with a coincident Skagit River flow.

b. Gates. The two 9-foot by 9-foot box culverts will have horizontally hinged flap gates. The 6-foot by 6-foot box culvert will be controlled by two vertically hinged miter-type flap gapes, each 3 feet wide and 6 feet high. The principal purpose of miter gates is to permit passage of migratory fish. Stops will be installed to insure closure against backflows.

c. Positive-Closure Gates. The outlet structure will be equipped with positive-closure gates for each box culvert. These gates are considered backup for the flap gates and will normally be kept in the open position. Operation of these gates will be limited to emergencies, such as flap-gate failure or debris blockage, to insure that Skagit River floodwaters will not flow into the Clear Lake area. A positive-closure gate will be located at the downstream end of each culvert.

d. Outfall Protection. Extending downstream from the edge of the outlet will be a concrete apron 27 feet long and 2 feet below the invert of the 6-foot culvert to insure that debris accumulation does not block the flapand miter-gate operations. Extending 15 feet downstream from the outlet apron will be a 2-foot-thick blanket of riprap, class II, to prevent scouring.

2.05 Carpenter Creek/Fisher Slough. The outlet structure for Fisher Slough will be constructed through the proposed levee located riverward of the railroad. The structure will be designed to pass the 50-year frequency flow on Carpenter Creek (1,000 c.f.s.), with Skagit River water surface elevation of 5.7 feet (MHHW), and not exceed extent of existing interior flooding. The design requirements for the structure were described in section 1 of this appendix. The structure will consist basically of a rectangular slot 9 feet wide by 13 feet high equipped with inlet and outlet apron-flared sidewalls, two vertically hinged tide gates, and a manually operated vertical slide gate. The tide gates will open and close automatically in response to changes in hydraulic head and will thus permit passage of fish and floating debris. A concrete wall across the slot will extend from top of tide gates to top of levee and thus prevent Skagit River from overtopping the gates and flowing into Fisher Slough. The slide gate will be upstream from the tide gates and normally be open, but will permit

SECTION 4. URBAN LEVEES

4.01 General. The urban levee system from Sedro Woolley downstream to below Mount Vernon consists of 22.7 miles of new and improved levees and is divided into six segments: Sedro Woolley-Sterling, Burlington, Avon, and west Mount Vernon comprising the 15.8 miles of right bank levee and 5.9 miles of left bank levee protecting Mount Vernon. The final segment consists of 1.0 mile of levee protecting the Clear Lake-East Fork Nookachamps Creek area. The urban levees will provide standard project flood protection to the portion of Mount Vernon east of the Skagit River; 100 year or greater flood protection to most of west Mount Vernon, Avon-Fredonia, Burlington, a portion of Sterling-Sedro Woolley, and Clear Lake; and 50-year protection from Skagit River overflows to the Cook Road-Samish Valley areas. An erosion control sill and berms in two segments will be placed at Sterling Hill to restrict Skagit River overflow into the Samish to no greater during a 100-year flood event than would be experienced without the project. The proposed levees are shown on plates 2A through 8B and 16A and 16 B of the main report.

4.02 Scope. Urban levee system design is to a Phase I GDM level. The design is based on field investigations and exploration, field surveys including cross sections taken at an average interval of 4,000 feet, river soundings, topography, orthographic aerial maps, and photographs. Further information was obtained from the Skagit County Engineer's Office, Mount Vernon and Burlington City Engineers, Skagit County Public Utility District No. 1, Burlington Northern Railroad, Washington State Department of Transportation, and city of Anacortes.

4.03 Design Criteria

a. Levee Top Elevation. Levee top elevation has been determined by adding 3 feet of freeboard to the design water surface profile for a 100-year or standard project flood with a controlled Samish overflow. Additional height was added for high velocity superelevation and wind induced wave action. The design water surface profiles include an allowance for sedimentation during the 100-year project life. A comprehensive discussion of the hydraulic design is contained in section 2 of this appendix.

b. Levee Configuration. The general levee design has a 12-foot top width and 1 vertical (V) on 2 horizontal (H) side slopes. Except where clearance for buildings or other factors dictate, project design utilizes existing levee embankment. Soil conditions along most of the alinement require incorporation of a toe drain which consists of a minimum 3-foot-thick, 12-foot-wide gravel berm with the berm top no more than 10 feet from levee top. Berm locations are shown on plates 2B through 8B of the main report. Where the improved levee utilizes the existing levee and a 1V on 3H landward slope exists, the gravel berm is not used. Access ramps will be provided to the top of the levee at the beginning and ending of berm reaches. Ramps will be constructed of embankment material, except for the top 6 inches which will be gravel and will have a maximum 10 percent grade. Intermediate levee access will be obtained through use of existing access roads. The improved levee will be constructed of semi-impervious embankment with the top 6 inches of levee template being a gravel driving surface. Excavation during construction will provide some of the required embankment material, and the rest will come from existing Skagit County and private borrow sources in the vicinity of Mount Vernon.

c. Erosion Protection. Where river velocities dictate, riprap or quarry spalls are used to prevent erosion. Riprap thickness is dictated by hydraulic conditions (see section 2 of this appendix). Riprap of required thickness, with buried toe above water, weighted toe below, underlain by a 1-foot-thick layer of gravel filter blanket above water surface and a minimum 1-foot-thick layer of quarry spalls below water surface will be used for erosion protection. Erosion protection for less severe velocities will consist of a 6-inch layer of quarry spalls. Table D4-1 lists the areas where riprap or quarry spalls will be required.

d. Alinements. The alinement has been adjusted to be cost-effective in all areas and to minimize environmental impacts. In general, the design utilizes the least costly real estate, and existing roads, homes, and buildings are avoided if at all possible. The necessity of using a gravel berm on the landside of the levee requires road relocation in two major locations: Whitmarsh Road on the right bank downstream from old Highway 99 and River Bend Road on the left bank on the inside of the big bend.

e. Access Roads. Existing state, county, local, and private roads will be ramped over the levee as part of the project. For economy of construction the levee freeboard is eliminated at road access points, allowing the road to be raised only to the design water surface. Emergency closure of the freeboard at these points will be made by sandbagging or dumping fill if required. There are nine of these locations on the urban levee system as indicated on plates of the main report. Major roads are ramped to the design water surface and use a 3 percent slope. Minor surfaced roads are also ramped to design water surface, but use a 5 percent slope. Unsurfaced roads and property owner access are ramped to levee top with 10 percent grade. Unauthorized levee access will be prevented by gates at access points.

4.04 Levee Description.

a. Sedro Woolley-Sterling.

(1) Right Bank. The levee from Sedro Woolley to near Sterling protects the right bank of the Skagit River from a 100-year floodflow along the segment. The project begins at high ground in Sedro Woolley along Rhoades Road, station RB 75+10, continues to RB 161+70 (0+00 DLR), and ends at 31+40 DLR. From Sedro Woolley the levee alinement runs west through rural residential areas to the bank of the high-water channel adjacent to Hart Island, station RB 97+00. The alinement follows the channel bank northwest by west to the Burlington Northern Railroad right-of-way, then parallels the railroad and Lafayette Road to District Line Road, station RB 161+70 (0+00 DLR).

(2) District Line Road. District Line Road prevents Skagit River overflow from entering Sterling from the west. The District Line Road levee begins at 0+00 DLR (RB 161+70) and crosses Burlington Northern Railroad where a closure structure is provided at station 0+50 DLR. The alinement continues northwest to the intersection of State Highway 20 and District Line Road, station 1+40 DLR. Both the State Highway and District Line Road will be ramped to the levee top at this point. From station 1+40 DLR to station 31+40 DLR, the alinement runs west of and parallel to District Line Road. The levee along this stretch will be protected by 2 feet of riprap.

(3) Buried Erosion Sill. From station 31+00 DLR west to Sterling Hill, approximately 1,760 feet, a buried sheet pile erosion control sill will be constructed to prevent excessive erosion when floodwaters overflow to the Samish Valley. This sill will consist of sheet piling 12 feet deep and extending the entire length. Elevation at the top of the sheet pile will be 38.7, about 3 feet under present ground level. A strip of riprap 60 feet wide and 3 feet deep will be placed downstream from the sill. The excavated soil will then be replaced over the sheet piling and riprap and mounded to elevation 43 feet. The levee alinement along the right bank is shown on plate 2A; the alinement along District Line Road and the sill is shown on plates 3A and 3B.

b. Burlington.

(1) Right Bank. Levees in the Burlington area along the right bank prevent overflow from entering Burlington. No improvements are proposed between stations RB 161+70 and RB 182+50 (17+50 GB). The levee follows the existing road and levee from stations RB 182+50 to RB 200+00. The alinement from station RB 75+10 to station RB 200+00 is shown on plate 2A. From station RB 200+00 to Burlington Northern Railroad, station RB 343+00, the levee utilizes existing levee embankment. From RB 325+00 to 342+50, foundation leakage is extensive. In this reach, a cutoff trench 3 feet wide and extending down

to the apparent ground water level will be constructed on the landward side. Along this reach, crop and grazing land is located on the landward side and grazing and woodland on the riverside. From station RB 343+00, the levee parallels the railroad to station RB 358+20, where it ties into east side of the railroad bridge abutment. The alinement from station RB 200+00 to station RB 358+50 is shown on plate 5A. From the west side of the railroad bridge abutment to station RB 368+00, the levee alinement is between Whitmarsh Road and the existing levee. Total utilization of the existing levee embankment in this reach is not possible because of the proximity of buildings on the landside of the levee. From station RB 368+00 to old Highway 99, station RB 386+00, the levee is raised and widened to accommodate Whitmarsh Road. The alinement follows the existing levee west from old Highway 99 to Pulver Road, station RB 441+00, and Whitmarsh Road is raised along this reach to allow for a 3-foot-thick gravel berm. The alinement from station RB 358+50 to station RB 505+00 is shown on plate 6A. At station RB 449+60, a section of sheet piling 20 feet deep and 100 feet long is placed along the axis of the levee to prevent levee failure to progress downstream into the residential area of Avon. Between stations RB 200+00 and RB 449+60, the top elevation of the levee is gradually decreased from 3 feet above SPF water suface (RB 200+00) to 2 feet above 100-year design water surface (RB 449+60), to allow for progressive failure in an upstream direction between stations (RB 449+60 to RB 200+00) should the discharge exceed the 100-year design flood. This progressive failure will backflood the Burlington area and will prevent catastrophic failure of the levee upstream of Burlington.

(2) Gages Slough to Burlington Hill. The levee begins at station 0+00 GB (RB 200+00) with the alinement following existing levees to station 17+50 GB (RB 182+50). At this point, the alinement departs from the existing levee, blocks off Gages Slough, and crosses Burlington Northern Railroad at station 21+30 GB and State Highway 20 at station 23+00 GB. The drainage from Gages Slough is redirected to Skagit River via a new culvert under the existing levee and into a new channel paralleling the initial 1,900 feet of this levee. A structural railroad closure, 9.1 feet high from top of tie to top of levee, will be constructed where the levee crosses the Burlington Northern Railroad. This structure consists of reinforced concrete bulkheads with sheet piling cutoff adjacent to the tracks and closure made by a hinged steel gate during high water. State Highway 20 will be ramped over the levee at the design (SPF) water surface with an emergency closure of the freeboard by sandbagging if required. From station 23+00 GB, the alinement follows the west bank of Gages Slough northerly to station 46+40 GB. Two feet of riprap protects the slough side of the levee from station 17+50 GB to 46+40 GB. At station 46+40 GB, the alinement turns west by northwest to where it meets Anderson Road at station 52+00 GB. A segment of the buried sill runs generally north from station 52+00 GB about 840 feet to

Sterling Hill. The design of the sill is identical to that as described in paragraph 4.04a(3). From Anderson Road, the levee alinement continues to Gardner Road, station 62+80 GB. Gardner Road is ramped to the design water surface, and an emergency closure of the freeboard is intended if required. At station 64+80 GB, the alinement turns south along the road to a property line at station 67+40 GB. From this point, the alinement runs due west to station 90+20 GB where it turns due south to the north end of Burlington Hill, station 110+80 GB. The alinement from station 0+00 GB (RB 200+00) to station 22+00 GB is shown on plate 2A, and the alinement from station 22+00 GB to station 110+80 GB is shown on plate 3A.

(3) Burlington Hill to Avon-Allen Road. The overflow levee between Burlington Hill and Avon-Allen Road starts on the west side of Burlington Hill, station 0+00 BB, near Chuckanut Interchange on Interstate 5 (I-5). The proposed alinement runs due west and crosses Burlington Northern Railroad at station 0+50 BB, then northwest to old Highway 99 at station 11+50 BB. From station 11+50 BB, the alinement utilizes the north onramp embankment of Chuckanut Interchange and crosses I-5 about 500 feet north of the overpass. No closure is required as both north and southbound lanes are above the design water surface. From I-5 the alinement runs south along the west side of the south bound offramps to the overpass embankment, utilizing this embankment for 400 feet to station 32+40 BB on the north side of Joshua Wilson Road. From station 32+40 BB to Avon-Allen Road where the levee ends, station 129+25 BB, the alinement is adjacent to and north of Joshua Wilson Road. Pulver Road is ramped to 100-year water surface where it crosses the levee at station 77+25 BB. The levee endpoint was hydraulically chosen so that floodwater from the 100-year event will not back into the Burlington area. The alinement from station 0+00 BB to 129+25 BB is shown on plate 4A.

c. Avon. The levee from station RB 450+00 to RB 560+60 protects the unincorporated town of Avon. From Pulver Road, the alinement follows the existing levee through a suburban area past the town of Avon and around the bend to station RB 500+00, where the suburbs give way to agricultural farmland. The levee is adjacent to Memorial Highway at station RB 535+00, and a basin bordering Memorial Highway opposite station RB 545+00 will be filled to prevent excessive seepage and piping. Plates 6A and 7A show the levee segment neighboring Avon.

d. West Mount Vernon. The alinement continues from station RB 560+60 along the existing levee to Ball Street where the alinement leaves the existing levee and goes to Front Street in west Mount Vernon, station RB 619+00. The alinement from station RB 505 to 614+60 is shown on plate 7A. At Front Street the levee turns south and parallels Front Street on the riverward side. The levee ties into the west abutment of the Mount Vernon bridge at station RB 625+50. From the south side of the abutment, the levee continues south by southwest to the Ball Street and Dike Road intersection at the entrance to Edgewater Park, station RB 631+00. From Edgewater Park, the alinement parallels Dike Road (Beherns Road) on the riverward side to station RB 675+00 where the road ascends and continues on top of the levee for 700 feet to station RB 682+00. From station RB 682+00 to station RB 698+60, the alinement is riverward adjacent to Beherns Road and Penn Road. At RB 698+60, the urban levee transitions into the rural levee at a 5 percent slope. The alinement from station RB 614+60 to station RB 698+60 is shown on plate 8A.

e. Clear Lake and Nookachamps. Two segments of levee will protect the Clear Lake area from 100-year frequency floods. The first runs along the west side of the town of Clear Lake generally bordering State Highway 9 (SH 9) and Mud Lake Road. The other crosses the East Fork Nookachamps Creek just downstream from SH 9. The Clear Lake levee starts at State Highway 9 north of the unincorporated town of Clear Lake, station 45+55 CL. From station 45+55 CL, the alinement proceeds southwest, south, and finally southeast through agricultural land. At station 28+80 CL, the levee turns south and runs parallel and adjacent to State Highway 9. The alinement also parallels the Burlington Northern Railroad from station 15+60 CL to Mud Lake Road, station 6+00 CL. Mud Lake Road is relocated on the levee top for 150 feet to station 4+40 CL where it ramps off and runs adjacent to the levee. At station 0+00, the levee ends at high ground. The East Fork Nookachamps Creek levee is 240 feet long and forms a barrier which prevents the flooding of Clear Lake from the west. Incorporated in this levee is a concrete box culvert consisting of two barrels 9 feet by 9 feet and one barrel 6 feet by 6 feet. The large barrels will have a flapgate and a positive closure sluice gate on the downstream end. The smaller barrel will have barn-door gates and a positive closure sluice gate. The alinement for the Clear Lake and Nookachamp Creek levees is shown on plate 16A.

f. Mount Vernon. The left bank levee begins at station LB 361+20 on the west side of the Burlington Northern Railroad embankment (south end of bridge) and protects Mount Vernon from SPF flow. The alinement follows the existing levee west through suburban and pastureland to the old Highway 99 bridge, station LB 385+80, which is perpendicular to the levee alinement. The bridge between the abutment and the existing levee alinement on the riverbank is too low to allow construction of levee embankment to pass underneath; therefore, the alinement makes a 90 degree turn and runs parallel to the bridge and connects to the abutment at Hoag Road. The abutment is about 1 foot below design water surface and will be raised 4 feet on each side of old Highway 99 to meet the levee embankment. An emergency closure will be necessary at this point during the 100-year flood. The alinement parallels the old Highway 99 bridge on the west side to the existing levee at station LB 386+80, and then runs west along the existing levee under the I-5 bridge at station LB 400+70. The alinement continues west from the I-5 bridge along the existing levee

(6) LB 441+00 to 582+50. The improved levee in the Mount Vernon big bend area will be raised, widened, have riprap erosion protection added, and will have a gravel berm toe drain for stability. All of these measures combine to require relocation of Big Bend Road, which is currently located at the toe of the existing levee. The reconstructed road will be located on the gravel berm and in general will be relocated vertically by 3 feet.

b. Building Relocations. Phase I urban levee design requires acquisition of 13 buildings, three of which are residences.

TABLE D4-3

BUILDING RELOCATIONS

Location	Station	Description
Sedro Woolley-Sterling	3+40 DLR	Residence
	10+35 DLR	Building
	30+40 DLR	Building
Clearlake and Nookachamps	5+40 CL	Residence
	6+20 CL	Residence
	21+00 CL	Building
	22+40 CL	Building
	23+00 CL	Building
Mount Vernon	LB 544+70	Building
	LB 545+60	Building
	LB 551+50	Residence
	LB 616+10	Building[1/]

[1/]Old Carnation Plant Addition

4.06 Special Features.

a. Railroad Closure. At station 21+30 GB and 0+50 DLR, the levee alinements cross the Burlington Northern Railroad. Closures of 9.1 feet and 7.3 feet, respectively, are required from top of rail to top of levee, which are greater than can be accomplished by normal flood-fighting methods. Structural closures similar to a 1977 design by Rock Island District, will be constructed at these locations. Both closures are on the Burlington Northern Railroad main line which will remain in service during construction by spanning the excavation with a temporary structural steel bridge.

b. Mount Vernon.

(1) Roadside Park. Between station 598+50 and station 606+00 on the left bank, the levee alinement passes through the city of Mount Vernon's Roadside Park. The park, shown on plate 20, was recently improved by local interests at a cost of $106,000 and contains a comfort station, picnic shelters including stoves and water, parking areas, sanitary dump station, children's play area, and a grassy overlook of the river. The park and the picturesque Skagit River can be viewed by motorists traveling on I-5 above the park and on Freeway Drive adjacent to the park. Since this part of the levee alinement has a particularly high esthetic value, careful detail has been given to preserving the area's natural beauty. A primary consideration is to preserve as much as possible the existing character and functional uses of Roadside Park. The design will retain the existing views of the river from the park, minimize the loss of park space, be compatible with the park environment, and protect the park from flooding. Alternative levee designs were evaluated on engineering, environmental, economic, and esthetic criteria: (1) raising Freeway Drive to act as the levee, (2) a standard floodwall between Freeway Drive and the railroad, (3) a standard floodwall along the edge of the parking areas, (4) a tilt-up floodwall along the parking area, (5) a standard floodwall along the river, (6) a tilt-up floodwall along the river, (7) raising the entire park area, (8) an earthen levee embankment, and (9) an aluminum floodwall.

Alternatives (1) and (2) were eliminated because of the longer, more costly alinement with anticipated high relocation costs. In addition, alternative (1) could result in serious traffic problems during flooded periods if Freeway Drive were closed. Alternatives (3) and (4) were dropped because the alinement is longer and more costly than an alinement along the riverbank and would leave much of the improvements in the park unprotected from flooding and susceptible to damage by drift and could create an eddy that would cause erosion problems. Alternative (9) would be similar to a wall designed by the Walla Walla District and built in 1956 at Kennewick, Washington, as part of the McNary Lock and Dam Project. This wall design was dropped from further consideration because the design was not suited to the height and length of wall under consideration, it would need a storage building, and the aluminum wall would be slower to erect than the tilt-up design.

(1) Acquisition/Relocation. At west Mount Vernon, the three blocks of the town riverward of the improved levee system contains 11 residences, a 40-lot trailer park, and one small retail firm. All of these improvements would be in the Skagit River floodway after the improved levee is built, and removal of these structures was deemed appropriate. The buildings would be purchased and removed, and the trailers relocated to another trailer park. In the Sterling and Nookachamps area, five trailers or modular homes would be relocated off of the flood plain and the land purchased in fee. In the Sterling area, 22 residences would be purchased and removed from the flood plain because the depth and velocity of floodwaters would cause severe erosion and danger to life during a major event. Included as part of the estimate is relocation assistance in accordance with the Uniform Relocation Assistance and Land Acquisition Policies Act. Total estimated acquistion/relocation costs for the project non-structural measures are about $2,240,000.

(2) Floodproofing. Included in this category are a number of measures to reduce flood damages, such as closing openings in buildings with temporary wooden or steel barriers reinforced with sandbags; building walls or berms around buildings subject to flooding; raising residential structures so that the first floor elevation would be 1 foot above the 100-year flood elevation; where farmers have livestock, raising their mounds or modifying their buildings to provide space for livestock, feed storage, and emergency milking operations above the 50-year flood elevation; and for garages, sheds and barns, modifying electrical, mechanical, or plumbing systems of the buildings to eliminate significant flood damages caused by the project. At Sedro Woolley, a berm would be built at the sewage treatment plant to floodproof it as well as several blocks of houses that would have been flooded without the berm. In east Mount Vernon, the two buildings outside the levee alinement, Moose Hall and Stokley-VanCamp warehouse, would be floodproofed or a flowage easement obtained. In the Nookachamps Creek and Sterling-south Sedro Woolley areas, 94 residences would be raised, 162 other buildings (barns, sheds, garages, etc.) floodproofed, and seven livestock mounds raised. Included as part of the estimate is relocation assistance for the residents while their residences are actually being raised. Total estimated floodproofing costs for the project are about $1,955,000.

(3) Flowage Easements. An analysis was made of the increased flooding that would be caused by the project. The with project 100-year flood levels would be about 1-1/2 to 2 feet higher than without the project in the Nookachamps Creek and Sterling areas and about 1 foot or less higher in the south Sedro Woolley area. The project would have no effect on the 12-year flood water surface (about the level of the 1975 flood). The 500-year flood would be less than a foot higher with the project than without it. Thus the effect of the project on water surfaces is zero for a 12-year flood,

builds to a maximum in the 50- to 100-year range, and then reduces to a negligible effect at greater than the standard project flood. An estimate was made of the amount of land where the extent of flooding (not depth) would be increased because of the project. The 12-year flood covers almost all the existing flood plain from Sedro Woolley to Mount Vernon, a strip estimated at 140 acres. Floodproofing for the buildings involved was included in the floodproofing estimate. Since this land is agriculture or pasture, the estimated cost of the flowage easements required is $7,000.

i. Land Acquisition. Land riverward of the existing levee is appraised at $500 per acre. For land landward of the existing levee, the following per-acre values are used depending upon the land use and location: agricultural, $3,000 to $5,000; industrial, $20,000; commercial, $40,000; and residential, $5,000 to $40,000. Total land required for the urban levees is about 278 acres. The local sponsor now owns in fee or controls with easements more than half of this total requirement. Flowage easements, part of the total land required (about 94 acres), will be needed for ponding areas along the overflow levees and for areas near the erosion control sill. In addition to the above permanent acquisitions, temporary construction easements will be required which average 10 feet wide on each side of the levee and total 78 acres.

SECTION 6. COST ESTIMATES

6.01 Construction Cost Estimate. Construction costs for work included in this design memorandum are summarized in table D6-1. The detailed cost estimate is shown on table D6-2. Costs are based on October 1978 price level.

TABLE D6-1

SUMMARY OF PROJECT COST ESTIMATE (OCTOBER 1978 PRICE LEVEL)

Federal Cost

Account No.	Feature		Cost
06	FISH & WILDLIFE		$ 180,000
11	LEVEES & FLOODWALL		$33,200,000
	Urban Levees	$20,950,000	
	Rural Levees	$12,250,000	
18	CULTURAL RESOURCES		$ 250,000
30	ENGINEERING & DESIGN		$ 4,450,000
	Urban Levees	$ 2,780,000	
	Rural Levees	$ 1,670,000	
31	SUPERVISION & ADMINISTRATION		$ 2,920,000
	Urban Levees	$ 1,840,000	
	Rural Levees	$ 1,080,000	
	NONSTRUCTURAL MEASURES		$ 4,000,000
	TOTAL FEDERAL COST		$45,000,000 1/

Non-Federal Cost

Item	Cost
1. Fish and Wildlife	$ 40,000
2. Urban Levees	$ 5,160,000
3. Rural Levees	3,200,000
4. Nonstructural Measures	1,000,000
5. Engineering & Administration	600,000
TOTAL NON-FEDERAL COST	$10,000,000 1/
TOTAL PROJECT COST	$55,000,000

1/The President's proposed cost-sharing policies will alter these totals to $44 million Federal and $11 million non-Federal. Details are in section 4 of the main report.

TABLE D6-2 (Con.)

	Feature or Item	Unit	Quantity	Unit Price	Amount
	FEDERAL COSTS				
11.	Levees & Floodwalls				
	URBAN LEVEES Sedro Woolley - Sterling				
1.	Clearing	Acre	4.3	$3,000.00	$ 12,900
2.	Stripping (6")	S.Y.	75,100	0.50	37,550
3.	Excavation, Common	C.Y.	59,000	3.50	206,500
4.	Embankment	C.Y.	125,000	4.70	587,500
5.	Gravel, Levee Top	C.Y.	3,000	5.00	15,000
6.	Gravel, Filter Blanket	C.Y.	2,100	6.70	14,070
7.	Backfill, Semi-impervious	C.Y.	59,000	8.00	472,000
8.	Riprap	C.Y.	32,000	12.10	387,200
9.	Topsoil (2")	C.Y.	2,600	8.00	20,800
10.	Topsoil (6")	C.Y.	2,500	6.00	15,000
11.	Seeding	Acre	1.6	1,500.00	2,400
12.	Culverts -				
	a. 18-inch	L.F.	200	15.00	3,000
	b. 24-inch	L.F.	100	20.00	2,000
13.	Flap Gates -				
	a. 18-inch	EA.	2	500.00	1,000
	b. 24-inch	EA.	1	800.00	800
14.	Concrete, Culvert Outlets	C.Y.	10	300.00	3,000
15.	Sheet Pile Cutoff Wall	S.F.	35,100	8.00	280,800
16.	Railroad Closure	EA.	1	L.S.	100,000
17.	Landscaping	Job	1	L.S.	31,000
			Subtotal		$2,192,520
			Contingencies		297,480
		Total Sedro Woolley - Sterling			$2,490,000

TABLE D6-2 (Con.)

	Feature or Item	Unit	Quantity	Unit Price	Amount
	Clear Lake-Nookachamps				
1.	Clearing	Acre	1.7	$3,000.00	$5,100
2.	Stripping (6")	S.Y.	37,000	0.50	18,500
3.	Pavement Removal	S.Y.	1,600	2.00	3,200
4.	Excavation, Common	C.Y.	1,700	3.50	5,950
5.	Excavation, Structural	C.Y.	300	8.00	2,400
6.	Embankment	C.Y.	111,000	4.70	521,700
7.	Gravel, Levee Top	C.Y.	1,200	5.00	6,000
8.	Riprap	C.Y.	300	12.10	3,630
9.	Topsoil (2")	C.Y.	2,000	8.00	16,000
10.	Seeding	Acre	8.5	1,500.00	12,750
11.	Culverts - 18-inch	L.F.	300	15.00	4,500
12.	Flap Gates - 36-inch	EA.	2	1,200.00	2,400
13.	Concrete, Culvert Outlets	C.Y.	600	300.00	180,000
14.	Reinforcing Steel	Lb.	48,000	0.50	24,000
15.	Cement	Cwt.	3,000	4.50	13,500
16.	Misc. Metal	Lb.	6,300	2.60	16,380
17.	Snag or Piling Removal	EA.	3	150.00	450
18.	Deck Grating	S.F.	300	15.00	4,500
19.	9' x 9' Sluice Gates	EA.	2	26,000.00	52,000
20.	6' x 6' Sluice Gates	EA.	1	15,700.00	15,700
21.	9' x 9' Flap Gates	EA.	2	16,000.00	32,000
22.	6' x 6' Barn Door Gates	EA.	1	9,000.00	9,000
23.	Elect. Equip.	Job	1	L.S.	2,000
24.	Power to Site	Job	1	L.S.	1,000
25.	Gate House	Job	1	L.S.	4,000
26.	Landscaping	Job	1	L.S.	16,000
			Subtotal		$972,660
			Contingencies		147,340
		Total Clear Lake-Nookachamps			$1,120,000

TABLE D6-2 (Con.)

	Feature or Item	Unit	Quantity	Unit Price	Amount
	NON-FEDERAL COSTS				
	Urban Levees Sedro Woolley-Sterling				
1.	Stripping (6")	S.Y.	2,700	$ 0.50	$ 1,350
2.	Pavement Removal	S.Y.	700	2.00	1,400
3.	Embankment, Road Fill & Ramps	C.Y.	3,600	4.70	16,920
4.	Gravel, Base Course	C.Y.	800	8.00	6,400
5.	Paving (2" A.C.)	S.Y.	3,100	4.00	12,400
6.	Topsoil	C.Y.	200	6.00	1,200
7.	Seeding	Acre	0.2	1,500.00	300
8.	Fences, Remove & Replace	L.F.	900	3.00	2,700
9.	Gates, 12 Foot	Ea.	10	500.00	5,000
10.	Power Poles	Ea.	4	300.00	1,200
11.	Guardrails	L.F.	300	12.00	3,600
12.	Relocate Buildings	Job	1	L.S.	30,000
13.	Lands, Improvements and Relocation Assistance	Job	1	L.S.	153,300
			Subtotal		$235,770
			Contingencies		44,230
		Total Sedro Wooley-Sterling			$280,000

TABLE D6-2 (Con.)

	Feature or Item	Unit	Quantity	Unit Price	Amount
	Clear Lake - Nookachamps				
1.	Stripping (6")	S.Y.	4,200	$ 0.50	$2,100
2.	Pavement Removal	S.Y.	1,300	2.00	2,600
3.	Embankment, Road Fill & Ramps	C.Y.	8,500	4.70	39,950
4.	Gravel, Base Course	C.Y.	1,300	8.00	10,400
5.	Gravel, Surface Course	C.Y.	100	10.00	1,000
6.	Double Bit-Surface Treat.	S.Y.	3,000	1.80	5,400
7.	Topsoil	C.Y.	200	6.00	1,200
8.	Seeding	Acre	0.4	1,500.00	600
9.	Fences, Remove and Replace	L.F.	2,100	3.00	6,300
10.	Gates, 12-foot	Ea.	5	500.00	2,500
11.	Relocate Buildings	Job	1	L.S.	50,000
12.	Guardrail	L.F.	1,000	12.00	12,000
13.	Remove Septic Tanks	Ea.	3	500.00	1,500
14.	Culverts, 18-inch CMP	L.F.	100	15.00	1,500
15.	Lands, Improvements and Relocation Assistance	Job	1	L.S.	170,800
			Subtotal		$307,850
			Contingencies		62,150
		Total Clear Lake - Nookachamps			$370,000

APPENDIX E
ECONOMIC EVALUATION

APPENDIX E

ECONOMIC EVALUATION

1. Introduction. This appendix presents procedures and projections used in determining benefits for a flood control project along the Skagit River below Sedro Woolley. Benefits considered were inundation reduction, National Economic Development (NED) employment, elimination of floodproofing costs, and intensification and location. Effectiveness of projects of various sizes was analyzed. A maximization study presents net benefits of these projects. Project year 1, the first year a project could be in operation, was assumed to be 1983.

2. Existing Average Annual Flood Damages - With Project Conditions. As shown in appendix A, existing average annual flood damages for the total flood plain area are $7,049,000. Out of this total, $6,850,000 are in those areas to be protected by the structural components of the proposed project and $199,000 are from those areas proposed for nonstructural measures. Figure 2-1 in the general design memorandum shows the flood plain under study. If the proposed project were in operation in October 1978, an estimated $5,455,000 in average annual damages would be prevented by the structural components, and $5,510,000 in average annual damages would be prevented by all proposals in the total project area, including those areas where nonstructural measures are proposed. The annual residual damages, or damages not prevented, would be about $1,539,000. Categorized existing average annual damages and residual damages were obtained for varying degrees of protection for each project area. These data were obtained by using Hydrologic Engineering Center Program 761-X6-L7580, Expected Annual Flood Damage Computation. Plate E-1 is an example of a summary printout for the Left Bank Urban Areas. Table E-1 summarizes these data at October 1978 price levels for the following areas: Right Bank Urban Areas; Left Bank Urban Areas; Rural Areas; Samish Overflow; Clear Lake; and unleveed areas at west Mount Vernon, Nookachamps, Sterling Area east of Burlington, and Sedro Woolley. These areas are displayed on figure 2-1 in the general design memorandum.

3. Average annual damages prevented were taken as project benefits only for the structural portion of the proposed project. Benefits for the nonstructural components of the project[1/] are presented in table E-2 and were calculated in accordance with ER 1105-2-353, "Evaluation of NED Benefits and Costs for Evacuation and Relocation as Nonstructural Measures for Flood Plain Management."

1/A description of the nonstructural components of the proposed project can be found in Appendix D, Engineering, Design, and Cost Estimates.

TABLE E-1

AVERAGE ANNUAL DAMAGES WITHOUT THE PROPOSED PROJECT,
RESIDUAL DAMAGES AND DAMAGES PREVENTED WITH PROPOSED PROJECT
SKAGIT RIVER FLOOD PLAIN
(October 1978 Prices and Conditions; $1,000)

Category	Without Project Existing Annual Damages	With Project Residual Annual Damages	 Average Annual Damages Prevented
Right Bank Urban Areas:			
Residential Structures	$522	$197	$325
Residential Contents	235	86	149
Commercial/Industrial	389	121	268
Emergency Aid	136	40	96
Public	161	45	116
Agricultural	47	14	33
Other	92	23	69
SUBTOTAL	$1,582	$526	$1,056 1/
Left Bank Urban Areas:			
Residential Structures	$902	$34	$868
Residential Contents	419	14	405
Commercial/Industrial	908	41	867
Emergency Aid	146	5	141
Public	580	23	557
Agricultural	33	1	32
Other	42	2	40
SUBTOTAL	$3,030	$120	$2,910 2/

1/Selected project provides 100-year (185,000 c.f.s.) or more protection.
2/Selected project provides SPF protection.

TABLE E-1 (con.)

Category	Without Project Existing Annual Damages	With Project Residual Annual Damages	With Project Average Annual Damages Prevented
Rural Areas:			
Residential Structures	$419	$122	$297
Residential Contents	232	65	167
Commercial/Industrial	149	59	90
Emergency Aid	411	101	310
Public	150	57	93
Agricultural	666	238	428
Other	24	8	16
SUBTOTAL	$2,051	$650	$1,401 [2/]
Other Areas - Structural:			
Samish Overflow	$137	$81	$56 [2/]
Clear Lake	50	18	32 [1/]
SUBTOTAL	$187	$99	$88
TOTAL STRUCTURAL PROJECT	$6,850	$1,395	$5,455
Other Areas - Nonstructural:			
Unleveed West Mt. Vernon	$13	$0	$13 [3/]
Nookachamps Area	77	46	31 [3/]
Sterling Area	16	3	13 [3/]
Sedro Woolley	93	95	-2 [3/]
SUBTOTAL - Nonstructural Project	$199	$144	$55
GRAND TOTAL	$7,049	$1,539	$5,510

1/Selected project provides 100-year (185,000 c.f.s.) protection.
2/Selected project provides 50-year (162,000 c.f.s.) protection.
3/Damages prevented but not claimed as benefits per ER 1105-2-353. Benefits are shown on table E-2.

a. Residual Damages. Residual damages shown in table E-1 were based on the assumption that inundation of areas protected by the structural project would result from floods exceeding the selected level of protection. In these areas, damages from flows greater than the design flood would be the same with or without the proposed project. In the unleveed areas, residual damages are those which would continue to be incurred after the nonstructural measures described in appendix D are in effect.

b. Induced Damages. In the unleveed areas, flood depths from a 50-year to about a 500-year event would be increased by the downstream levees. With the nonstructural measures described in appendix D in effect, no structures will incur increased flood damages as a result of the proposed project. South of Sedro Woolley, the 50-year and 100-year water surface profiles would be raised by about 1 foot. A log storage area and about 4,000 lineal feet of railway line may incur minor additional damages from these events. Average annual induced damages to these facilities were estimated at $11,000.

c. Standard Project Flood - With and Without the Project. Standard project flood (SPF) damages with and without the proposed project have been estimated under existing and future conditions. Future flood plain development with the project was not expected to differ significantly from without the project due to local land-use zoning ordinances, the relatively low level of flood protection to be provided in the rural areas, and the current intensive flood plain land use in the urban areas. Except for the Left Bank Urban Areas, which would receive SPF protection, future SPF damages in areas protected by the structural project were expected to increase at the same rate of growth as analyzed in paragraph 4, both with and without the project. In the unleveed areas, SPF damages with the project are those which would occur with nonstructural measures in effect. Table E-5 presents SPF damages under existing and future conditions, with and without the project.

6. Inundation Reduction Benefits - Future Conditions.

a. Discounted Benefits. Future growth in benefits in the flood hazard areas to be protected will be at the average annual rates displayed in table E-3. Application of average annual growth factors associated with these growth rates indicates that by the first year of project operation (1983), total average annual benefits will be $5,589,000. For the 100-year project life (1983-2083), discounted average annual equivalent benefits are expected to be $6,018,000. Table E-6 shows the discounted benefits by category.

b. Undiscounted Benefits. Table E-7 presents benefits as undiscounted average annual values for present conditions (October 1978), for project year 1 (1983), and for subsequent decades following plan which enables existing flood plain activities to utilize their land more intensively. The flood plain presently is used for residential development, commercial and industrial development, and agricultural production. The majority of the land is currently at its highest and best use. No land is anticipated to change use or go to a higher or more intensive use as a direct result of the proposed project. Therefore, location and intensification benefits were not taken as project benefits.

12. Project Justification.

a. Average Annual Charges. The detailed cost estimate for both the Federal and non-Federal first costs associated with the proposed project can be found in appendix D. Estimates of annual charges were based on a 100-year period of analysis or economic life. As the construction period was estimated at 4 years, interest during construction (IDC) was included in the total investment cost. Interest and amortization charges and IDC costs were based on a 6-7/8 percent interest rate. Estimated annual operation and maintenance costs were also included. Table E-9 summarizes total annual charges.

b. Existing and Future Conditions. Table E-10 presents a summary of annual benefits and costs under existing and future conditions. Existing conditions include benefits which would accrue to the plan if the proposed project were constructed and in place in October 1978. Future conditions include benefits which would be realized if the project were completed in 1983 and had an effective economic life of 100 years.

TABLE E-9

PROJECT COSTS
(October 1978 Prices and 6-7/8 Percent Interest)

Federal Costs	$45,000,000
Non-Federal Costs	10,000,000
Total Estimated Construction Cost	$55,000,000
Interest During Construction	$7,563,000
Total Investment Cost	$62,563,000
Annual Costs:	
Interest and Amortization	$4,307,000
Operation and Maintenance	90,000
TOTAL	$4,397,000