

089955

B-136280
9-19-72



RESTRICTED — Not to be released outside the General Accounting Office except on the basis of specific approval by the Office of Legislative Liaison, a record of which is kept by the Distribution Section, Publications Branch, OAS

RELEASED

Computation Of
Flood Control Benefits For The
Cascadia Reservoir Project, Oregon,
Not Adequately Supported B 136280

Corps of Engineers (Civil Functions)
Department of the Army

*BY THE COMPTROLLER GENERAL
OF THE UNITED STATES*

089955

9734 72

SEPT 10, 1972



COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON DC 20548

B-136280

Dear Senator Packwood.

This is our report on inadequate computation of flood control benefits for the Cascadia Reservoir Project, Oregon. Our review was made pursuant to your request of August 6, 1971. Whereas the matters presented in this report have been discussed with officials of the Corps of Engineers, we have not obtained the comments of the Department of the Army.

We plan to make no further distribution of this report unless copies are specifically requested, and then we shall make distribution only after your agreement has been obtained or public announcement has been made by you concerning the contents of the report.

Sincerely yours,

A handwritten signature in cursive script that reads "James B. Stacks".

Comptroller General
of the United States

The Honorable Bob Packwood
United States Senate

C o n t e n t s

	<u>Page</u>
DIGEST	1
CHAPTER	
1 INTRODUCTION	5
Benefit-cost analysis	7
2 CORPS' ACTIONS PLANNED TO VERIFY CASCAIDA'S FLOOD CONTROL BENEFITS	9
Cascadia's ability to control floods	9
Determining flood damage	11
Projecting future growth in the flood plain	14
Summary	16
Recommendation to the Secretary of the Army	16
Actions planned by the Portland District	17
3 OTHER PROJECT MATTERS CONSIDERED DURING OUR REVIEW	19
Reporting benefit-cost ratios	19
Conclusions	20
Recommendation to the Secretary of the Army	21
Review of Cascadia's postauthorization studies	21
Effect of interest rates on Cascadia's benefit-cost ratio	23
APPENDIX	
I Letter dated June 5, 1972, from the District Engineer, Portland District, Corps of En- gineers, to the General Accounting Office	27

ABBREVIATIONS

GAO	General Accounting Office
OCE	Office of the Chief of Engineers
OMB	Office of Management and Budget

CHAPTER 1

INTRODUCTION

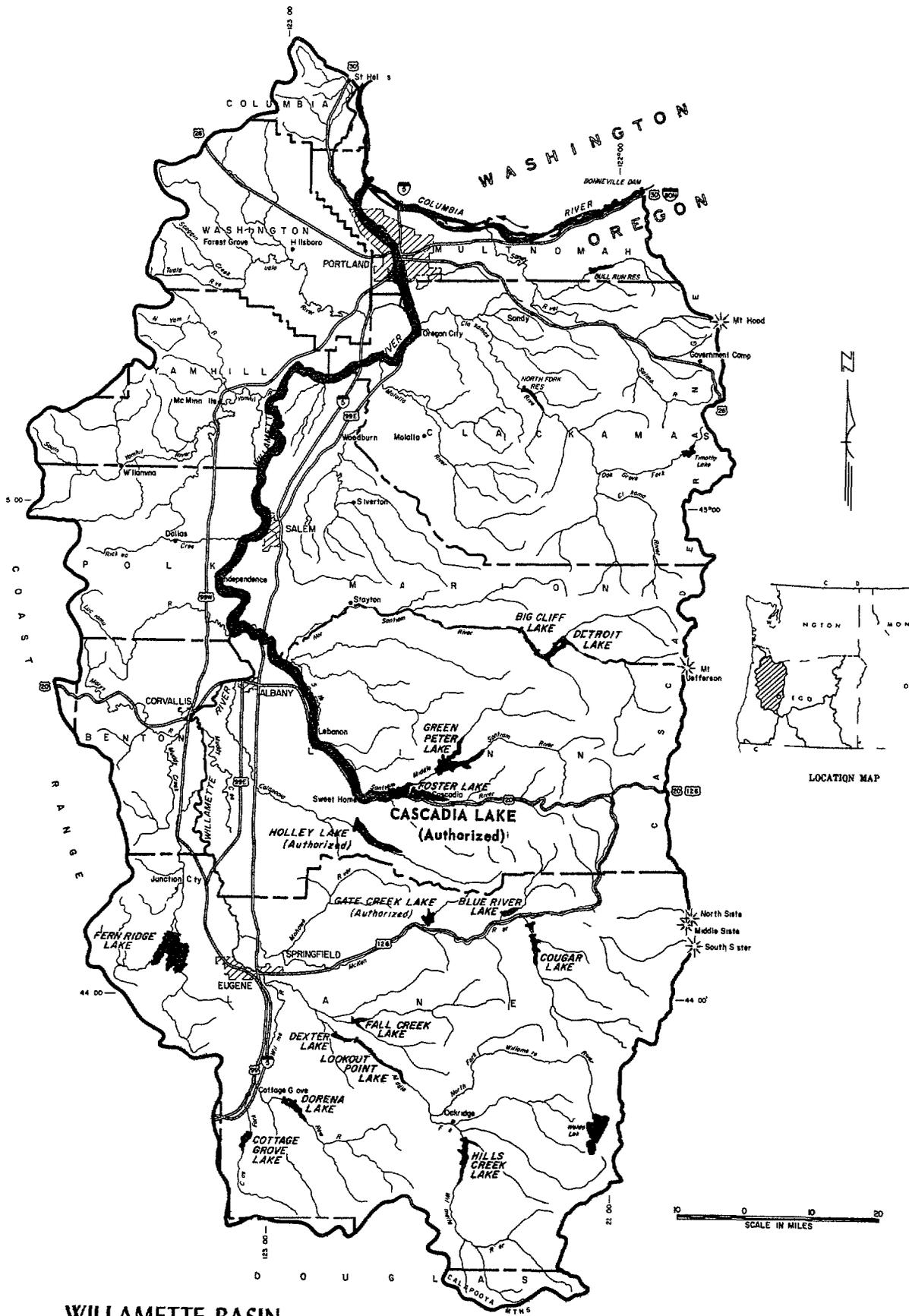
At the request of Senator Bob Packwood, we reviewed the Corps of Engineers' computation of flood control benefits for the Cascadia Dam and Reservoir, South Santiam River, Oregon. The review was performed at the Corps' district office in Portland, Oregon, which had developed the data and performed the studies used in computing the project's flood control benefits. Whereas the matters presented in this report have been discussed with Corps officials, we did not obtain comments from the Department of the Army.

The Flood Control Act of 1962 (Public Law 87-874) authorized construction of the Cascadia Dam and Reservoir, a multiple-purpose project to be located on the South Santiam River in the Willamette River Basin. In addition to controlling floods, the project will provide recreation, navigation, and downstream power.

To control floods on the Willamette River Basin, the Corps planned to construct a system of 14 multiple-purpose dams, of which 11 are completed and functioning; Cascadia would be the 12th dam. Two additional projects--Gate Creek and Holley--have been authorized but, like Cascadia, are not yet under construction.

The map on the following page shows the 14 multiple-purpose Corps' projects in the Willamette River Basin. Cascadia would help control floods for about 160 miles from its site on the South Santiam River to the Columbia River, immediately downstream from Portland. Corps' studies show major flood-damage centers downstream from Cascadia in the Salem, Oregon City, and Portland areas.

The estimated cost to construct Cascadia increased from \$28.4 million at the time it was authorized in 1962 to \$58.4 million as of January 1972. Although about \$1.1 million had been appropriated for project studies through fiscal year 1971, the Congress did not approve the first request for \$600,000 for project construction in the President's fiscal year 1972 budget, because the South Santiam River could possibly be declared a scenic waterway under Oregon's



WILLAMETTE BASIN

1970 Scenic Waterways Act. A Portland District official advised us that the President's fiscal year 1973 budget did not include a request for project construction funds because the scenic waterway issue had not been resolved.

On May 16, 1972, the Oregon State Highway Commission recommended to the Governor that the South Santiam River not be designated a scenic waterway. The State Water Resources Board made the same recommendation to the Commission. Since the Governor is authorized to designate new scenic waterways only after they have been recommended by both the Highway Commission and the Water Resources Board, the scenic waterway issue apparently may no longer affect Cascadia.

As of June 1972, the Portland District had not prepared its fiscal year 1974 budget estimate. Any decision to include construction funds for Cascadia in the fiscal year 1974 budget would be made later, according to a district official.

BENEFIT-COST ANALYSIS

Benefit-cost analysis is the Corps' basic tool for economically evaluating a project. Project benefits are the net identifiable increases in goods or services which result from project construction. Flood control benefits include reduction in flood damage and the increased utilization or enhancement of property that will result because of the project.

The district used two approaches--the incremental approach and the system approach--to compute Cascadia's flood control benefits and used both to develop project benefit-cost ratios.

The incremental approach attempts to identify the specific value of benefits gained, from the value of costs to construct, operate, and maintain the project. This approach determines flood control benefits by comparing existing flood conditions with the conditions that would exist if the project were constructed. Thus, the incremental approach credits benefits to Cascadia which result directly from its construction.

The system approach attempts to allocate to each project the total estimated flood control benefits from all existing and authorized projects in the Willamette River Basin. Total system benefits are the sum of the benefits determined for each project in the system using the incremental approach, plus the benefits resulting from the increased effectiveness of the projects acting as a system. The system approach determines a project's share by distributing the total benefits among all the projects of the system according to the extent that each project would reduce flood stages. The system approach assumes Cascadia would help control all floods, including the smaller, more frequent ones.

Using a system approach, the district estimated in January 1972 that Cascadia's annual project benefits were about \$11.7 million, of which flood control benefits accounted for \$10.8 million, or about 92 percent. The district also computed a 4.18-to-1 benefit-cost ratio for Cascadia.

Using the incremental approach, the district computed the benefit-cost ratio at 1.32 to 1, with total average annual benefits of about \$3.7 million. About \$2.8 million, or 76 percent, of this amount is for flood control.

We primarily examined the Corps' incremental approach to compute flood control benefits, because this approach identifies only those benefits resulting directly from Cascadia's construction and does not allocate benefits claimed for the whole system.

In chapter 3, we discuss our views on the Corps' need to report to the Congress the benefit-cost ratio resulting from both the incremental and system approaches.

CHAPTER 2

CORPS' ACTIONS PLANNED TO VERIFY

CASCADIA'S FLOOD CONTROL BENEFITS

Flood control benefits are estimated by determining the project's capability to reduce flood stages throughout the range of possible floods and the damages which reducing flood stages would prevent

Existing Corps' projects afford a high degree of flood protection to the Willamette River Basin. Most of the flood control benefits estimated by the Corps to justify constructing Cascadia and other proposed basin projects under study were derived on the basis of providing additional protection against floods greater than the largest recorded flood.

Our review of available documentation raised questions as to whether the Corps' support for three key issues was adequate: (1) Cascadia's ability to control the full range of floods for which they claimed benefits, (2) the damages which would be prevented by controlling floods greater than the largest recorded flood, and (3) the projected increased value of damageable property in the flood plain over the economic life of the project.

CASCADIA'S ABILITY TO CONTROL FLOODS

The Portland District estimated that Cascadia would provide some control over all floods in the Willamette River Basin up to that flood which would occur once in 10,000 years. This estimate is particularly significant for the basin because Corps' studies show that the highest recorded flood occurred in December 1964 and had a recurrence probability of once in 100 years.

Information from the district shows that about 62 percent of Cascadia's flood control benefits are associated with the project's ability to control large floods which would occur less frequently than once in 100 years. The 11 existing projects are designed to control the smaller, more frequent floods to stages at which relatively small damage would result.

To determine Cascadia's ability to control the full range of recorded and projected floods, the district analyzed the project's capability to reduce flows of five floods up to the 100-year flood level.

The district then developed a hypothetical flood for the Willamette River Basin called a Standard Project Flood and studied Cascadia's capability to exhibit some control over it. Corps' regulations define "Standard Project Flood" as a flood which:

"*** may be expected from the most severe combination of meteorologic and hydrologic conditions that are considered reasonably characteristic of the geographical region involved, excluding extremely rare combinations."

The Standard Project Flood for the Willamette River Basin has a recurrence frequency of once in 500 years.

For projected floods more severe than the Standard Project Flood, the district estimated that Cascadia's effectiveness would gradually decrease to zero for the 10,000-year flood in all reaches¹ except Portland, where the limit would be a 5,000-year flood. Because no known floods had approached these magnitudes, the dam's effectiveness was based on judgment; no studies had been made to support Cascadia's capability to control floods above the Standard Project Flood.

The following table compares Cascadia's total flood control benefits claimed and that portion of these benefits derived from floods more severe than the 500-year flood.

¹When typical flood damage is analyzed, the area subject to flooding is divided into subareas, usually designated as river reaches. In selecting the reaches, the district considers factors such as political boundaries, zoning plans, and differences in development.

<u>River reach</u>	<u>Percent of total flood control benefits</u>	<u>Percent of total benefits due to floods over the 500-year frequency</u>
South Santiam	5	1
Santiam	6	1
Salem	21	1
Grand Island	9	0
Newberg	2	0
Oregon City	20	2
Portland	<u>37</u>	<u>18</u>
Total	100	24 ^a

^aDifference due to rounding

Although approximately 24 percent of the benefits claimed for Cascadia were attributed to more severe floods than those which would occur once in 500 years, the district did not study the project's capability to control these larger floods.

DETERMINING FLOOD DAMAGE

To assign dollar values to the expected flood level reductions, the district estimated the damages from the full range of floods that Cascadia would help control. It used damage surveys from the 1955 flood (a 10-year flood) and the 1964 flood (a 100-year flood) to establish damage values for floods that would occur once in 100 years. For floods above the 100-year level, an upper limit damage value was estimated on the basis of a 10,000-year flood (a 5,000-year flood was used in the Portland reach).

The following table compares the actual damages caused by the 100-year flood and the district's estimate for the upper limit flood.

<u>River reach</u>	Surveyed damages for 100-year flood (note a)	Estimated damages for upper limit flood (note a)
	(millions)	
South Santiam	\$ 3.7	\$ 16.7
Santiam	1.3	7.6
Salem	7.6	172.0
Grand Island	4.8	18.3
Newberg	1.2	5.8
Oregon City	17.0	80.8
Portland	11.2	585 0

^aAll damages at 1965 price levels

The district used these limits to establish damage values for intermediate floods, although the upper limit damage value was an estimate. It did not conduct damage surveys or studies to support either the upper limit values or the damage values for the intermediate floods above the 100-year level.

The following table shows the portion of the total flood control benefits that are derived from floods more severe than those which occur once in 100 years.

<u>River reach</u>	Percent of total flood control benefits	Percent of total benefits due to floods over the <u>100-year frequency</u>
South Santiam	5	2
Santiam	6	1
Salem	21	8
Grand Island	9	2
Newberg	2	-
Oregon City	20	13
Portland	<u>37</u>	<u>35</u>
Total	<u>100</u>	<u>62</u> ^a

^aDifference due to rounding.

About 62 percent of Cascadia's claimed flood control benefits are for floods over the 100-year frequency. Damage surveys or studies do not support such benefits.

PROJECTING FUTURE GROWTH
IN THE FLOOD PLAIN

To project increased property value that would occur in the flood plain during Cascadia's economic life, the district applied the following factors: (1) the normal growth rate, (2) the induced growth rate, and (3) nonstructural alternatives, such as floodproofing and flood plain zoning.¹

The district developed the normal growth rate to reflect long-term increases in economic development in the area subject to flooding, using the 1969 Willamette Basin Comprehensive Study Report² as its primary source. District officials advised us that the report showed regional and sub-regional growth rates but not specific growth rates for the flood plain. Corps regulations make the following reference to regional studies.

"Trends and forecasts developed for larger areas, such as entire cities, metropolitan areas, river basins or states, should not be assumed directly applicable to flood areas in estimating flood damages and flood control benefits, without adequate demonstration of their applicability, or adjustment to the smaller areas."

¹"Floodproofing" is a combination of structural changes and adjustments to properties subject to flooding primarily to reduce or eliminate flood damage. "Flood plain zoning" is a legal means used by the local community to preclude the occupancy of the flood plain by certain types of residential, commercial, or agricultural development.

²The report resulted from a comprehensive study of water and related land resources in the Willamette River Basin. The study was directed and coordinated by the Pacific Northwest River Basins Commission's Willamette Basin Task Force. The task force consisted of representatives of six Federal departments, the Federal Power Commission, and the State of Oregon.

District officials said that they had not made studies of the flood plain which would determine whether the normal growth rates used were applicable.

The district developed the induced growth (or land enhancement) rate to estimate the increased use of property that further flood protection from the project would make possible. Concerning the derivation of induced growth rates, Corps regulations state:

"Evaluation *** will require consideration of past use of the affected property and the probable future uses of the property ***. Care must be taken to exclude that portion of the earning power of property creditable to the additional investments other than for flood control, that must be made in order to realize an increased or higher utilization of the property. This is particularly important when use of land for residential and industrial purposes is involved. *** Increased utilization benefits will be evaluated on the basis of sound and conservative estimates of probable future land use."

District officials based the induced growth rate on their professional judgment and not on a study of the flood plains. They expect most of the induced growth in the flood plain to accrue from converting agricultural land to residential or industrial use.

The third economic factor was an adjustment to reflect nonstructural alternatives to constructing the project, such as floodproofing and flood plain zoning. This adjustment assumes that maximum floodproofing and flood plain zoning will reduce the growth of flood damageable property in the 100-year flood plain. Thus, this factor reduces the flood control benefits claimed.

The district made the following adjustments for nonstructural alternatives for Cascadia.

1. A 10-percent reduction in existing urban benefits within the 100-year flood plain.

2. A 50-percent reduction in future urban benefits within the 100-year flood plain.

District officials made these adjustments on the basis of professional judgment and not on specific studies.

SUMMARY

The district estimated that Cascadia would help control floods up to the 10,000-year flood level. However, the district did not study or demonstrate the project's capability to control floods greater than that flood which would occur once in 500 years. About 24 percent of Cascadia's flood control benefits are attributed to its capability to provide some control over such floods.

The district estimated the damage which would result from all possible floods up to the 10,000-year flood. Their estimates, however, were limited to determining damages which resulted from recorded floods, the highest of which had a recurrence probability of once in 100 years. The district did not make any studies to support its projections of flood damages from the 100-year to the 10,000-year flood. About 62 percent of Cascadia's flood control benefits are dependent on the projected damage values for floods greater than the 100-year flood.

The district determined future growth in the value of damageable property in the flood plain during the project's 100-year economic life by estimating the normal growth rate, the induced growth rate, and the potential effects of measures such as flood plain zoning. The normal growth rate was estimated from basin and subbasin growth rate data on the total Willamette River Basin and was not supported by studies of potential growth rate within the flood plain to be affected by Cascadia. The district based the induced growth rate and the potential effects of growth due to zoning on professional judgment rather than on specific studies.

RECOMMENDATION TO THE SECRETARY OF THE ARMY

We recommend that additional studies be made to verify the flood control benefits claimed for Cascadia.

ACTIONS PLANNED BY THE PORTLAND DISTRICT

We discussed the need for additional studies to support the flood control benefits claimed for Cascadia with Corps officials at the Office of the Chief of Engineers (OCE) in March 1972 and with district officials in May 1972.

By letter dated June 5, 1972 (app. I), the District Engineer, Portland District, advised us of the district's plans to initiate studies to verify damage values estimated for flood stages above the 100-year flood.

Referring to the damage studies, the District Engineer stated:

"*** The Portland District agrees that there is a need to verify flood frequency-damage relationships for rare floods based on detailed field studies to resolve the issues raised and to provide better data for other Willamette Basin projects. Because of the critical manpower shortage in the District and the urgency for completion of the damage survey, we propose to accomplish this work through contractual agreements with one or more architect-engineering firms.

"The initial contract, which we are presently preparing, will cover field and office work for re-evaluating flood stage-damage relationships for the Portland reach of Willamette River which extends from the mouth of the Willamette to Oregon City. Our plans call for this work to be under contract by 30 June 1972. Work on the remaining reaches of the basin will follow as funds become available ***."

Concerning other issues which relate to computing flood control benefits, the District Engineer stated:

"We also recognize the need for developing more supporting data pertaining to hydrologic analysis and economic growth in the various reaches of the flood plain. Our present plan is to conduct the necessary work for resolving these two

problem areas in-house as the Corps of Engineers has special expertise in these two fields. Attached is a brief outline of the scope and coverage we feel is required."

The first contract, according to district officials, was let on June 30, 1972, to map the Portland river reach and to develop procedures to be applied in studying the other river reaches.

We believe that the studies, as summarized in the outline of study requirements attached to appendix I, should provide the additional data needed to better determine the flood control benefits to be expected from Cascadia and other planned Willamette River Basin projects.

CHAPTER 3

OTHER PROJECT MATTERS CONSIDERED

DURING OUR REVIEW

We considered other matters relating to the project such as (1) the Corps' method of reporting benefit-cost ratios to the Congress, (2) the Corps' review of Cascadia's postauthorization studies, and (3) the effect of interest (discount) rates on the project's benefit-cost ratio.

REPORTING BENEFIT-COST RATIOS

In our opinion, the Corps did not fully disclose Cascadia's economic effectiveness to the Congress because the Corps, in requesting postauthorization study and construction funds, reported benefit-cost ratios which include flood control benefits not directly attributable to Cascadia.

The benefit-cost ratio compares the estimated average annual benefits to be realized from a project with its estimated average annual costs. As such, the Corps used it as the prime indicator of economic effectiveness. It is the principal single factor provided to the Congress which can compare and evaluate a project's relative economic effectiveness and merit.

The Corps had used two approaches--the incremental and the system--to compute project benefits and to report project benefit-cost ratios. With one exception, the Corps had reported to the Congress only those benefit-cost ratios for Cascadia determined on the system approach. According to a North Pacific Division official, the Corps reported only Cascadia's system benefit-cost ratio in its requests for postauthorization study funds and in its initial request for construction funds for fiscal year 1972. The only time Cascadia's incremental benefit-cost ratio was reported to the Congress was in July 1971 in recall testimony on the fiscal year 1972 budget.

The two approaches resulted in markedly different ratios. Portland District analyses prepared in January 1972

showed benefit-cost ratios for Cascadia of 4.18 to 1 under a system approach and 1.32 to 1 under an incremental approach. The following table shows Cascadia's benefits and costs under the two approaches.

<u>Approach</u>	<u>Average annual benefits</u>			<u>Average annual cost</u>	<u>Benefit-cost ratio</u>
	<u>Flood control</u>	<u>Other</u>	<u>Total</u>		
	----- (millions) -----				
System	\$10.8	\$0.9	\$11.7	\$2.8	4.18 to 1
Incremental	<u>2.8</u>	<u>.9</u>	<u>3.7</u>	<u>2.8</u>	1.32 to 1
Difference	<u>\$ 8.0</u>	<u>\$ -</u>	<u>\$ 8.0</u>	<u>\$ -</u>	

The difference in benefit-cost ratios shown by the table is due solely to the \$8 million difference in flood control benefits.

Cascadia would derive the major portion of its benefits from reducing floods in excess of the 100-year flood, because projects already constructed effectively control the smaller, more frequent floods. The system approach, however, assumes that Cascadia helps control all floods including those smaller, more frequent ones.

Senate Document 97, Eighty-seventh Congress, second session, provides guidance in formulating, evaluating, and reviewing plans for using and developing water and related land resources. Senate Document 97 requires that tangible benefits exceed project costs. It defines "benefit" as increases or gains in the value of goods and services which result from conditions with the project, compared to conditions without the project. Thus, we believe that using an incremental analysis to determine a project's economic feasibility would comply with Senate Document 97.

Conclusions

Because some projects' benefit-cost ratios are reported on an incremental approach and others such as Cascadia are reported on a system approach, the Congress does not have the information necessary to judge the projects' relative effectiveness or merit. This could result in approving

projects which are far less deserving than others being considered.

We believe that the incremental approach best measures Cascadia's economic effectiveness because it compares the increase in benefits to be provided by the project with the project costs.

Recommendation to the Secretary of the Army

Whereas the Corps may wish to inform the Congress of a project's benefit-cost ratio determined by the system approach, we recommend that the Corps also report the incremental benefit-cost ratio to the Congress when it requests project authorization or appropriations for construction.

REVIEW OF CASCADIA'S POSTAUTHORIZATION STUDIES

The Corps requested funds to construct Cascadia before it had formally reviewed and approved the Portland District's postauthorization studies of the project.

The first request for Cascadia's construction funds was contained in the President's fiscal year 1972 budget. Referring to funding requirements, the Corps' regulations on postauthorization studies state that:

"Post-authorization studies of individual projects will normally require, as a minimum, the submission of a general design memorandum in two phases followed by feature design memorandums covering separate aspects of the work. In Phase I of the general design memorandum, appropriate studies and investigations will be made to either reaffirm the authorized project or reformulate the project to meet present day conditions and/or criteria. Phase I will be primarily a planning document in which formulation, evaluation, coordination, and preliminary cost allocation will be presented in sufficient detail to support the conclusions and recommendations made. Phase II will be *** concerned primarily with the technical design of the structures ***."

Corps' regulations further state that the postauthorization schedule:

"*** should provide for approval of Phase II *** of the general design memorandum prior to the request for funds to initiate construction of the project."

At the time of our review, the only postauthorization studies submitted to OCE for formal review and approval were the district's design memorandums covering the project's hydrological aspects and site selection. The district was completing the general design memorandum, which discusses the flood damage and economic analysis. OCE officials had not reviewed the details supporting the district's determination of flood control benefits for Cascadia.

In March 1972 we discussed our preliminary findings with OCE officials to determine whether they felt the district's procedures in determining Cascadia's flood control benefits were appropriate and adequate. They concluded that more analysis and support were needed to justify the district's conclusions.

OCE, in our opinion, should have reviewed and approved Cascadia's postauthorization studies before it requested construction funds from the Congress. Subsequently, OCE officials plan to explore certain aspects of the project with the district office, such as the development of the hydrologic aspects of the project, the methodology used in evaluating Cascadia's flood control benefits, and the Corps' policy of reporting project economic feasibility with both systems and incremental analyses to the Congress. As discussed on pages 17 and 18 of this report, the Portland District plans additional studies.

EFFECT OF INTEREST RATES ON
CASCADIA'S BENEFIT-COST RATIO

A major factor in the Portland District's determination of Cascadia's flood control benefits and the resulting benefit-cost ratio is the interest or discount rate.¹ Opponents of the project have questioned the interest rate applied to Cascadia's economic analysis because they believe that it is too low. Corps' regulations and directives allow the 3-1/4-percent rate used for Cascadia. The incremental approach would not economically justify Cascadia if the interest rate exceeded 4 percent.

Senate Document 97, approved May 15, 1962, provides guidance on the interest rate to be used. It states:

"The interest rate to be used in plan formulation and evaluation for discounting future benefits and computing costs, or otherwise converting benefits and costs to a common time basis shall be based upon the average rate of interest payable by the Treasury on interest-bearing marketable securities of the United States outstanding at the end of the fiscal year preceding such computation which, upon original issue, had terms to maturity of 15 years or more."

Cascadia was authorized in 1962 on the basis of economic analysis using a 2-5/8-percent interest rate. A district official said that the interest rate required for updating economic analyses of the project increased annually until fiscal year 1968 when it reached 3-1/4 percent.

¹In formulating water resources projects, the values of benefits and costs that accrue at varying times are comparable only if all are adjusted to a uniform time basis. The use of interest rates provides a means for converting estimates of benefits and costs to a common time point or period.

In December 1968, the Office of Management and Budget (OMB) announced that it was adopting a new formula to compute the discount rate to be used in formulating plans and analyzing the economics of Federal projects. In announcing the formula, the OMB instructions stated that the new rate would be applied to future projects, and that "The old rate--3 1/4 percent--will be used on authorized projects if non-Federal financial commitments are made by December 31, 1969." Subsequent OCE instructions added the following criteria:

"For any active projects that have no requirements of local cooperation or reimbursement, a discount rate of 3 1/4 percent will be used."

Pending completion of Bureau of Reclamation studies on possibly using the project for irrigation (a purpose which would require reimbursement), there are no allocated share of costs for non-Federal interests to repay for Cascadia. Neither are there any other reimbursable, or potentially reimbursable, project purposes involved. Thus, the Corps believes that Cascadia can continue to use the 3-1/4-percent interest rate.

Since 1968 a statement of the discount (interest) rate to be used during the ensuing fiscal year has been published annually in the Federal Register. For fiscal year 1972 this interest rate was 5-3/8 percent. But this rate does not apply to Cascadia.

On December 21, 1971, the Water Resources Council published a study, entitled "Proposed Principles and Standards for Planning Water and Related Land Resources," in the Federal Register. The principles and standards suggested that discount rates from 7 to 10 percent may be appropriate and proposed that a 7-percent rate be used to evaluate water resource projects during the next 5 years, because the rate approaches the total cost of Federal borrowing. If adopted by the Federal Government, these proposed principles and standards would replace those contained in Senate Document 97.

To determine the potential impact of the Water Resources Council's proposal regarding discount rates, the Corps

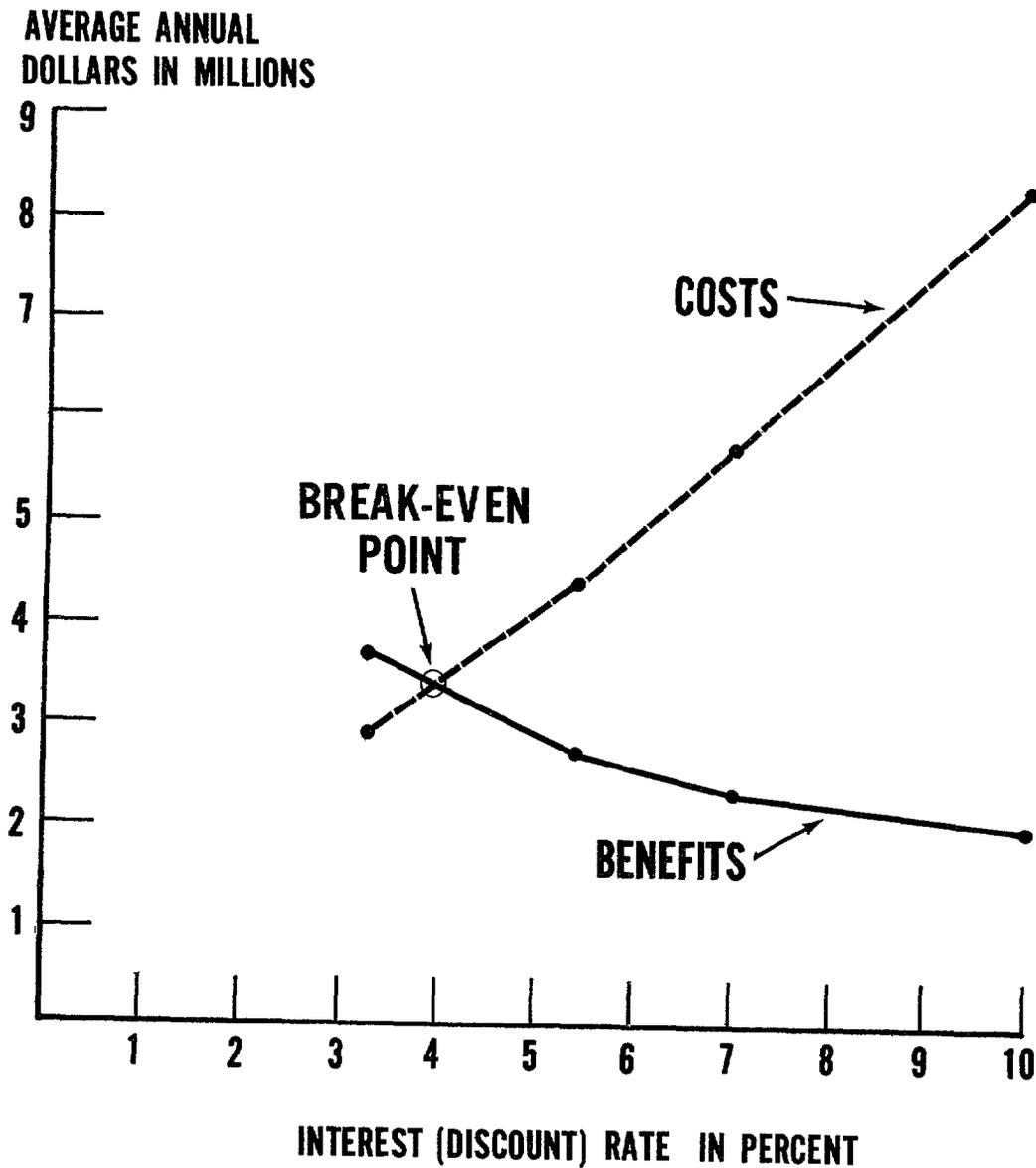
reevaluated the economic feasibility of proposed and authorized but unconstructed projects using the proposed interest rates. Using an incremental approach the Portland District analyzed the economic feasibility of Cascadia using the 3-1/4-percent rate, the fiscal year 1972 rate of 5-3/8 percent, and the proposed rates of 7 and 10 percent. Cascadia's benefit-cost ratio for each of the interest rates was as follows:

<u>Interest rate used</u>	<u>Benefit-cost ratio</u> <u>(note a)</u>
3-1/4%	1.29 to 1
5-3/8	.61 to 1
7	.41 to 1
10	.24 to 1

^aThe Portland District subsequently reevaluated project costs. As a result, the costs decreased and the benefit-cost ratio increased. The incremental benefit-cost ratio shown elsewhere in this report (1.32 to 1) is based on the revised costs.

The sensitivity of Cascadia's economic feasibility under the incremental approach to changes in the interest rate is depicted on the chart on the next page. It shows that at any interest rate above 4 percent Cascadia would not be economically justified.

CASCADIA RESERVOIR PROJECT BENEFIT/COST ANALYSIS USING VARIOUS INTEREST RATES (INCREMENTAL APPROACH)





DEPARTMENT OF THE ARMY
PORTLAND DISTRICT CORPS OF ENGINEERS
P O BOX 2946
PORTLAND OREGON 97208

NPPEN-PL-1

5 June 1972

Mr Michael Zimmerman
U S General Accounting Office
Washington, D C 20510

Dear Mr. Zimmerman

Reference is made to your telephone request of 1 June 1972 concerning progress being made on re-evaluating stage-damage relationships for the Willamette River Basin flood plain.

The basic problem centers around the fact that much of the flood control benefits for Cascadia and other proposed projects under study are derived from flood frequency probabilities greater than the largest flood for which damages are recorded. That flood of December 1964 had a recurrence probability of once in about 100 years, on the average, throughout the basin. Thus a significant portion of the flood control benefits have been evaluated on the basis of extrapolated frequency-damage relationships, rather than being based on field appraisals of probable flood damages that would result from these larger probable floods.

Several issues have been raised by representatives of environmental organizations and the General Accounting Office with respect to the reliability of flood control benefits. The Portland District agrees that there is a need to verify flood frequency-damage relationships for rare floods based on detailed field studies to resolve the issues raised and to provide better data for other Willamette Basin projects. Because of the critical manpower shortage in the District and the urgency for completion of the damage survey, we propose to accomplish this work through contractual agreements with one or more architect-engineering firms.

The initial contract, which we are presently preparing, will cover field and office work for re-evaluating flood stage-damage relationships for the Portland reach of Willamette River which extends from the mouth of the Willamette to Oregon City. Our plans call for this work to be under contract by 30 June 1972. Work on the remaining

APPENDIX I

NPPEN-PL-1

5 June 1972

Mr Michael Zimmerman

reaches of the basin will follow as funds become available. Seven reaches would be affected by Cascadia storage, 5 on the Willamette and 1 each on Santiam and South Santiam Rivers. There is a total of 33 river reaches on Willamette River and its tributaries, 7 of which are on Willamette River. Damages in each reach will be classified into not less than 3 damage categories. That is, 3 damage curves, 1 for each category, will be made for each river reach.

We also recognize the need for developing more supporting data pertaining to hydrologic analysis and economic growth in the various reaches of the flood plain. Our present plan is to conduct the necessary work for resolving these two problem areas in-house as the Corps of Engineers has special expertise in these two fields. Attached is a brief outline of the scope and coverage we feel is required.

I wish to take this opportunity to express my appreciation for the cooperative spirit, the open-minded approach, and the sincere effort put forth by the General Accounting Office personnel in their determination to appraise Corps procedures as related to issues discussed herein. I trust this letter furnishes the information necessary to answer your questions pertaining to these problem areas. If further information is desired, please do not hesitate to call my office.

Sincerely yours,



PAUL D TRIEM
Colonel, Corps of Engineers
District Engineer

1 Incl
Outline

COPY

OUTLINE OF STUDY REQUIREMENTS

1 System and Incremental Analysis Requirements An incremental analysis is required for all projects under study regardless of whether they are part of a defined system. For the incremental analyses, discharge-frequency and discharge-damage data are required for conditions without the project (but including all projects existing and under construction) compared with conditions with these projects plus the project under study. For projects which are included in a system analysis, the following data are required

a. Definition of the system objective, identification of projects in the system and a showing that the project being added is essential to attainment of the system objective

b. Comparative discharge-frequency and discharge-damage data for unregulated conditions and conditions provided by regulation of the complete system.

c. Presentation and explanation of how system regulation effects are to be apportioned among components of system (by reaches as pertinent), and resulting benefit distribution among all projects in the system.

2 Hydrologic Analysis: Discharge-Frequency Curves.

a. Explain fully the derivation of the unregulated curve

(1) Supporting explanation of its development, including why the most probable or average curve is used.

(2) Explain reason for skew coefficient used, by reference to and summary of findings of regional studies that established it.

APPENDIX I

b Identify, on maps, several flood plains For actual floods, the 1964 flood plain and that of at least one smaller flood should be shown Additional flood plains of larger floods should also be identified as necessary to establish the shape of the curve, including an estimate of the flood plain for the largest flood for which benefits are claimed The study should describe, by reaches, factors which affect damage determinations such as increased depth and duration of inundation and velocities, as well as increased areas.

c Present summary of routings for representative floods, including the largest for which any regulation is claimed, supporting and describing the effectiveness of such regulation in terms of prospective damage reduction by reduced area or reduced depth and duration of inundation, etc This should include support particularly for effectiveness at the upper end of the curve, and emphasis should be given to the Portland reach and other reaches where, because of extent of damages, the protection is most needed or most significant to the benefit analysis.

d Regulated curves for the complete system by appropriate reaches

e Regulated curves for existing conditions (projects existing and under construction) by same reaches as item d above

3 Discharge-Damage Analysis The incremental justification for any additional projects under study apparently rests primarily on reduction of damages from floods of lesser frequency than once in about 100 years on the average Large floods also are a significant factor in system benefit analysis Actual damages from such rare floods have not been experienced Therefore, it is essential that estimated damages and

benefits be fully supported. Data necessary to establish the shape of the curve and its upper limits will require extensive field and office appraisals to support claimed benefits, to include the following:

a. Based on flood plain delineations provided from the hydrologic analysis (2b), determine from field observations the acreages, types of use, property, and property valuations for the actual and estimated flood plains. Data for the actual floods should include the 1964 flood and one or two smaller floods. At least two or three larger floods should also be included, including the largest flood for which benefits are claimed.

b. Some supporting data should be shown for damage estimates, such as acreage, crop types and typical production losses applicable to agricultural damages, and for other types of damages appropriate description of derivation, such as major industrial plants, loss of bridges, numbers of residential units and per unit damage, etc. The basis for damage estimates for the larger floods should be well supported in terms of additional areas, depths of inundation, increased velocities, etc., which explain the increases relative to actual historical records of damages. Comparable explanatory data should also be furnished in support of claimed damage reductions.

c. The summary breakdown of damages by type of property should conform with ER 1120-2-113, paragraph 3b (4), i.e., agricultural, commercial, industrial, residential, utilities, etc., with agricultural further broken down between crop and other.

d. Existing and future damages should be shown separately by categories, also per ER 1120-2-113. Rates of growth used to derive

APPENDIX I

future damages should be in terms of indicators appropriate to each category of damage. Reliance cannot be placed solely on historical or projected national relationships between selected economic indexes and categories of property or activity without corroborating evidence that flood plain variables demonstrate a generally similar relationship.

e. Land enhancement benefit should be identified as appropriate, and supported.