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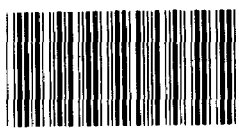
REPORT BY THE U.S.

General Accounting Office

Information On Corps Of Engineers' Clarence Cannon Dam And Mark Twain Lake Project

This report discusses the 1981 flooding along the Salt River in northeast Missouri and the resulting damages above and below the Corps of Engineers' Clarence Cannon Dam project. It further discusses the potential impact hydropower operations of the dam will have on downstream landowners, and the current cost and schedule estimates for completing the project.



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UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

RESOURCES, COMMUNITY,
AND ECONOMIC DEVELOPMENT
DIVISION

B-211410

The Honorable Thomas F. Eagleton
United States Senate

The Honorable Harold L. Volkmer
House of Representatives

In response to your letters of August 5 and August 11, 1982, and subsequent discussions with your offices, we have obtained information on the Corps of Engineers' Clarence Cannon Dam and Mark Twain Lake related to the July 1981 flood. Specifically, you requested us to determine

--the status of lease agreements for agricultural lands between upstream lessees and the Corps and

--whether hydropower operations at the dam will cause flooding, as contended by downstream landowners, and the actions the Corps is taking or plans to take to address their concerns.

You also asked us to update the project's cost and schedule estimates and the benefit/cost ratio discussed in our 1977 report[1] and review actions taken by the Corps to implement our recommendation to improve its cost-estimating procedures.

The Clarence Cannon Dam and Mark Twain Lake (formerly the Clarence Cannon Dam and Reservoir; Joanna Dam and Reservoir) was authorized by the Flood Control Act of 1962 (Public Law 87-874). The project is under construction and is about 94 percent complete. Located in northeast Missouri on the Salt River, the project will provide flood protection to approximately 27,500 acres of land in the Salt River Basin, 58,000 kilowatts of hydroelectric power, recreation facilities for about 3.9 million visitors annually, and other fish and wildlife, water supply, and navigation benefits.

This letter summarizes our findings, which are discussed in more detail in the appendix.

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[1]"Clarence Cannon Dam and Reservoir: Cost, Schedule, and Safety Problems" (PSAD-77-131, July 18, 1977).

WHAT WERE THE EFFECTS OF THE JULY 1981 FLOOD AND THE STATUS OF LEASE AGREEMENTS?

In July 1981 the Corps raised the height of the cofferdam--a temporary dam protecting the earthen portion of the main dam--to prevent overtopping and possible dam failure and then, fearing a sudden collapse in the face of rising flood waters, cut a notch in the dam to release the water under more controlled conditions. Both of these actions resulted in flood damage. Raising the cofferdam flooded leased lands above the dam, and cutting the notch flooded property below the dam and caused extensive damage to the main dam.

In 1981 the Corps leased a total of 6,041 acres of land above the dam, not immediately needed for construction, for agricultural and grazing purposes. Leases were awarded to the highest bidders, provided the bids were above an established fair market rental value which took into consideration the possibility of flooding. The leases, signed by the lessees, pointed out the Government's non-liability in the event flooding occurred. A provision of the leases specifically stated:

> "* * * the United States shall not be responsible for damages * * * arising from or incident to the flooding of the said premises by the Government or flooding from any other cause, or arising from or incident to any other Governmental activities and the lessee shall hold the United States harmless from any and all such claims."

Notwithstanding the above lease provisions, 16 persons leasing Corps land above the dam for agricultural purposes notified the Corps that their land had been flooded and requested compensation for damages. The Corps estimated that the losses on the leased land were about $340,000. The Chief, Real Estate Division, advised the lessees that the Corps had no liability for the flood damage and no legal authority to make any restitution. Three of the lessees subsequently filed formal claims totaling about $45,000. The Corps forwarded one of the claims to GAO for adjudication with the recommendation that the claim be denied because of the specific non-liability clause in the leases. On April 13, 1983, we disallowed the claim, stating that the terms of the lease specifically released the Government from responsibility for losses caused by flooding. The other two claims are being readied by the Corps for submission to GAO.

Another 171 property owners below the dam submitted damage claims totaling about $5.2 million. The Corps denied these

claims, stating that the action taken was an exercise of the Corps' discretionary authority to control flood waters and that no negligence was involved. The claimants were informed that they could appeal the decision in the U.S. District Courts within 6 months of the denial. The Corps St. Louis District Counsel said that no claimants appealed the decision within the 6-month appeal period.

WILL HYDROPOWER OPERATION RESULT IN DOWNSTREAM FLOODING?

According to a 1971 Corps hydrology study, no flooding will occur downstream of the Cannon Dam due to normal operation of the dam. However, subsequent investigations made in response to concerns expressed by downstream property owners revealed that flows of 12,000 cubic feet per second (cfs)--the maximum flow needed to produce capacity power--might prevent access to some fields. Based on a simulated operation of the project and utilizing about 50 years of data for the Salt River, the 12,000 cfs releases would have occurred an average of 16 days a year. Under natural conditions, this flow would be equaled or exceeded an average of 11 days per year.

A Memorandum of Opinion prepared by the St. Louis District Office relative to one of the downstream properties has concluded that although some of the property is subject to intermittent flooding, there is very little injury in comparison with far greater benefits conferred by the project and therefore the Government has no liability for the damages. District officials said the opinion had been forwarded to their Division Office for its information.

COST, SCHEDULE, AND BENEFIT UPDATE

The latest Corps project construction cost estimate, made in October 1982, was $308 million--$76 million greater than the estimate included in our 1977 report. The reasons for this increase are revisions made because of additional or more current data, correction of errors or omissions, and award of contracts for amounts differing from Corps estimates ($38 million); design changes ($21 million); and price-level increases ($17 million). The $38 million increase includes $7.4 million attributable to damage resulting from the 1981 flood and $21.3 million due to increased contractor costs for construction delays.

In our 1977 report, we pointed out that (1) the District's estimating procedures were not adequate to assure that construction cost estimates were reasonable, (2) documentation for estimates was not available, and (3) allowances for contingencies

were excessive. We recommended that the Secretary of the Army have the Corps review and strengthen its cost-estimating procedures to develop more realistic cost estimates.

Since then, the Corps has revised its cost-estimating manuals emphasizing the need for complete documentation of cost estimates, including unit prices and materials quantities. Also added to the manuals was an allowance for future years' inflation in developing the estimates for the project.

However, we found that about 18 percent of the cost estimates prepared by the Corps St. Louis District in October 1981 for the Clarence Cannon Dam fiscal year 1983 budget request were not adequately documented and that contingencies exceeded Corps guidelines without adequate explanation. We discussed these conditions with the District Engineer, who said that future cost estimates would include appropriate documentation and that when contingencies exceed Corps guidelines, they would be fully explained.

The scheduled project completion date is now September 1985, 4 years later than the completion date we reported in 1977. The main causes of delays were the July 1981 flood, which caused extensive damage at the construction site; other adverse weather; design changes; and labor-management problems, including a strike.

In 1977, we reported that while both annual benefits and costs reported by the Corps had increased since the original project authorization in 1962, the ratio of benefits to costs in 1975 remained 1.3 to 1--that is, for every dollar spent on the project, the Corps estimates that $1.30 in benefits will be realized. Since 1976, the benefit/cost ratio has ranged as low as 1.12 to 1 in 1977 but had returned to 1.3 to 1 in 1982. The major cause of the cost increases since 1976 was higher interest expenses. Benefit increases were largely attributable to hydroelectric power, flood control, and recreation benefits.

SCOPE AND METHODOLOGY

To obtain information related to the July 1981 flood, we reviewed laws and regulations on flood liability and real estate procurement and Corps records documenting the flood and subsequent damage claims. We interviewed (1) Corps real estate officials in its St. Louis District and Washington, D.C., headquarters offices, (2) Corps St. Louis District hydrologists, and (3) representatives of the Salt River Basin Committee--a group of landowners concerned about flooding below the dam. We reviewed studies and reports on the potential for flooding below the dam prepared by the St. Louis District office. Although we

examined and analyzed Corps hydrologic reports and charts, we did not verify the accuracy of the models, the data used to support them, or the conclusions reached by the Corps.

In order to update cost and schedule data, we reviewed Corps records dealing with the cost of construction and completion schedules and related costs, including reports, contract modifications, design memorandum, and Corps cost-estimating documents and manuals. At the time we began our field work, the most recent cost estimates available were those prepared in October 1981 for the fiscal year 1983 budget request. Consequently, we used these estimates in our detailed review. Subsequently, estimates for the fiscal year 1984 budget became available and are included in this report only to update the project's cost and completion date. We also analyzed changes in the project's benefit/cost ratio, developed by the Corps, since 1976. We interviewed St. Louis District Officials, including the officials of the Construction and Engineering Divisions, Contract Management and Supervision and Inspection Branches, and Estimating Section. We discussed actions taken in response to recommendations made in our 1977 report with officials from the Corps Engineering Division in Washington, D.C., but did not perform a detailed audit of the Corps' cost-estimating procedures.

We made this review in accordance with generally accepted government audit standards.

AGENCY COMMENTS

In its May 20, 1983, comments, the Department of the Army concurred with the report findings. However, the Department wished to emphasize that (1) losses due to the release of water through the notch during the July 1981 flood were less than would have been experienced with the collapse of the cofferdam and (2) without the dam the flood of the magnitude experienced would also have damaged downstream property.

The Department also concurred with the need for proper documentation of cost estimates and commented that the Lower Mississippi Valley Division commander will furnish guidance to the District to reiterate the need for proper documentation of cost estimates and use of appropriate contingencies. However, the Department noted that the Corps' experience with cost estimating in this area has shown that a 25 percent contingency for projects prior to completion of plans and specifications is not excessive. Engineering judgment concerning the type of project, the stages of design, and the inherent unknowns associated with the project dictate the allowance used.

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Copies of this report are being sent to the Director, Office of Management and Budget, the Secretaries of Defense and the Army, and other interested parties.

J. Dexter Peach
Director

Contents

ABBREVIATIONS

CFS	Cubic feet per second
GAO	General Accounting Office

INFORMATION ON THE CORPS OF ENGINEERS' CLARENCE CANNON DAM AND MARK TWAIN LAKE

JULY 1981 FLOODING PROBLEMS AT THE DAM

In July 1981 heavy rainfall resulted in flooding above and below the Clarence Cannon Dam being built by the Corps on the Salt River in northeast Missouri. In an attempt to contain the heavy rainfall, the Corps raised by 4 feet the height of a cofferdam. This action caused flooding of land, leased from the Corps, above the dam. Fearing an even higher flood crest which could cause a sudden collapse of the cofferdam and the attendant damages downstream, the Corps directed the contractor to cut a notch in the cofferdam to provide a more controlled release of the water. This action caused the flooding of private lands below the dam as well as considerable damage to the main dam structure.

The cofferdam--completed in August 1979--was designed to (1) divert the flow of the Salt River away from the earthen portion of the main dam and (2) protect this portion in the event of a flood during construction. Up to 30,000 cubic feet of water per second (cfs) is diverted into sluices through the nearly completed concrete portion of the main dam.

According to Corps St. Louis District officials, the cofferdam height was determined using Engineering Regulation 1110-2-2901. The regulation provides guidelines for making engineering judgments as to the degree of protection needed depending on estimates of the damages and the delay costs that could result from overtopping or flooding. Documents obtained from the district indicate that the factors used were

--risk of flooding,

--damage and delay costs which would result if the construction site was flooded,

--cofferdam construction cost, and

--cofferdam maintenance cost.

Based on an analysis of these factors, the cofferdam was built to withstand a flood having a frequency of occurrence of once in 10 years (574 feet above mean sea level) plus 3 feet.

Because of heavy rains in May 1981, the Corps directed the contractor to raise the cofferdam by 4 feet to 581 feet. From July 23 to July 28, 1981, heavy rains--9.29 inches at one recording station approximately 15 miles upstream from the dam--

fell in the Salt River Basin. Because the Corps predicted that the pool above the cofferdam would crest at 581.8 feet, it directed the contractor on July 26, 1981, to raise the cofferdam an additional 4 feet to an elevation of 585 feet. Raising the cofferdam resulted in flooding Corps-owned land leased for agricultural purposes above the dam.

On July 27 the Corps predicted, using National Weather Service rainfall and forecast data, that the crest of the pool would be 588.9 feet. The Corps decided that it was not feasible to raise the cofferdam to such a level. Fearing an overtopping or collapse of the cofferdam and the resulting destruction and possible loss of several bridges below the dam, the Corps, on July 27, directed the contractor to cut a notch in an area of the cofferdam considered to be more erosion resistant. District officials believed this would allow a slower and safer release of the impounded waters. The highest water elevation, 584.8 feet, was reached on July 28, 1981. Releasing the water through the notch resulted in extensive damage to downstream property and to the earthen portion of the main dam.

A Corps hydrologist told us that the July 1981 flood at the dam site approached a 50-year flood occurrence. The U.S. Geological Survey, Department of the Interior, based on data recorded about 28 miles downstream of the dam, estimated that the flooding at that point was equivalent to a 35-year occurrence. A Geological Survey hydrologist said that the cofferdam probably had little effect on the flooding downstream but may have slightly reduced the peak stage.

Flood damage to lands leased above the Cannon Dam

When constructing water resource projects the Corps purchases land necessary for permanent structures, the reservoir, and public access to both. Land not immediately needed for construction is leased for agricultural and grazing purposes. Leasing places the land into productive use and generates revenue which the Federal Government shares with counties to replace revenues lost by removal of lands from the tax roles. Under Corps policy, leases are awarded to the highest bidders provided the bids exceed the Corps' established fair market rental value. The Chief of the Real Estate Division, St. Louis District, said that the fair market rental value takes into consideration the possibility of flooding.

In 1981, the Corps issued three invitations for bids (IFB) on 6,860 acres of land above the Clarence Cannon Dam. Bids were received and leases totaling about $210,000 were awarded on 6,041 acres. Each lease, signed by the lessee, contained the following provisions:

> "* * * the right is hereby reserved to the United States, * * * to flood the leased premises whenever necessary, and the lessee shall have no claim for damages of any character on account thereof against the United States or any officer, agent, or employee thereof."
>
> * * * * *
>
> "* * * the United States shall not be responsible for damages * * * arising from or incident to the flooding of the said premises by the Government or flooding from any other cause, or arising from or incident to any other Governmental activities and the lessee shall hold the United States harmless from any and all such claims."

According to Corps district officials, these provisions were placed in the leases to limit the Government's liability should flooding occur and to put the lessee on notice that the land was subject to flooding.

To provide the lessee limited protection against losses, rental fees in excess of $1,000 could be paid in two installments. At the lessee's option, the lease could be terminated prior to the second installment due date. Four lessees exercised this option. Two terminated their leases prior to the due date, thus avoiding $14,040 in lease payments. Two other lessees whose land had been flooded did not make second installment payments totaling $1,779.

After the flood, 16 lessees requested compensation from the Corps, claiming that parts of their leased land had been flooded. Annual rental payments for the 4,400 acres they leased totaled about $197,000. Most, however, did not indicate how much acreage was flooded or the dollar amount of loss incurred.

The Chief, Real Estate Division, responded that, although he sympathized with the lessees' problems, the Corps had neither legal liability for flood damage nor legal authority to renegotiate the leases or to make any other type of restitution. Because the Corps did not believe that it was liable for the flood damage, it did not survey the lands to assess actual damages. However, using topographical maps and recorded flood levels, the District estimated that about 2,400 acres were flooded and that rental and crop losses amounted to about $340,000.

Despite the Corps' position, three lessees filed formal damage claims totaling about $45,000 against the Corps. The Corps forwarded one of the claims to GAO for adjudication with a recommendation that the claims be denied because of the specific

nonliability clauses in the leases. The other two claims are being readied by the Corps for submission to GAO.

On April 13, 1983, we disallowed the claim, stating:

"Although the flooding of the land you leased may have been caused by raising the height of the cofferdam, this action did not create any liability on the part of the Government, since the terms of your lease specifically released the Government from responsibility for losses caused by flooding."

The letter disallowing the claim also cited a 1980 U.S. Court of Claims ruling that the Government did not have to pay damages on leased land when the terms of the lease gave the Government the right to flood the land when necessary.

Flood damages below the Cannon Dam

Releasing the impounded water through the notch in the cofferdam caused extensive damage to the partially completed embankment of the main dam as well as damage to privately owned lands downstream. The Corps estimated damage to the construction area at about $7.4 million. In addition, claims totaling about $5.2 million were filed by 171 property owners. However, the Corps made only limited investigations of these claims because it did not consider itself liable for the damages incurred. As of September 1982, the U.S. Army Claims Service denied these claims, citing the following reasons:

--The release of water represents the exercise of a discretionary function on the part of the U.S. Army Corps of Engineers and claims based thereon are not payable. (See 28 U.S.C. § 2680 (a).)

--The United States is not liable for damage caused by flood or flood waters at any place. (See 33 U.S.C. § 702 c.)

--There is no evidence of any negligence on the part of the Corps of Engineers.

The Claims Service, however, advised the claimants that if they were dissatisfied with the decision they could file suit under the Federal Tort Claims Act (28 U.S.C. § 2671-2680) in an appropriate United States District Court not later than 6 months from the date of the mailing of the denial. According to the Corps St. Louis District Counsel, no suits were filed to seek recovery within the 6-month appeal period.

APPENDIX I

WATER RELEASED FOR POWER GENERATION

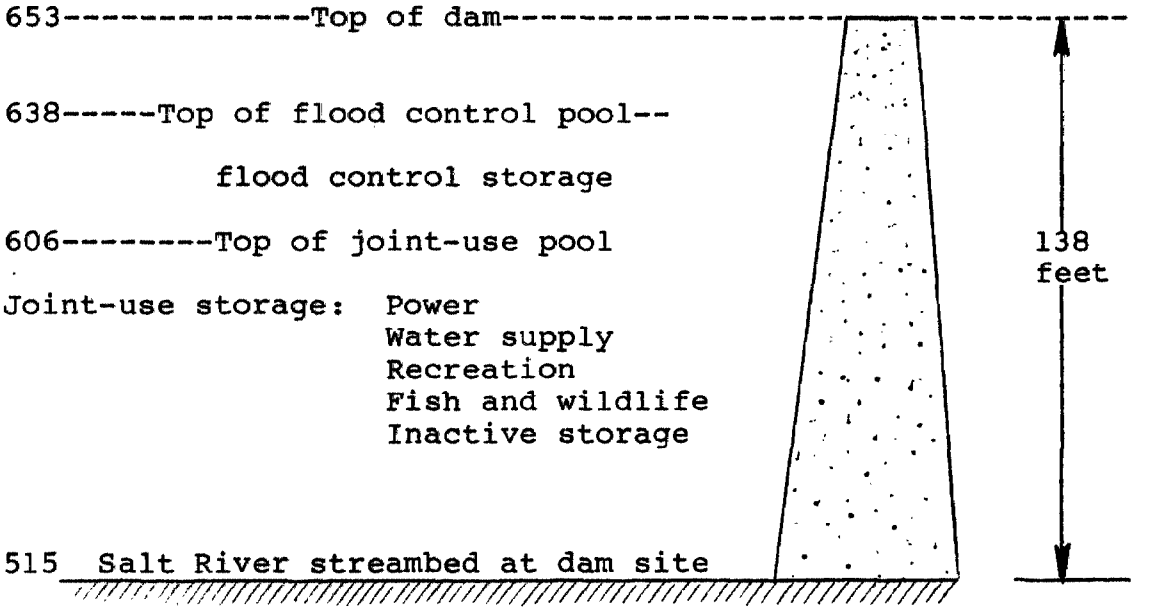
The Clarence Cannon Dam hydroelectric power facilities include a re-regulation dam and pool and two turbine generators capable of producing 58,000 kilowatts (KW) of power. To generate this power, about 12,000 cfs will be released through the turbines. The purpose of the re-regulation dam, located 9.5 miles below the main dam, is to store part of the water released during power generation. This water will then be pumped back into the main reservoir when power is not being generated or when the flow of the river is not sufficient to maintain adequate water levels for continued power operation.

The 1979 draft Clarence Cannon Reservoir regulation manual sets forth conditions for releasing water for power generation. The Assistant Chief, Engineering Division, St. Louis District, said that the data in the manual should be considered very tentative because the Associated Electric Cooperative, contracted to purchase the power, has not submitted a schedule of power needs. In November 1982 the Chief, Engineering Division, requested the Cooperative to provide a preliminary power schedule showing a typical daily discharge fluctuation for power generation. As of April 7, 1983, the Cooperative had not responded. The Assistant Chief said that because the schedule of power needs could affect planned releases, the information is needed to complete the project's water control plan. He also said that until it is received, he did not wish to speculate on the impact the operating schedule would have on downstream releases.

Under the draft operating procedures, however, the Corps estimates that, based on recorded hydrological data from 1925 through 1973, the reservoir water level will be at or below the top of the joint-use pool--elevation 606 feet--91 percent of the time. (See profile on next page.) During such times, releases from the re-regulation dam are expected to average 3,296 cfs. Whenever the reservoir water level is above elevation 606--about 9 percent of the time--water will not be pumped back from the re-regulation pool to the main reservoir because this would diminish the reservoir's flood control capability. At such times, releases from the re-regulation dam would be equal to the inflow into the re-regulation pool.

Releases from the Clarence Cannon Dam will also be affected by flows on the Mississippi River. If the Mississippi River is in flood stage, Clarence Cannon Dam releases may be restricted to reduce flows into the Mississippi.

Profile of Water Storage at Clarence Cannon Dam and Mark Twain Lake



Will hydropower operations cause downstream flooding?

Property owners below the Clarence Cannon Dam are concerned that their fields will be flooded, or access to them will be limited, when the Corps begins releasing water to generate power. Limiting access to fields, particularly during the planting and harvest seasons, would be a problem.

A 1967 Corps design memorandum for the project states that 12,000 cfs will be the maximum release for power generation. According to a hydrology study made by the St. Louis District in 1971, the Salt River channel will contain releases of 12,000 cfs without damage to downstream property. As a result, the Corps did not obtain easements or purchase any land below the re-regulation dam.

Corps officials informed property owners during an August 1979 public meeting that (1) maximum releases for power generation would be 12,000 cfs and (2) if the reservoir had been in operation during the period of record--1925 through 1973--a release of over 12,000 cfs would have occurred only once (1973). If the project had been in operation in 1973, the natural discharge of 107,000 cfs would have been reduced to 20,000 cfs for 2 days. Under natural conditions the flow would exceed 12,000 cfs an average of at least once a year.

However, in comparing water levels reported by downstream property owners with known discharges through the sluices at the construction site, the Corps subsequently determined that flows of 12,000 cfs might prevent access to fields. After further investigation, the District Chief of the Hydrological and Hydraulics Branch, Engineering Division, reported in January 1983:

--Recent field checks and contact with Salt River property owners have identified seven locations where 12,000-cfs releases might interfere with individual property owners rights of access. Most of these locations are low water field crossings of tributaries to the Salt River which are used by farmers to gain access to some of their fields. Complete data was not available for all seven locations, but enough is available to indicate that two of the seven locations will be considerably affected by flows of 12,000 cfs. These locations are also affected by flows of 12,000 cfs under natural conditions. The regulation of Cannon will cause such occasions to occur less frequently but for longer durations.

In a March 10, 1983, Memorandum of Opinion relative to one of the locations noted above, the District Real Estate Division concluded that the District has no liability for the intermittent flooding that may prevent access to the property or any authority to take remedial action. Specifically, the memorandum stated:

--A landowner maintained that releases from the project would back up a tributary of the Salt River and flood his crossing and limit access to a 40-acre field. The Districts' Engineering Division surveyed the crossing and concluded that a 12,000-cfs release would place about 3 to 4 feet of water on the crossing. The Corps further determined, based on a simulated operation of the project and about 50 years of data, that this situation would probably occur an average of 16 days a year. Without the project, this flow would be equaled or exceeded an average of 11 days a year.

--Releases from the project greater than about 5,000 cfs will flood the crossing. This flow would be equaled or exceeded an average of about 23 days a year with the project and about 30 days a year under natural conditions.

--The adverse effect is relatively minimal, and discussion with Engineering Division personnel indicates that the property will, overall, enjoy benefits from the project. The property fronts the Salt River for an estimated three-quarters of a mile, and operating the project will

keep very high waters from flooding any significant portion of the land. In addition, the project will provide water during droughts.

--It appears that while the creek on the property will, to a small degree, be adversely affected by the project, the total property will receive benefits from the project. Thus, it appears that there is very little injury in comparison with the greater benefits conferred. Based upon this, and assuming that the information with regard to detriments and benefits can be substantiated, in our opinion the property owner is entitled to no compensation.

According to District officials, the Memorandum of Opinion has been forwarded to the Lower Mississippi Valley Division office for its information.

COST AND SCHEDULE EXPERIENCE AND BENEFIT/COST DATA

In 1977 we reported[1] that the project was to be completed by June 1981 at a cost of $232 million. We also reported that annual project benefits were estimated by the Corps to be $1.30 for each $1 of annual costs. The most recent estimates--October 1982--indicate that the project will be completed in September 1985 at a cost of $308 million. The Corps' current estimates continue to indicate that the project will provide about $1.30 in benefits for every $1 in costs.

Cost experience

In October 1982, the Corps estimated the project would cost $308.1 million--an increase of $76.1 million since 1976, the latest data included in our 1977 report, and $244.8 million since 1962 when the project was authorized. The following schedule shows the increase by project feature since 1962.

[1]"Clarence Cannon Dam and Reservoir: Cost, Schedule, and Safety Problems" (PSAD-77-131, July 18, 1977).

Project feature	Annual cost estimates (millions) 1962	1976	1982
Lands and damages	$ 7.7	$ 17.4	$ 20.8
Relocation	15.5	77.8	56.8
Reservoirs	1.5	6.2	4.8
Dams	21.4	54.6	108.8
Fish and wildlife facilities	-	1.1	1.1
Powerplant	9.0	23.0	36.7
Roads, railroads, and bridges	0.1	2.4	1.7
Recreational facilities	0.8	15.5	22.2
Cultural resource preservation	-	-	1.6
Buildings, grounds, and utilities	0.3	1.1	2.9
Permanent operating equipment	0.2	1.9	2.9
Engineering and design	3.8	20.5	30.5
Supervision and administration	3.0	10.5	17.3
Total	$63.3	$232.0	$308.1

The following table, based on information obtained from Corps documents supporting its annual appropriation requests, shows the Corps' reasons for project cost growth since our 1977 report.

Reason for cost growth	Amount (millions)	Percent of total increase
Post-contract award and other estimating adjustments	$37.9	49.8
Design changes	21.1	27.7
Price-level increase	17.1	22.5
Total	$76.1	100.0

Post-contract award and other estimating adjustments include all adjustments to cost estimates due to contracts awarded in amounts different from Corps estimates, contract overruns/underruns, changes to quantity estimates, correction of errors or omissions, and changes in unit prices not attributable to price-level increases. Significant adjustments since 1976 include:

--A 1977 decrease of $15.9 million because Corps estimates were higher than the contracts awarded by the State Highway Department for relocations of five State highways.

--A 1977 increase of $4.3 million because the previous estimate erroneously based the powerhouse cost on a structure to house one power unit instead of two power units as shown in the design memorandum.

--A 1979 increase of $2.7 million for supervision, inspection, and administrative costs based on the revised project completion date.

--A 1981 increase of $7.4 million due to the July 1981 flood which includes repairs to the main dam structure of $5.2 million; repairs of $0.1 million to the re-regulation dam; engineering and design work of $1.4 million; and supervisor and administrative cost of $0.7 million.

--1981 and 1982 increases of $21.3 million for estimated costs due contractors for Government-caused construction delays[2] from 1973 through mid-July 1981.

Design changes include any increases or decreases in cost due to design modifications or new designs. Significant revisions since 1976 include:

--A 1977 decrease of $8.8 million. The Assistant Chief of the Design Branch said this decrease is an estimate of savings that resulted from a more economical bridge design used in relocating five State highways.

--A 1977 increase of $1.2 million to provide additional utilities, roads, site work, and buildings for one of the recreation areas.

--A 1979 increase of $6.5 million to prevent water seepage, including (1) $3.4 million for grouting to fill crevices found in the rock that connects with the dam structure

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[2]Government-caused delays are attributable to design changes and conditions at the construction site not detected during tests made for the design of the project. In addition, weather delays and strikes occurring after the original contract completion date are included and are compensable if they result in additional contractor costs. Costs associated with such delays include escalation of labor and material costs, loss of efficiency due to disruption of work, performing work at a less favorable time, overtime, extended overhead, and increased equipment rental.

and (2) an increase of $3.1 million for a concrete wall to cover a large crevice in the rock.

--A 1981 increase of $1 million for engineering and design costs, including (1) costs associated with widening roads due to a reanalysis of traffic and (2) asphalting the surface of two roads as stipulated in a court settlement during condemnation proceedings.

Price-level increases reflect the amount of commodities and services money will purchase in one period as against another. The Corps develops the current-year price level by (1) applying an industry index to construction costs, (2) obtaining current values for real estate, and (3) applying the Federal salary rate increases to the cost estimates for engineering and design, and supervision and administration. Beginning in October 1979, the Corps also included in its manuals a requirement to estimate future price-level increases through project completion. The inflation factor used is provided by the Office of Management and Budget. In total, price-level increases since 1976 were $17.1 million.

District to provide better documentation for cost estimates

In our 1977 report on the Clarence Cannon Dam project, we pointed out that (1) the District's estimating procedures were not adequate to assure that construction cost estimates were reasonable, (2) documentation for estimates was not available, and (3) allowances for contingencies were excessive. We recommended that the Secretary of the Army have the Corps review and strengthen its cost-estimating procedures to develop more realistic cost estimates.

Since then, the Corps has revised its cost-estimating manuals and included a section emphasizing the need to fully document all cost estimates. The Planning and Design Stages manual requires supporting documentation for all major cost items, including the method of construction, items of major construction equipment, access, description of project features, assumptions used in developing the estimates, and sources of unit costs. The Government Estimate of Fair and Reasonable Cost to Contractor manual also requires supporting documentation for cost estimates used as a guide in awarding construction contracts and in negotiating modifications to awarded contracts. Both manuals state that an estimate shall be prepared on the basis of quantities and unit prices.

Contingency allowance guidelines are specified in the Corps' Planning and Design Stages manual. For awarded contracts, the suggested contingency allowance is 5 percent of the uncompleted portion of the contract. For projects not yet under

contract, the guidelines suggest a 10- to 20-percent allowance, depending upon the stage of completion of plans and specifications. Districts can deviate from the guidelines, but Army Regulation 11-2-240 requires a statement justifying such a deviation.

However, the Corps St. Louis District has continued to develop cost estimates and contingency allowances for the Clarence Cannon Dam project without adequate documentation. For example, the District was unable to provide documentation showing the quantities and the unit prices used in developing some of its cost estimates for the main dam. Specifically, of the $40 million identified in the Corps' budget request for fiscal year 1983 as needed to complete the project, the District could not provide adequate documentation for about $7.4 million (about 18 percent), as follows:

--$4.7 million for costs attributable to Government-caused construction delays.

--$1.3 million for engineering, design, supervision, and administration costs based on an analysis of remaining work.

--$1.4 million in engineering cost included in the estimate of the effects of the July 1981 flood.

Some estimates for the Clarence Cannon Dam project presented in the Corps' budget request for fiscal year 1983 exceeded Corps guidelines without adequate explanations. For example:

--A $5.8 million contingency on the awarded main dam contract. The Corps guidelines would have allowed $1.5 million, or a difference of $4.3 million.

--A $1 million contingency on contracts to be awarded for relocating county roads. The Corps guidelines would have allowed about $400,000, a difference of $600,000.

The Program Development Officer said that the District's practice has been to exceed the Corps guidelines for contingency allowances on both awarded and unawarded contracts. However, the District could not document why this practice was established or provide justification for contingencies which exceeded the guidelines.

We discussed our concerns related to problems in documenting cost estimates and contingency allowances for the Clarence Cannon Dam project with the District Engineer and other District officials on January 28, 1983. In the course of the discussion, district officials commented that these problems were not limited to the Clarence Cannon Dam project but were district-wide

problems. Subsequently, the District Engineer directed his staff to (1) provide justification when deviating from the contingency allowance guidelines and (2) adequately document future cost estimates.

Schedule experience

The current estimated completion date is September 1985, about 4 years later than reported in our 1977 report. Although contract modifications which may grant the contractor additional time are still pending, issued contract modifications and the July 1981 flood report show delays totaling 46.4 months since 1976. The following table summarizes the reasons for the delay and the amount of time attributed to each reason.

Reason for delay	Delay (in months)
Adverse weather conditions (including the 1981 flood)	25.6
Design changes	10.4
Strikes and other labor management problems	4.6
Scheduling problems	3.6
Unanticipated site conditions	2.2
Total	46.4

The primary project feature affected by these delays is the main dam structure. The construction of the main dam began in 1970 and was 67 percent complete in January 1977. The District Engineer said that as of December 31, 1982, the main dam was 99 percent complete.

Current benefit/cost ratio

Benefits and costs have fluctuated since our 1977 report but generally have increased. The 1975 benefit/cost ratio, the latest included in that report, was 1.3 to 1. Since then, the benefit/cost ratio has ranged from 1.12 to 1 in 1977 to 1.3 to 1 in 1982. Benefits have increased about 48 percent since 1976 with hydroelectric power, flood control, and recreation accounting for 90 percent of this increase.

Type of benefit	Annual benefit estimates (000 omitted) 1962	1976	1982
Hydroelectric power	$1,090	$4,673	$6,168
Flood control	1,318	4,289	6,523
Recreation	1,380	2,513	4,422
Fish and wildlife	262	319	381
Water supply	105	407	671
Navigation	3	9	21
Redevelopment (note a)	-	399	515
Advanced replacement of bridges (note b)	-	65	92
Total	$4,158	$12,674	$18,793

a/The Corps added redevelopment benefits in 1974.

b/The Corps added benefits for advanced replacement of bridges in 1976.

In general, benefits increase because of either price-level changes of commodities and services money will purchase in one period or changes in the basic assumption or methodology used to calculate the benefit.

Cost, as used in the benefit/cost ratio, is the average annual cost over the 100-year life of the project. Included is interest, amortization, operation and maintenance costs, replacement costs, and loss of productivity of land needed for the project. The increase (77 percent) in average annual costs since 1976 is due largely to increased interest expense brought about by an increase in the total cost of the project from $232 million to $308 million. Overall, average annual costs have increased 41 percent during this period.

The average annual benefits and costs and the corresponding benefit/cost ratios between 1962 and 1982 are shown below.

	Annual benefit/cost estimates (000 omitted) 1962	1976	1982
Benefits	$4,158	$12,674	$18,793
Costs	3,142	10,353	14,630
Benefit/cost ratio	1.3:1	1.2:1	1.3:1

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