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RECLAMATION SAFETY OF DAMS ACT

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HEARING

BEFORE THE

SUBCOMMITTEE ON
PUBLIC LANDS AND RESOURCES

OF THE

COMMITTEE ON
ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

NINETY-FIFTH CONGRESS

SECOND SESSION

ON

S. 2820

A BILL TO AUTHORIZE THE SECRETARY OF THE INTERIOR
TO CONSTRUCT, RESTORE, OPERATE, AND MAINTAIN NEW
OR MODIFIED FEATURES AT EXISTING FEDERAL RECLAMA-
TION DAMS FOR SAFETY OF DAMS PURPOSES

MAY 10, 1978

Publication No. 95-131

Printed for the use of the
Committee on Energy and Natural Resources



U.S. GOVERNMENT PRINTING OFFICE

WASHINGTON : 1978

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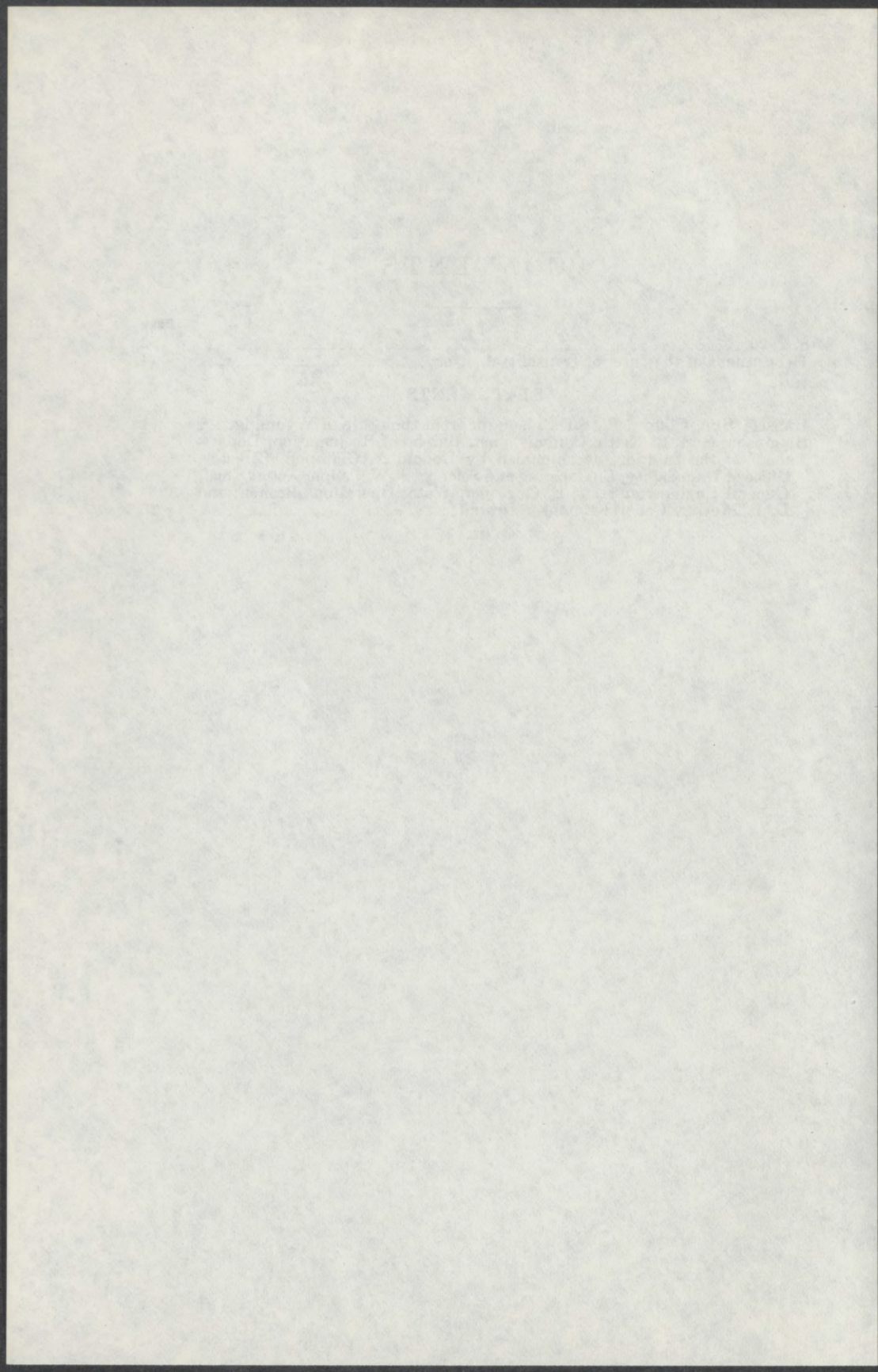
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RECLAMATION SAFETY OF DAMS ACT

WEDNESDAY, MAY 10, 1978

U.S. SENATE,
SUBCOMMITTEE ON PUBLIC LANDS AND RESOURCES
OF THE COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, D.C.

The subcommittee met, pursuant to notice, at 7 a.m., in room 3110, Dirksen Office Building, Hon. Clifford P. Hansen presiding.

Present: Senator Hansen.

Also present: Russell R. Brown, professional staff member.

OPENING STATEMENT OF HON. CLIFFORD P. HANSEN, A U.S. SENATOR FROM THE STATE OF WYOMING

Senator HANSEN. The subcommittee will come to order.

We meet at this early hour of the day to hear testimony on legislation which would authorize the Secretary of the Interior, through the Bureau of Reclamation, to proceed in a timely fashion with work to preserve the structural safety of dams under the jurisdiction of the Bureau.

A number of dams have been preliminarily identified as being in need of repairs and modification for safety reasons. It is imperative that funding be authorized for this work immediately.

Concerns for life and property and safety of our people have to be first priority in our minds and actions. The reduced water levels and secondary hardships on recreation, streamflows, et cetera, are of concern also. I would urge my colleagues to assist us in the prompt reporting and passage of this legislation.

It is my pleasure to welcome Commissioner Higginson to the hearing and ask him to present his views.

I will insert in the record, at this point, a copy of S. 2820 and the letter of transmittal from the Department of the Interior.

[The text of S. 2820 and letter of transmittal follow:]

95TH CONGRESS
2D SESSION

S. 2820

IN THE SENATE OF THE UNITED STATES

APRIL 4 (legislative day, FEBRUARY 6), 1978

Mr. JACKSON (by request) introduced the following bill; which was read twice and referred to the Committee on Energy and Natural Resources

A BILL

To authorize the Secretary of the Interior to construct, restore, operate, and maintain new or modified features at existing Federal reclamation dams for safety of dams purposes.

1 *Be it enacted by the Senate and House of Representa-*
2 *tives of the United States of America in Congress assembled,*
3 That this Act shall be cited as the "Reclamation Safety of
4 Dams Act of 1978".

5 SEC. 2. In order to preserve the structural safety of Bu-
6 reau of Reclamation dams and related facilities the Secretary
7 of the Interior is authorized to perform such modifications as
8 he determines to be reasonably required. Said performance of
9 work shall be in accordance with the Federal reclamation

1 laws (Act of June 17, 1902, 32 Stat. 388, and Acts amenda-
2 tory or supplementary thereto).

3 SEC. 3. Construction authorized by this Act shall be for
4 the purposes of dam safety and not for the specific purposes
5 of providing additional conservation storage capacity or of
6 developing benefits over and above those provided by the
7 original dams and reservoirs. Nothing in this Act shall be
8 construed to reduce the amount of project costs allocated to
9 reimbursable purposes heretofore authorized.

10 SEC. 4. There is hereby authorized to be appropriated
11 such sums as may be necessary to accomplish the purposes of
12 this Act. All costs heretofore or hereafter incurred in the mod-
13 ification of dams to insure their safety from failure shall be
14 allocated among the authorized purposes served by the dams
15 and related reservoirs in accordance with standard cost alloca-
16 tion procedures: *Provided, however,* That costs allocated to
17 irrigation shall be reimbursable to the extent of the water
18 users' ability to repay as determined by the Secretary of the
19 Interior in the light of their outstanding repayment obliga-
20 tions.



United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

FEB 14 1978

Honorable Walter F. Mondale
President of the Senate
Washington, D. C. 20510

Dear Mr. President:

Enclosed is a draft of a bill "To authorize the Secretary of the Interior to construct, restore, operate, and maintain new or modified features at existing Federal reclamation dams for safety of dams purposes."

We strongly recommend that the bill be introduced and expeditiously passed.

The purpose of the draft bill is to authorize modification of Bureau of Reclamation dams for safety purposes.

In 1948, Reclamation's efforts to ensure that existing dams and reservoirs are operated and maintained safely led to the development of a formal program for periodic inspections of existing structures. Each dam is included in that program, entitled the Review of Maintenance Program, as soon as the dam has been transferred from construction to operation and maintenance status.

Under the Review of Maintenance Program, each dam is examined by Reclamation project and regional personnel at 2- or 3-year intervals, depending upon the nature of the facility. Specialists from Reclamation's Engineering and Research Center, Denver, Colorado, participate in the review of each dam at least once every 6 years.

A formal report on the condition of each dam and of its appurtenant structures, including recommended corrective actions, if any, is prepared after the examination and becomes a part of the permanent history of the dam's performance.

As the engineering profession develops new criteria and technology for the design of dams, it becomes necessary to reevaluate the safety of the older dams. In 1965, the Examination of Existing Structures Program was initiated to evaluate the ability of reclamation's older dams to withstand safely the currently estimated maximum probable flood and to prescribe corrective action necessary to ensure the safety of the dams.

Initially, the Examination of Existing Structures Program focused on structural and hydrological aspects of the dams. New methodology for estimating floodflows made the review necessary. Later, the scope of the program was enlarged to include new methodologies for evaluating the response of dams to earthquakes, the effect of existing or potential landslides, and a review of the condition of upstream dams.

Under the Examination of Existing Structures Program, a formal report is prepared for each structure which the review identifies as having significant deficiencies. The report includes information on the need for structural modification, the hazards to the public, the recommended corrective action and alternatives thereto, the environmental impacts, and the repayment ability of the water users. The completed reports are used as a basis for recommending corrective action.

Of the dams for which studies have been completed under the Examination of Existing Structures Program, major modifications have been completed at Boca and Clear Lake Dams (California) and Conconully Dam (Washington). Minor modifications (less than \$250,000) have been completed at Bull Lake, Pathfinder, and Seminoe Dams (Wyoming), Gerber Dam (Oregon), and Vallecito Dam (Colorado).

Major work is authorized and is in progress on McMillan and Avalon Dams (Brantley Project, New Mexico), American Falls Dam (Idaho), and Belle Fourche Dam (South Dakota). Major work is authorized but has not been started on McKay Dam (Oregon) and Dickinson Dam (North Dakota).

As a result of studies completed to date, we have found 13 other dams which require structural modification to enable them to withstand safely the inflow design flood and/or the maximum credible earthquake. The names of the 13 dams, the project, State, modifications required, and estimated costs (January 1977 price level) are as follows (also refer to the attached fact sheets for each dam):

1. Deerfield Dam, Rapid Valley Project, South Dakota. Increase the height of the dam 16 feet and modify the spillway and dam outlet works. (The increase in dam height is the only feasible way of ensuring dam safety, and is not for the purpose of increasing operating capacity.) Estimated cost \$1,092,000.
2. Lahontan Dam, Newlands Project, Nevada. Rehabilitate the spillway and outlet works and construct a concrete curtain wall in the dam crest. Estimated cost \$5,070,000.
3. Hyrum Dam, Hyrum Project, Utah. Construct an auxiliary spillway. Estimated cost \$810,000.

4. Stony Gorge Dam, Orland Project, California. Construct an auxiliary spillway. Estimated cost \$2,600,000.
5. Gibson Dam, Sun River Project, Montana. Construct aeration piers and protect the downstream abutments by the installation of rockbolts. Estimated cost \$962,000.
6. Black Canyon Dam, Boise Project, Idaho. Construct an auxiliary spillway. Estimated cost \$3,250,000.
7. Altus Dam, W. C. Austin Project, Oklahoma. Lower the height of the north dike 1 foot, raise the height of the other dikes 2 feet, and construct a new dike. Estimated cost \$858,000.
8. Theodore Roosevelt Dam, Salt River Project, Arizona. Increase the height of the dam 4 feet and modify the spillway. Estimated cost \$1,209,000.
9. Stewart Mountain Dam, Salt River Project, Arizona. Modify the spillway. Estimated cost \$6,760,000.
10. Jackson Lake Dam, Minidoka Project, Wyoming. Protect the dam against possible seismic events in the vicinity of the dam. Estimated cost \$4,000,000.
11. Island Park Dam, Minidoka Project, Idaho. Modify the spillway and outlet works. Estimated cost \$2,405,000.
12. Willow Creek Dam, Sun River Project, Montana. Construct a replacement spillway. Estimated cost \$3,640,000.
13. East Park Dam, Orland Project, California. Construct a larger spillway. Estimated cost \$3,900,000.

(Additional information on the above dams is provided on attached sheets).

Although the 13 dams are not in imminent danger of immediate failure, failure would be possible if a "maximum probable flood" were to occur upstream from those dams incapable of safely passing or storing such a flood or if the maximum credible earthquake occurred at those dams incapable of withstanding such an event.

(While the probability of such a flood occurring at a given site is small such floods have been known to occur. The term "maximum probable flood" is an engineering term generally defined as "the largest flood that theoretically could occur at a given site during our present geological and climatic era." The time frame for the probability of such a flood cannot be precisely estimated and would vary from site to site, but it is greater than 100 years, and usually considerably greater.)

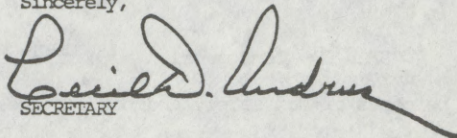
The bill would provide general authority to undertake work on these dams, and on others when the need is discovered, for safety purposes. The bill would authorize appropriation of such sums as may be necessary. As drafted, the bill provides that the costs of modifying the dams shall be allocated among the authorized purposes served by the dams and reservoirs in accordance with standard cost allocation procedures. Costs allocated to irrigation shall be reimbursable only to the extent of the water users' ability to repay as determined by the Secretary. This is based on the premise, stated in section 2 of the bill, that the modifications are for safety purposes only, and not for providing any additional benefits over and above those originally authorized and provided by the original dams and reservoirs.

Proposals for modification shall appear as line items for budget review. They shall be based upon such assessment, as necessary, of the relative costs of the modification as compared to the costs and benefits of other measures which may be taken to achieve the same safety objective, such as modified operating procedures, phasing out the use of a project facility, or replacement of a project facility.

The bill is consistent with our desire for an active dam safety program within the Department and we strongly recommend that the bill be expeditiously approved by the Congress.

The Office of Management and Budget has advised that the enactment of this draft bill would be in accord with the program of the President.

Sincerely,


SECRETARY

A B I L L

To authorize the Secretary of the Interior to construct, restore, operate, and maintain new or modified features at existing Federal reclamation dams for safety of dams purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act shall be cited as the "Reclamation Safety of Dams Act of 1978."

SEC. 1. In order to preserve the structural safety of Bureau of Reclamation dams and related facilities the Secretary of the Interior is authorized to perform such modifications as he determines to be reasonably required. Said performance of work shall be in accordance with the Federal reclamation laws (Act of June 17, 1902, 32 Stat. 388, and Acts amendatory or supplementary thereto).

SEC. 2. Construction authorized by this Act shall be for the purposes of dam safety and not for the specific purposes of providing additional conservation storage capacity or of developing benefits over and above those provided by the original dams and reservoirs. Nothing in this Act shall be construed to reduce the amount of project costs allocated to reimbursable purposes heretofore authorized.

SEC. 3. There is hereby authorized to be appropriated such sums as may be necessary to accomplish the purposes of this Act.

All costs heretofore or hereafter incurred in the modification of dams to ensure their safety from failure shall be allocated among the authorized purposes served by the dams and related reservoirs in accordance with standard cost allocation procedures. Provided, however, that costs allocated to irrigation shall be reimbursable to the extent of the water users' ability to repay as determined by the Secretary of the Interior in the light of their outstanding repayment obligations.

DEERFIELD DAM

Deerfield Dam, a feature of the Rapid Valley Project, South Dakota, was completed in 1947. It is located on Castle Creek, approximately 27 miles west of Rapid City. The dam is a 133-foot-high zoned earthfill structure. The dam crest is 35 feet wide and 825 feet long. An uncontrolled, concrete, side-channel-type spillway is located at the right abutment of the dam. The reservoir capacity is 16,000 acre-feet when the water level is at the spillway crest. Deerfield Dam was constructed to supply water to approximately 8,900 acres of supplemental-service land.

If the maximum probable flood were to occur, the capacity of the spillway and outlet works would be exceeded, and approximately 23,000 cubic feet per second would flow over the dam crest. Rapid erosion of the earth embankment would result, and the peak flow below the dam would probably exceed 700,000 cubic feet per second.

The seismic analysis of Deerfield Dam indicates that the dam is capable of withstanding safely the maximum credible earthquake event.

The proposed corrective action includes raising the dam 16 feet and modifying the spillway. The estimated cost of the work is \$1,092,000 (based on January 1977 price level).

Deerfield Reservoir and the downstream Pactola Reservoir are operated on a pooled storage basis. Deerfield Reservoir is filled each spring. The water elevation is held high during the summer months for recreation and is drawn down following the irrigation and recreation season. The evacuated reservoir space is reserved for winter inflow to prevent use of the outlet works and spillway during the coldest winter months.

LAHONTAN DAM

Lahontan Dam, a feature of Newlands Project, Nevada, was completed in 1915. It is located on the Carson River, 18 miles west of Fallon, Nevada. The dam is a 162-foot-high zoned earthfill structure; the crest is 20 feet wide and 5,400 feet long. The active storage capacity of 295,000 acre-feet when the water level in the reservoir is at the spillway crest can be increased to approximately 314,000 acre-feet by the installation of flashboards across the two spillways. The project is designed to irrigate approximately 73,000 acres of full-service land, including approximately 4,900 acres of Indian land.

Lahontan Dam is incapable of storing or safely passing the maximum probable flood. Flows from such a flood would damage the already deteriorated concrete in the spillway chutes, cause the right abutment of the dam to slough, and ultimately, failure of the dam. The resulting breach in the dam would permit an uncontrolled peak discharge of approximately 275,000 cubic feet per second.

The maximum credible earthquake event would cause substantial damage to Lahontan Dam but would not cause it to fail.

Corrective action includes the rehabilitation of the spillways and the outlet works and the construction of a concrete curtain wall in the dam crest. The estimated cost is \$5,070,000 (based on January 1977 price level).

Until the corrective work can be accomplished, the amount of storage during the snowmelt runoff season has been restricted.

HYRUM DAM

Hyrum Dam, a feature of the Hyrum Project, Utah, was completed in 1935. It is located on Little Bear River at the southwest corner of the town of Hyrum, about 10 miles south of Logan, Utah. The dam is a 116-foot-high rolled earthfill structure; the crest is 35 feet wide and 540 feet long. The active storage capacity of the reservoir is approximately 15,000 acre-feet. Hyrum Project contains approximately 6,800 acres of supplemental-service land.

Porous material was used to construct the top 5 feet of the dam. Even if the reservoir were empty at the start of the maximum probable flood, the water level in the reservoir would rise sufficiently to permit the water to saturate and flow through the porous material. The flowing water would cause rapid breaching of the embankment and, ultimately, failure of the dam.

The seismic analysis of the dam has not been completed.

The proposed corrective action includes the construction of an auxiliary spillway at an estimated cost of \$810,000 (based on January 1977 price level).

Until the corrective action is completed, the spillway gates are kept completely open throughout the winter months, until runoff forecasts indicate that low frequency, high-volume snowmelt runoff is not likely to occur.

STONY GORGE DAM

Stony Gorge Dam, a feature of the Orland Project, California, was completed in 1928. It is located on Stony Creek, approximately 40 miles southwest of Orland. The dam is a 139-foot-high concrete slab and buttress structure. The dam crest is 9.75 feet wide and 868 feet long. Flow in the spillway at the center of the dam is controlled by three crawler gates. The active storage in the reservoir is approximately 50,000 acre-feet. The Orland Project contains approximately 19,600 acres of full-service land.

If the maximum probable flood were to occur, the capacity of the spillway and outlet works would be exceeded and the water level in the reservoir would rise 4 or 5 feet higher than the crest. Overtopping the dam would result in the undermining of the buttresses and cause failure of the dam.

The seismic analysis of Stony Gorge Dam indicates that no appreciable damage would result from the occurrence of the maximum credible earthquake event.

The proposed corrective action includes the construction of an additional spillway and would cost an estimated \$2,600,000 (based on January 1977 price level).

Because Stony Gorge Dam can store or safely pass intermediate size floods safely, no interim operating procedures have been implemented.

GIBSON DAM

Gibson Dam, a feature of the Sun River Project, Montana, was completed in 1927. It is located on the north fork of Sun River, 70 miles west of Great Falls. The dam is a 199-foot-high concrete arch structure. The 960-foot-long crest is 15 feet wide. A drop-inlet spillway is located near the left abutment. The active reservoir capacity is 105,000 acre-feet. The Sun River Project contains approximately 91,000 acres of full-service irrigable land.

If the maximum probable flood were to occur, the capacity of the spillway and outlet works would be exceeded, and the water level in the reservoir would rise 11 feet above the dam crest. Although the overflow would not cause the dam to fail, it would erode the abutments and weaken the dam.

The seismic analysis indicates that the dam would not fail during the occurrence of the maximum earthquake event and that damage resulting from the event would not be major.

The proposed corrective action includes the installation of aeration piers and protection of the left and right abutments by the installation of rockbolts. The estimated cost is \$962,000 (based on January 1977 price level).

To protect the dam from being overtopped by floods of less than a 100-year frequency, the reservoir storage is restricted until the snowmelt runoff recedes to less than 6,000 cubic feet per second.

BLACK CANYON DAM

Black Canyon Dam, a feature of the Payette Division, Boise Project, Idaho, was completed in 1924. It is located on Payette River, 5 miles northeast of Emmett, Idaho. The dam is a concrete gravity structure with a gated ogee spillway. The dam crest is 1,039 feet long. A power-pumping plant is located at the north end of the dam. The dam serves to divert water into the Black Canyon Canal. The Payette Division contains approximately 60,000 acres of full-service land and approximately 54,000 acres of supplemental-service land.

If the maximum probable flood were to occur, the dam would be overtopped by more than 3 feet, and the power-pumping plant building and penstocks, the utility building, the switchyard, and the new control building would be extensively damaged. No lives would be endangered.

There is some concern about the capability of the dam to withstand the maximum credible earthquake event, and seismic studies have been initiated.

The proposed corrective action includes the construction of an auxiliary spillway. The estimated cost is \$3,250,000 (based on January 1977 price level). The results of the seismic studies may indicate that additional corrective action is required.

Because Black Canyon Dam is a diversion dam and the reservoir contains only limited storage, a change in operation would not eliminate the need for corrective action.

ALTUS DAM

Altus Dam and related earth dikes, features of the W. C. Austin Project, Oklahoma, were completed in 1945. The dam is located on the north fork of Red River, approximately 18 miles north of Altus, Oklahoma. The 110-foot-high concrete gravity dam is faced with granite masonry on both faces except for the downstream face of the overflow section. The crest is 10 feet wide and 1,112 feet long. The active storage capacity of the reservoir is 154,000 acre-feet. The W. C. Altus Project furnishes water to approximately 47,000 acres of full-service land.

If the maximum probable flood were to occur, the water level in the reservoir would rise approximately 12 feet above the crest of the dam, assuming that the existing dikes did not fail.

The seismic analysis indicates that the dam and dikes would withstand safely the occurrence of the maximum credible earthquake.

The proposed corrective action includes the lowering of the north dike, raising other dikes, and constructing one new dike. The estimated cost is \$858,000 (based on January 1977 price level).

To reduce the probability of serious freeboard encroachment at Altus Dam prior to the completion of corrective action, special arrangements for the receipt of precipitation and streamflow data have been made with the Weather Service and with the Corps of Engineers. We are cooperating with the Corps in revising flood-control regulations for Altus Dam.

THEODORE ROOSEVELT DAM

Theodore Roosevelt Dam, a feature of the Salt River Project, Arizona, was completed in 1911. The dam is located on the Salt River, approximately 30 miles northwest of Globe. The 280-foot-high rubble-masonry, thick-arch structure has two overfall spillways. Flows in the spillways are controlled by radial gates. The dam crest is 16 feet wide and 723 feet long. The active storage capacity of the reservoir is approximately 1,382,000 acre-feet. A powerplant is located at the base of the left abutment. The Salt River Project contains approximately 263,000 acres of irrigable land, of which 238,000 acres are full-service land.

If the maximum probable flood were to occur, the water in the reservoir would rise approximately 2.5 feet above the top of the dam parapet and the dam would fail.

The seismic analysis indicates that the dam is capable of withstanding the maximum credible earthquake event safely.

The corrective action being considered at the present time includes raising the dam and modifying the spillway at an estimated cost of \$1,209,000 (based on January 1977 price level).

Under present operating restrictions, the normal water level in the reservoir has been reduced to protect against failure during intermediate floods.

STEWART MOUNTAIN DAM

Stewart Mountain Dam, a feature of the Salt River Project, Arizona, was completed in 1930 and modified by the Bureau of Reclamation in 1936. It is located on the Salt River, approximately 41 miles northeast of Phoenix, Arizona. The dam, a thin-arch, concrete structure, has a concrete weir spillway at the left abutment. The dam crest is 8 feet wide and 1,260 feet long. The active capacity of the reservoir is approximately 70,000 acre-feet. A powerplant is located at the base of the right abutment. The Salt River Project contains approximately 263,000 acres of irrigable land, of which approximately 238,000 acres are full-service land.

In the event the maximum probable flood were to occur, Stewart Mountain Dam would not fail; the undermining effect of the high-velocity flows in the spillway, however, would cause severe damage to the right wall and floor slab of the spillway chute.

A seismic analysis of Stewart Mountain Dam indicates that the dam could withstand the maximum credible earthquake event safely.

The proposed corrective action includes raising the dam and modifying the spillway at a cost of \$6,760,000 (based on January 1977 price level).

To minimize damage to the spillway, discharges through the spillway should be restricted to a 105,000 cubic feet per second (approximately two-thirds of its capacity) until the corrective work has been completed.

JACKSON LAKE DAM

Jackson Lake Dam, a feature of the Minidoka Project, Idaho-Wyoming, was completed in 1911 and was enlarged in 1916. It is located on the Snake River, near Moran, Wyoming. The 78-foot-high dam is a concrete gravity structure with earth embankment wings. The crest is 20 feet wide and 4,920 feet long. The active capacity of the reservoir is approximately 847,000 acre-feet. The concrete overflow spillway is controlled by radial gates. Jackson Lake Dam is one of five Minidoka Project dams. The project contains approximately 1,163,000 acres of irrigable land, of which 217,000 acres are full-service land.

Jackson Lake Dam is capable of withstanding the maximum probable flood.

The seismic studies are incomplete, however, the indications are that the earth embankments may require stabilization to enable them to withstand the maximum credible earthquake event. The concrete section of the dam has been stabilized and is capable of withstanding that event.

The amount of corrective action needed to make the earth embankments safe will be determined when the current seismic studies have been completed. At this time, the estimated cost of the work needed to stabilize the embankments is \$4 million (based on January 1977 price level).

Interim operating procedures are not required at Jackson Lake Dam.

ISLAND PARK DAM

Island Park Dam, a feature of the Upper Snake River Storage Division, Minidoka Project, Idaho, was completed in 1938. The dam is located on Henrys Fork, approximately 38 miles north of Ashton, Idaho. The 91-foot-high zoned earthfill structure has a U-shaped concrete weir spillway located at the right abutment. The dam crest is 35 feet wide and 9,448 feet long. The active capacity of the reservoir is approximately 128,000 acre-feet. The Upper Snake River Storage Division contains approximately 112,000 acres of supplemental-service land.

The concrete in the Island Park Dam spillway is in an advanced stage of deterioration. Studies have indicated that the dam is incapable of storing or passing safely the maximum probable flood.

The proposed corrective action includes the modification of the spillway and outlet works of the dam, at an estimated cost of \$2,405,000 (based on January 1977 price level).

The material in the upper portion of the embankment is not watertight, and the operating procedures have been revised to limit the amount of storage in the reservoir during periods when the maximum probable flood could occur.

WILLOW CREEK DAM

Willow Creek Dam, a feature of the Fort Shaw Division, Sun River Project, Montana, was completed in 1911. The dam is located on Willow Creek approximately 5 miles northwest of Augusta, Montana. The 93-foot-high modified homogeneous earthfill structure has an uncontrolled open channel emergency spillway in dike No. 5, approximately 3,600 feet north of the dam. The crest of the dam is 30 feet wide and 650 feet long. The active reservoir capacity is approximately 32,000 acre-feet. The Fort Shaw Division contains approximately 10,000 acres of full-service land.

A geological investigation revealed that the top 7 or 8 feet of the unlined spillway channel are highly erodible. If the maximum probable flood were to occur, the spillway would fail and a substantial loss of reservoir storage would occur.

The seismic analysis indicates that Willow Creek Dam is capable of withstanding the maximum credible earthquake event.

The proposed corrective action includes raising the dam and the construction of a replacement spillway. The estimated cost of the work is \$3,640,000 (based on January 1977 price level).

There are no operating restrictions at Willow Creek Dam.

EAST PARK DAM

East Park Dam, a feature of the Orland Project, California, was completed in 1914. The outlet works were modified in 1916. The dam is located on the Little Stony Creek, approximately 31 miles southwest of Orland, California. The 139-foot-high concrete thick-arch dam has a concrete multiple-arch uncontrolled overflow spillway approximately 2,000 feet south of the dam. The crest of the dam is 10 feet wide and 266 feet long. The active storage capacity of the reservoir is approximately 51,000 acre-feet. The Orland Project contains approximately 19,600 acres of full-service land.

If the maximum probable flood were to occur at East Park Dam, the water surface in the reservoir would rise approximately 4 feet higher than the dam. The event would cause failure of the spillway structure and probably one or both dikes and the small retaining wall south of the dam.

Results of the seismic analysis indicate that the dam would suffer damage during the occurrence of the maximum credible earthquake event; although the dam would not fail, the stability of the spillway structure is marginal, and it would probably fail.

The proposed corrective action includes the construction of a larger spillway, at an estimated cost of \$3,900,000 (based on January 1977 price level).

There are no operating restrictions at East Park Dam.

The Senator HANSEN. Mr. Higginson, please proceed.

STATEMENT OF HON. R. KEITH HIGGINSON, COMMISSIONER, BUREAU OF RECLAMATION, U.S. DEPARTMENT OF THE INTERIOR; ACCOMPANIED BY DONALD A. GIAMPAOLI, DIRECTOR, OFFICE OF DAM SAFETY, ENGINEERING AND SCIENCE; J. W. PEPPLER, ACTING CHIEF, GENERAL ENGINEERING STAFF; E. C. ROPER, WATER OPERATIONS BRANCH; AND D. P. PROSSER, GENERAL ENGINEERING STAFF

Mr. HIGGINSON. Thank you, Mr. Chairman, it is a pleasure for us to have this opportunity, even at this early morning hour, to appear before the committee and present our views concerning this bill.

Mr. Chairman, this legislation is needed to authorize the Secretary of the Interior as you have indicated, to construct, restore, operate, and maintain new or modified features at existing Federal reclamation dams for safety purposes.

As the engineering profession develops new criteria and technology for design of dams, it becomes necessary to reevaluate the safety of the older dams. As a result of studies to date using modern criteria, we have identified 27 dams which require structural modification to enable them to withstand safely the inflow design flood and/or the maximum credible earthquake.

Needed modifications have been completed on 10 of the 27 dams and are authorized and underway on 4 other dams; however, authorization is still required for work on the remaining 13 dams and other dams that may be found to be hazardous in our continuing review program.

Since the inception of the Reclamation Act of 1902, the Bureau has constructed more than 240 reservoirs impounded by more than 310 dams and dikes. Implicit in Reclamation's responsibility for these facilities is the assumption that they will be designed, constructed, operated, and maintained in a safe manner.

During the past 76 years, programs to insure the safety of dams have been developed, amended, and updated to incorporate new technologies and to reflect the experience of Reclamation and other construction entities.

Initially, all Reclamation dams and reservoirs were operated and maintained by Government forces. In 1914, Reclamation law was amended to permit the responsibility for the operation and maintenance of facilities to be transferred to water user organizations.

Currently, more than 110 of the Reclamation's storage dams and reservoirs are operated and maintained by water user organizations. As the number of transfers increased, Reclamation saw the need to document procedures to insure the proper operation and maintenance of the facilities.

In response to the need, Reclamation developed a formal program for periodic inspections of dams and other structures in 1948, entitled the "Review of Maintenance Program." Under the review of maintenance program, each dam is examined by Reclamation project and regional personnel at 2 or 3 year intervals, depending upon the nature

of the facility. Specialists from Reclamation's Engineering and Research Center, Denver, Colo., review the dams at least once every 6 years, along with regional personnel.

A formal report on the condition of each dam and of its appurtenant structures, including any recommended corrective actions, is prepared after the examination and becomes a part of the permanent history of the dam's performance. The correction of structural or procedural deficiencies observed during the examination is the responsibility of the regional director having jurisdiction for the facility.

Corrective measures resulting from the review of maintenance program are accomplished under normal operation and maintenance funding, rehabilitation and betterment programs, or emergency funding, depending upon the urgency of the particular deficiency.

In 1965, an additional program, the examination of existing structures program was initiated to evaluate the original dam design, in light of modern criteria for flood analysis, seismicity, and other concerns. As a result of the completion of some of these investigations, the need for authorizations to construct safety relating modifications to some existing dams was identified.

The current policy for insuring the safety of the older dams having inadequate spillways or seismic concerns includes the study of alternative structural solutions, and use of operating restrictions until a permanent solution is completed.

It was determined that 88 dams required study to determine their ability to withstand safely the currently estimated inflow design flood. Flood studies have been completed on 83 of the 88 dams. Flood studies on the remaining five dams will be completed in fiscal years 1978 and 1979.

The engineering profession is developing new methodologies for evaluating the response of structures to earthquakes. Seismic studies have been scheduled to reexamine 235 Bureau dams in priority order of their hazard potential.

Out of these 235 dams, 64 are in high seismic risk areas. Seismic studies of 26 dams have been completed; studies of all reclamation dams in high seismic risk areas are scheduled to be completed by the end of fiscal year 1980.

Other activities under the examination of existing structures program include landslide surveillance, structural behavior analysis, upstream dams surveys, and the documentation of operating instructions.

A formal report of each examination is prepared. The report includes information on the need for structural modification, if any; the hazards to the public, the recommended corrective action and alternatives, and the environmental impacts.

The completed reports are used as a basis for recommending corrective action. At this time, reports are completed on Lahontan and Deerfield Dams, and we plan to complete the reports on Hyrum, Stony Gorge, and Gibson Dams this fiscal year.

Of dams for which studies have been completed under the examination of existing structures program, major modifications have been completed at Boca and Clear Lake Dams (California), Conconully Dam (Washington), and Belle Fourche Dam (South Dakota).

Minor modifications have been completed at Bull Lake, Pathfinder, and Seminoe Dams (Wyoming), Gerber Dam (Oregon), Vallecito Dam (Colorado), and Como Dam (Montana).

Major work is authorized and is in progress on American Falls Dam (Idaho). Major work is authorized and specifications for modifications will be issued this year on McKay Dam (Oregon) and Dickinson Dam (North Dakota).

Major work is authorized on Brantley project, New Mexico and investigations are proceeding. We have identified 13 other dams which require major work. The 13 dams are: Deerfield Dam (South Dakota), Lahontan Dam (Nevada), Hyrum Dam (Utah), Stony Gorge and East Park Dams (California), Gibson and Willow Creek Dams (Montana), Black Canyon and Island Park Dams (Idaho), Altus Dam (Oklahoma), Theodore Roosevelt and Stewart Mountain Dams (Arizona), and Jackson Lake Dam (Wyoming).

Although the 13 dams are not in imminent danger of immediate failure, failure would be probable if the inflow design flood were to occur upstream from those dams that are incapable of safely passing or storing such a flood or if the maximum credible earthquake occurred at those dams incapable of withstanding such an event.

The modifications are for safety purposes only, and not for providing any additional benefits over and above those originally authorized and provided by the original dams and reservoirs.

Mr. Chairman, we have a series of slides and with these slides, we would be able to identify to you some of the problems associated with these dams and we will proceed if that is your pleasure.

The first slide is Hyrum Dam, Utah, constructed in 1935, and it is an earth dam in which porous material was used to construct the top 5 feet of the dam. Even if the reservoir were empty at the start of the inflow design flood, the water level in the reservoir would rise sufficiently to permit the water to saturate and flow through the porous material. The flowing water would cause rapid breaching of the embankment and, ultimately, failure of the dam. We plan to construct an auxiliary spillway. You can see the proposed alignment.

Lahontan Dam, Nevada, is a zoned earthfill structure, constructed in 1915. It is equipped with a left and right spillway and outlet works. The dam is incapable of passing the inflow design flood. Flows from such a flood would damage the already deteriorated concrete in the spillway chutes, and cause the right abutment to slough. Corrective action includes the rehabilitation of the spillways and the outlet works and the construction of a concrete curtain wall in the dam crest.

Stony Gorge Dam, California, a concrete slab and buttress structure, constructed in 1928, does not have sufficient capacity of the outlet works and spillway to handle the inflow design flood.

If such a flood were to occur, overtopping of the dam by 4 to 5 feet could cause undermining of the buttresses and failure of the dam. Proposed corrective action includes the construction of an additional spillway.

East Park Dam, Calif., was constructed in 1914. The 139-foot-high concrete, thick-arch dam has a concrete multiple arch uncontrolled overflow spillway approximately 2,000 feet south of the dam.

If the inflow design flood were to occur, the reservoir would rise approximately 4 feet higher than the crest of the dam, causing failure of the spillway structure. Proposed corrective action includes construction of a larger spillway. This slide is a spill event in which you can see the spillway is crowded almost to its full capacity.

Gibson Dam, Mont., is a 199-foot-high concrete arch dam. Completed in 1927, the dam is well maintained by the Greenfields Irrigation District.

In 1964, Gibson Dam was overtopped by approximately $3\frac{1}{4}$ feet of water with an estimated flow of 60,000 cfs. As vividly demonstrated, overflow did not cause this dam to fail. The inflow design flood, however, would cause a reservoir rise of 11 feet above the dam crest, eroding the abutments and weakening the dam. Proposed corrective action includes installation of aeration piers and protection of the abutments by rockbolting.

At the 133-foot-high, zoned earthfill, Deerfield Dam, S. Dak., completed in 1947, a maximum flood probably would exceed the spillway and outlet works capacity and cause approximately 23,000 cfs to flow over the crest of the dam.

Erosion of the embankment would occur resulting in flows below the dam exceeding 700,000 cfs. Proposed corrective action includes raising the dam 16 feet and modifying the spillway.

Theodore Roosevelt Dam, Ariz., was completed in 1911. The 280-foot-high dam is the world's largest masonry thick arch dam and was the first major reclamation dam in the United States.

Present operating procedure at Theodore Roosevelt Dam requires the normal reservoir elevation be lowered approximately 9 feet when a major flood is forecast. Using the reduced normal operating level, and limiting the spillway discharge to the existing spillway capacity at Stewart Mountain Dam, which is downstream, would result in overtopping the dam parapet by approximately 2.5 feet in the event of an inflow design flood.

Just recently, however, the reservoir stored approximately 600,000 acre feet during floods on the Salt and Verde Rivers. Proposed corrective action includes raising the dam and modifying the spillway.

Stewart Mountain Dam, Ariz., is a thin arch, concrete structure completed in 1930, with a concrete weir spillway at the left abutment. Spillway capacity is 105,000 cfs. In the event of the inflow design flood, the dam would not fail.

However, the undermining effect of the high velocity flows in the spillway would cause severe damage to the right spillway wall and floor slab. The proposed corrective action includes raising the dam and modifying the spillway.

The 93-foot-high modified homogeneous earthfill, Willow Creek Dam, Mont., completed in 1911, has an uncontrolled spillway in a dike north of the dam. Slide 16, if the inflow design flood were to occur, the spillway and the top 7 or 8 feet of the unlined spillway channel, which is highly erodible, would fail and a substantial loss of storage would occur. The proposed corrective action includes raising the dam and the construction of a replacement spillway.

Located on the north fork of the Red River, Altus Dam, Okla., is a 110-foot-high concrete gravity dam which was completed in 1945. If the inflow design flood were to occur, the reservoir would rise approximately 12 feet above the crest of the dam, assuming that the existing dikes did not fail. Proposed corrective action would provide for lowering the north dike, raising the other dikes, and constructing one new dike.

Studies show that Island Park Dam, Idaho, is incapable of storing or passing safely the inflow design flood. The 91-foot-high, zoned

earthfill structure was completed in 1938. Slide 19, the spillway is in an advanced stage of deterioration. The proposed corrective action includes modification of the spillway and outlet works.

The one you've been waiting for, Senator, Jackson Lake Dam, Wyo., a 78-foot-high dam constructed in 1916. It has a concrete gravity section and earth embankment wings.

Seismic studies, though incomplete, indicate the earth embankments may require stabilization to enable them to withstand the maximum credible earthquake event. A major earthquake in this vicinity could cause liquefaction of the saturated silty sandy foundation of the dam.

Liquefaction is a process whereby, under certain conditions the silty sandy material acts like a fluid. Our concern for the dam led to a recent maximum reservoir elevation restriction of 9 feet less than the normal reservoir level. The concrete section has been stabilized and is capable of withstanding that event. The dam can pass the inflow design flood.

Black Canyon Dam, Idaho, a concrete gravity structure completed in 1924, has a power and pumping plant located at the north end of the dam. If the inflow design flood were to occur, the dam would be overtopped by more than 3 feet, resulting in extensive damage to the power and pumping plants, penstocks, switchyards, and utility buildings. The proposed corrective action includes the construction of an auxiliary spillway, however, seismic investigations are not yet complete.

Although significant progress in correcting deficiencies at existing dams has been made, the program is a long way from complete.

We have organized an Office of Dam Safety to formulate policy and guidelines for, and evaluation of, the effectiveness of the safety of dams program and other organizational and procedural changes are in progress.

We are instituting a general, overall strengthening of our dams process. At this hearing, our concern is specifically directed toward the operation and maintenance portion of that process. We are developing an intensified program of safety reviews of existing dams.

The legislation currently under consideration will provide the necessary authority to proceed with needed safety modifications to dams as the need is determined. It will provide for timely solution to structural problems.

The bill provides for repayment of modification costs allocated to irrigation on the basis of the water users' ability to repay, as determined by the Secretary of the Interior, in light of their other outstanding repayment obligations.

Our fiscal year 1979 appropriation request includes five safety of dams programs, Hyrum Dam, Utah; Stony Gorge Dam, California; Lahontan Dam, Nevada; Deerfield Dam, South Dakota; Gibson Dam, Montana.

Reports have been completed on Deerfield and Lahontan Dams, and we expect to complete the other three reports in fiscal year 1978. As reports are completed, they will be made available to the subcommittee.

Our immediate need is for authorization of safety modifications to these five dams. However, to provide the kind of program strengthening and high priority to dam safety issues which we believe necessary, full authority to perform safety modifications at existing structures,

upon the determination of technical and engineering necessity, is required.

We urge your favorable consideration on S. 2820 and will be pleased to respond to your questions.

Senator HANSEN. Thank you very much, Commissioner, for a very comprehensive and thorough report on the situation. I compliment you for it.

I note as I read it, the administration bill is open-ended, whereas the House version has a ceiling of \$100 million. Do you have any recommendation as to what should be the language contained in the Senate version?

Mr. HIGGINSON. Mr. Chairman, our current estimate at 1977 prices of the cost for the 13 dams we are asking authority for is some \$36,500,000. We would hope that whatever the committee's pleasure would be, that some limitation slightly above that at least would be acted upon by the committee. Our need is in that area.

Senator HANSEN. In order that I might more clearly understand what is intended, on the last page of your prepared statement, you say at the top of the page, "The bill provides for repayment of modification costs allocated to irrigation on the basis of the water users' ability to repay, as determined by the Secretary of the Interior, in light of their other outstanding repayment obligations."

A couple of dams come to mind, McKay and Dickinson. These would be examples of dams where this particular language would apply; is that right?

Mr. HIGGINSON. Yes, sir, those would be examples, except where Congress has previously determined that the cost should be non-reimbursable. Under this bill, costs would be reimbursable up to the water users' ability to repay.

Senator HANSEN. That would be a determination made by the Secretary?

Mr. HIGGINSON. By the Secretary; yes.

Senator HANSEN. Are there plans or provisions in your safety review program for external or independent review of the safety considerations of these dams? That is, a review outside of the Department or Bureau of Reclamation.

Mr. HIGGINSON. Mr. Chairman, we have incorporated an extensive program of outside review of all of our design as part of our dam safety activity. We have created the Office of Dam Safety, Mr. Giampaoli, seated on my left, is the director of that office, a new activity in which we will be conducting internal audit reviews, as well as through his office, using consultants to review material and plans and specifications prepared by our engineering and research center in Denver. They also will extensively employ consultants to give an independent review of any design or any structural problem we have with every dam currently and in the future planned by the Bureau.

Senator HANSEN. Very good. We are pleased to have you here, Mr. Giampaoli.

Mr. GIAMPAOLI. Thank you, Mr. Chairman.

Senator HANSEN. I will call on Mr. Brown for a question.

Mr. BROWN. This is not that germane to this subject at hand. However, I would be interested to know if in the evaluation of the existing structures, if any consideration was given to providing for the development of any hydroelectric power potential?

A lot of these, I understand to be older structures built primarily for storage and what have you. Perhaps at that date, no consideration was given to the installation of generating facilities. But now, in light of the higher fuel costs, higher costs of electricity, perhaps some of those sites could have economic potential for generation.

Mr. HIGGINSON. Mr. Brown, that is correct, we have looked at that. I believe you are familiar with our western energy expansion study in which we did examine existing structures within the Bureau as to their potential for addition of hydroelectric and those kinds of reviews are continuing.

We have a number of structures in which penstocks were actually installed at the time the original dam was built but no powerplant was provided because of the then value of the hydroelectric energy. With present prices and values, we are considering hooking on to those penstocks with powerplants and proposals and programs for that will be included in subsequent submissions.

You are aware in the 1979 President's budget request, there are 18 new investigation starts associated with power, associated with existing dams, where we could potentially add additional hydroelectric energy. So we are looking at that extensively, yes, sir.

Mr. BROWN. Thank you, Mr. Commissioner.

Senator HANSEN. Let me thank both of you for your appearance here this morning. I think you have made a very fine case for the legislation that is before us. We appreciate your appearance, thank you so much. The hearing is adjourned.

[Whereupon, at 7:25 a.m., the hearing was adjourned.]



