Statement of Gilbert G. Stamm, Commissioner of Reclamation
Before the Subcommittee on Energy Research and Water Resources
of the Senate Committee on Interior and Insular Affairs
on the Failure of Teton Dam
January 24, 1977

Mr. Chairman and members of the subcommittee, we are appearing today at your request to provide information related to the failure on June 5, 1976, of the Teton Dam in Idaho. The dam was designed by the Bureau of Reclamation and was constructed under its supervision. It is the first and only failure of a Reclamation dam. The loss of life, destruction of property, and disruption to the thousands of victims weigh heavily upon us individually and as a professional organization.

Since its inception in 1902, the Bureau of Reclamation has designed and built 240 earthfill dams and dikes, and about 50 concrete dams—many of which were unique in some respect at the time of construction and all of which, except for Teton, have performed well. For these and other works, Reclamation earned a worldwide reputation for engineering competence and innovation in the planning, design, and construction of dams and associated water control facilities. The failure of Teton Dam placed a severe blemish on that record.

You have requested the views of the Bureau of Reclamation regarding the Independent Panel Report on Failure of Teton Dam dated December 1976, but not released until January 1977. The panel was appointed by the
Secretary of the Interior and the Governor of Idaho and was charged with determining the cause of the Teton Dam failure. The panel conducted an extensive study documented in its 400-page report. Reclamation immediately initiated a technical review of the report, which review is expected to be completed in 30 to 60 days. At this time it is not expected that technical differences will be found that would significantly alter the conclusions reached by the panel. The objectivity and professionalism of the panel are commendable. We hold the chairman and all members of the Independent Panel in high regard.

Several of the initially advanced failure hypotheses were considered by the panel and dismissed as untenable. These included seismic activity, foundation settlement, reservoir leakage, and seepage around the end of the grout curtain.

Conclusions which support Bureau practice include predesign site selection and geological studies, construction practices, and responsible action of Bureau people throughout the emergency. The report further states the rate of filling was not the cause of failure, although it could have affected the timing and possibly the consequences.

Findings of the Independent Panel which relate to the cause of the failure are summarized as follows:
1. Numerous open joints in the abutment rock.

2. Highly erodible material used for the dam's core.

3. Complete dependence for seepage control on key trenches filled with wind blown soils, and a grout curtain.

4. Configuration of the key trench that encouraged arching, cracking, and hydraulic fracturing.

5. Reliance on special compaction of fill material as the only protection against piping and erosion.

6. Inadequate provisions for collection and safe discharge of seepage.

Reclamation's technical analysis will give close attention to those findings. Of the 6, we believe, at this time, that the principal contributing cause was the deep narrow configuration of the key trench. That element of the design was unique and appears to have been the feature that gave rise to the series of circumstances that permitted internal erosion that led to failure.

Our intended analyses will include inspection of conditions in the left abutment, delineation of pre-failure vs. post-failure conditions in the right abutment, effects of stress relief on apparent post-failure conditions in the right abutment, three dimensional finite element analysis of the fill, and other studies and research as are significant not only to the cause and cure for Teton, but also to advancement of the state of the art in earth dam design.
Reclamation's long standing design and construction policy has been not only to keep pace with the state of the art but to advance it through research and practice whenever possible without compromising the safety factor. Any deficiency in this area must be corrected immediately.

Reclamation procedures involving design, management, and operation and maintenance are being reviewed internally as well as through the investigations directed by the Secretary of the Interior. Reclamation is cooperating fully with all investigative groups in thorough analyses of the facts. I have been insistent that Reclamation be guided by all of the pertinent findings of the Independent Panel, our own staff, and others so that the engineering community, and the people it serves worldwide can benefit from this tragic experience.

Several months ago I took steps to tighten the Bureau's reporting obligations and procedures to accelerate the disclosure of any geologic, design, or construction condition discovered during construction which would affect safety.

In addition, I have announced that Reclamation will obtain independent technical review of its designs of all future dams. This doublecheck on our procedures and technology is intended to avoid any recurrence of conditions which could lead to a dam failure. Also, I have
announced that the Bureau will expand instrumentation of future dams, will adopt conservative initial filling criteria for new reservoirs, where applicable, and will intensify behavioral monitoring.

Since 1922, when the Bureau of Reclamation used a five-man consulting board in the selection of a damsite for Hoover Dam and to make recommendations regarding related geologic explorations, the Bureau has on more than 100 occasions used outside consultants. While this procedure has been used selectively and frequently in the past, it will be applied generally in the future. We believe such independent review will be very helpful as a supplement to, or a doublecheck on, our procedures and technology, and will be an effective future safeguard.

The letter to me signed by Senator Church and Senator McClure, dated January 14, 1977, asked for replies to 15 specific questions. We have prepared replies, some of which must be considered preliminary because of the short time available for their preparation.

The answers are included in a separate statement which I can read into the record or submit for the record, whichever you prefer.
QUESTIONS AND ANSWERS

FOR A HEARING ON

THE FAILURE OF TETON DAM

CONDUCTED BY

UNITED STATES SENATE COMMITTEE
ON
INTERIOR AND INSULAR AFFAIRS
SUBCOMMITTEE ON
ENERGY RESEARCH AND WATER RESOURCES

PREPARED BY

BUREAU OF RECLAMATION

ON

JANUARY 20, 1977
Question No. 1

The Panel report states that:

"The design followed USBR practices, developed over a period of many years from experience with other Bureau projects, but without sufficient consideration of the effects of differing and unusually difficult geological conditions at the Teton Dam site. Every embankment can be said to have its own personality requiring individual design consideration and construction treatment. Treatment of such individualities produces most of the continuing advances in dam design and construction technology."

In view of this statement, please indicate the policy, if any, maintained by the Bureau for continually reviewing and updating its design criteria for dams. How frequently are design standards modified?

To what extent is the design of a dam uniquely devised on the basis of its site characteristics?

Has there been a tendency to perpetuate previous design practices without adequate consideration of their suitability for locations having significantly different physical characteristics?
Question No. 1 (Cont)

Is the engineering for a particular dam innovative and based on current technology or is it a transfer of traditional designs to new sites?

Answer to Question No. 1

The Office of Design and Construction constantly modifies its design criteria and standards as appropriate in order to stay as close to the state-of-the-art as practicable. In general, design standards are maintained in the design section responsible for the specific type of structure. Major changes in design philosophy or techniques are approved by the Design branch chief; the Chief, Division of Design; and/or the Director of Design and Construction, as appropriate. These standards are modified when a more appropriate method of design is developed. Approval of the Commissioner's Office is not required.

Many design standards are published in Bureau Manuals, Engineering Monographs, Research Reports, Technical Records of Design and Construction, and in Journals of Professional Societies. These documents are used throughout the world. When a sufficient number
Answer to Question No. 1 (Cont)

of changes have been accumulated, the publications are revised. The following examples reflect recent practice:

Design of Gravity Dams, 1976
Design of Arch Dams (in preparation, with tentative publication date of August 1977)
The Dynamic Analysis of Embankment Dams (completed and scheduled for 1977 publication by the International Congress of Large Dams)

Each dam is designed to satisfy the site conditions at a particular location and geological setting. Designers take advantage of the experience gained by previous designs and incorporate new technologies in the design of the next project.
Question No. 2

The Panel stated the following in its report:

"The volcanic rocks at the Teton damsite are highly permeable and moderately to intensely jointed. Water was therefore free to move with almost equal ease in most directions except locally where the joints had been effectively grouted. Thus during reservoir filling water was able to move rapidly to the foundation of the dam. Open joints existed in the upstream and downstream faces of the right abutment key trench providing potential conduits for ingress or egress of water."

Did designers consider the possibility of rapid water movement to the foundation of the dam? If so, why wasn't the design and/or choice of construction materials and procedures modified accordingly?

If it was assumed that rapid water movement to the foundation would not occur or was precluded by grouting and/or other procedures, what field tests or analytic methods were used to arrive at this conclusion?

What are the Bureau's procedures for evaluating design integrity during construction?
Answer to Question 2

It is normal design practice to assume that the reservoir will have access to the upstream foundation of the dam, and in this case, the upstream face of the key trench as well. Rapid water movement to the foundation of the dam was recognized. As a result of the pilot grouting program in 1969, the decision was made to replace grouting from the ground surface on the abutments with the impervious soil filled key trench, and the three-row grout curtain in the bottom of the key trench.

In order to provide a dense, well-bonded material against the rock surface, specially compacted zone 1 material was specified. Earthwork construction control tests and close inspection of the specially compacted material assured a quality product. The Panel's report states:

"The embankment foundation contact in the key trench was excellent and well bonded where observed at many locations in the side wall, transverse invert trenches, and the longitudinal trenches extending to the top of the grout cap. Foundation cleanup was excellent * * *. No dry, pervious, or low density layers or lenses were found. A few localized, saturated pockets of Zone 1 material were encountered along the upstream wall of the key trench * * *"
The Panel excavations did not reveal any locations where reservoir water had penetrated the fill beyond the face of the trench, except for the localized pockets.

Grouting techniques required by the Bureau provide a reliable check on the adequacy of foundation grouting.

The Bureau continually evaluates the design integrity during construction. Weekly and/or monthly progress reports are prepared by each Construction Engineer. Design engineers monitor each construction contract through construction liaison engineers stationed in Denver. Design engineers visit the jobsite at selected times such as when the foundation is exposed or a problem related to the design arises. Designs are modified by the original design group when field conditions dictate.
Question No. 3

Relative to the material used in zone 1 (the core), the Panel commented as follows:

"The wind-deposited nonplastic to slightly plastic clayey silts used for the core and key trench fill are highly erodible. The Panel considers that the use of this material adjacent to the heavily jointed rock of the abutment was a major factor contributing to the failure."

It is assumed that Bureau of Reclamation engineers employ state-of-the-art technology in the design and construction of earthfill dams. Considering the Panel's comment that the manner of use of the selected zone 1 material was a major factor contributing to failure, why weren't provisions made in the dam's design to circumvent this problem?

It is documented that the Bureau noted the highly erosive character of the core fill. This factor combined with the difficult geologic conditions at the damsite would suggest the exercise of great caution and special design accommodations. What options for design and choice of construction materials were explored?
Question No. 3 (Cont)

What were the alternatives to the use of the selected zone 1 material?

Answer to Question No. 3

This soil was used within a deep abutment key trench to create an impermeable barrier. The Bureau assumed that this trench in combination with the grout curtain would provide a sufficiently impermeable barrier to the water. Provisions were made to make sure the barrier was impermeable. Although the Bureau is just beginning to evaluate the data collected by the Independent Panel, our preliminary evaluations indicate that the major problem occurred because of the configuration of the deep key trenches.

Initially the Bureau planned to design a rockfill dam at the site of Teton Dam. This type of design is highly resistant to earthquake effects and to erosion by flowing water. This design was revised due to the environmental consideration of defacing the upstream reservoir abutment area. Following this, a homogeneous type design embankment constructed of the wind-deposited silt was considered for the site. This design was rejected due to the erodible
Characteristics of the wind-deposited silt and possible earthquake effects at the site. Finally the present design wherein the silt material would be contained within sand gravel shells and within the key trench was decided upon. The choice of material for the core was limited to the wind-blown loessial material which covers the uplands adjacent to the damsite. This material is commonly used in the construction of earth dams and was selected here because it was strong, impermeable, and readily available.
Question No 4

The rate of filling of the reservoir was affected in part by the delay in completion of the river outlet works. To what extent, if any, could this have impacted on the extent and timing of the failure and the opportunity to provide more advanced warning of the breach of the dam?

Answer to Question No. 4

In the Panel's view, as stated by Mr. Chadwick at the January 6, 1977 press conference, with which the Bureau agrees,

"* * * we did not believe that the rapid filling rate was a fundamental cause of the failure of the dam. It might have changed the timing, but we don't think that it would have saved the structure if it had been able to fill the reservoir at its lower rate."

The effect of any change in timing is speculative.
Regarding the grout curtain, the Independent Review Panel stated the following:

"The records show that great effort was devoted to constructing a grout curtain of high quality and the Panel considers that the resulting curtain was not inferior to many that have been considered acceptable on other projects. Nevertheless, the Panel's on-site tests and other field investigations showed that the rock immediately under the grout cap at least in the vicinity of stas. 13+00 to 15+00 was not adequately sealed and that additional unsealed openings may have existed at depth in the same locality. The leakage beneath the grout cap was capable of initiating piping in the key trench fill leading to the formation of an erosion tunnel across the base of the fill. The Panel considers that too much was expected of the grout curtain and that the design should have provided measures to render the inevitable leakage harmless."

To what extent was an effort made to determine the degree to which the rock below the grout cap was adequately sealed? Could a better determination have been made?
Question No. 5 (Cont)

In view of the fact that leakage beneath the grout cap could significantly affect the integrity of the dam, why weren't more adequate measures taken to eliminate this hazard?

Answer to Question No. 5

The foundation grouting in the reach between stations 13+00 and 15+00 consisted of two outer rows of grout holes on 20-foot centers and a centerline curtain through a grout cap on 10-foot centers with closure holes on 5-foot centers as necessary. Centerline holes were grouted to refusal under established standards. Final closure holes had negligible grout take under pressure. The grouting techniques employed furnished a good check on the adequacy of the grout curtain so there was no reason to doubt the quality of the grout curtain in this area.

Foundation conditions in the reach after failure, when additional drilling and water testing were done, were quite different than during construction. Approximately 300,000 cubic yards of rock and considerable grout cap were eroded during the failure which produced vibrations in the area. The tremendous force of water which was directed against the abutment may have affected previously filled
Answer to Question No. 5 (Cont)

cracks and stress relief resulting from the removal of the rock may have contributed to post failure open joints that did not exist immediately after grouting. This may have contributed to the amount of leakage beneath the grout cap indicated by the tests performed after failure.
Question No. 6

The Review Panel noted that the key trench design created some problems. It stated that:

"The geometry of the key trenches, with their steep sides, was influential in causing transverse arching that reduced the stresses in the fill near the base of the trenches and favored the development of cracks that would open channels through the erodible fill. Arching in the longitudinal direction due to irregularities in the base of the key trenches and arching adjacent to minor irregularities and overhangs undoubtedly added to the reduction of stress."

The arching condition referred to is well understood and yet a questionable design was chosen with knowledge beforehand of the difficult geology and less-than-optimal zone 1 material. Why was this selection made? What other options, if any, were evaluated?

Answer to Question No. 6

The following options were evaluated for providing an impervious barrier in the abutments:
1. Constructing a grout barrier from the ground surface

2. Excavating the highly fractured and jointed rock to form a key trench, constructing a grout curtain from its bottom, and replacing the highly fractured and jointed rock with compacted impervious soil

Option No. 2, the key trench in combination with the grout curtain, was selected because it was felt that it would provide a more reliable cutoff in the highly fractured zone.

The imperviousness of the material is stated in the Panel's report, "** the coefficient of permeability of the in situ zone 1 fill varies from about 0.1 \( \times 10^{-6} \) to 5 \( \times 10^{-6} \) cm/sec," which is a very satisfactory impermeability.

The phenomenon of arching with potential for hydraulic fracturing was not well understood at the time of design and construction of the dam and in particular with reference to the key trench situation. The Panel in their report also made the statement, "** the phenomenon (hydraulic fracturing) is not yet fully understood and deserves research **. When a better physical understanding of
the creation and propagation of cracks by water pressure has been achieved, the criteria for initiation of hydraulic fracturing utilized herein may require modification."
Question No. 7

Stress calculations made at the request of the Independent Panel by the finite element method indicated that at the base of the key trench near stations 14+00 and 15+00 the arching was great enough that the water pressure could have exceeded the sum of the lateral stresses in the impervious fill and the tensile strength of the fill material. Thus cracking by hydraulic fracturing was a theoretical possibility and may have led to flow of water in the base of the key trench between stations 14+00 and 15+00, and erosion of the key trench fill.

To what extent was the hazard of hydraulic fracturing considered in the design of the Teton Dam?

Does the Bureau routinely use analytic tools such as the finite element method to evaluate prospective designs?

What analytic procedures are required as part of the Bureau's design and analysis methodology?

To what extent are studies conducted to identify potential hazardous conditions in proposed structures?
Answer to Question No. 7

The hazard of hydraulic fracturing was not considered in the design of Teton Dam. At the time Teton Dam was designed the analytical methods which were capable of indicating the possibility of hydraulic fracturing were not a generally accepted design tool for embankment design.

At the present time the Bureau uses both static and dynamic finite element analysis in the design of dams. Additional analytical procedures used in the design of a dam include laboratory analyses, geological assessment, and conventional limit equilibrium analyses.

Where the safety of a dam is involved, the Bureau goes to the maximum extent possible to identify a potentially hazardous condition. This is well illustrated by the fact that at Teton Dam the Bureau had drilled 102 preconstruction drill holes which totaled 17,864 feet of core. In addition, a test grouting program was accomplished and seismic monitoring stations established to verify the seismicity of the area.
Question No. 8

The Review Panel stated that:

"The dam and its foundations were not instrumented sufficiently to enable the Project Construction Engineer and his forces to be informed fully of the changing conditions in the embankment and its abutments."

Why was the instrumentation insufficient?

Was the extent of monitoring at Teton consistent with that used at other damsites?

What procedures are used to determine the degree and nature of monitoring required?

Is the monitoring program for a dam standardized or designed specifically based on the properties of the site?

Answer to Question No. 8

The minimum instrumentation provided at Bureau earth dams consists of surface measurement points for measuring settlement or heave
Answer to Question No. 8 (Cont)

and deflection upstream and downstream, plus seepage monitoring features as required, such as toe drains, weirs, collection facilities, and observation wells. Additional instrumentation is used to monitor some particular condition for which more information is desired or to help evaluate the overall performance of the structure. Palisades Dam and other Bureau dams of similar material and height were well instrumented and the data therefrom showed what the material behavior was like. It was therefore felt that instrumentation at Teton to reaffirm previously established performance was not necessary.

The monitoring program for a dam is only standardized from the standpoint of minimum instrumentation and observation. Additional instrumentation is designed specifically for each site. The Bureau has pioneered the design and application of many types of instruments for monitoring embankment behavior. These are used worldwide.

Instrumentation, however, is not a foolproof means for detecting all internal happenings; it has to be at the right place, at the right time. While additional instrumentation data might have been helpful, the Panel states in their report:

"The paucity of instrumentation and the decision to allow an increased rate of filling had no demonstrable influence
on the failure. The short time within which the chain of events occurred that culminated in the catastrophe suggests that there would have been insufficient reaction time to take advantage of instrumental warnings * * *."
"The fundamental cause of failure may be regarded as a combination of geological factors and design decisions that, taken together, permitted the failure to develop. The principal geologic factors were (1) the numerous open joints in the abutment rocks, and (2) the scarcity of more suitable materials for the impervious zone of the dam than the highly erodible and brittle windblown soils. The design decisions included among others (1) complete dependence for seepage control on a combination of deep key trenches filled with windblown soils and a grout curtain; (2) selection of a geometrical configuration for the key trench that encouraged arching, cracking, and hydraulic fracturing in the brittle and erodible backfill; (3) reliance on special compaction of the impervious materials as the only protection against piping and erosion of the material along and into the open joints, except some of the widest joints on the face of the abutments downstream of the key trench where concrete infilling was used; and (4) inadequate provisions for
Answer to Question No. 9

Control of seepage in the abutments by using the combination of a key trench filled with impervious soil and a grout curtain was considered at the time of the design to be a completely satisfactory solution. It now appears that because of arching and high reservoir heads, the key trench was conducive to hydraulic fracturing. The silt material placed in the trench provided a satisfactory impervious barrier (see Question No. 6).

The Bureau has relied on special compaction in a large number of dams in which no problems have been experienced. At Teton, the bonding of the zone 1 material to the floor and walls of the key
trench was found by the Panel to be satisfactory. The Bureau has supporting evidence that the cracks in the floor were sealed with grout as were the larger cracks in the walls. The design contemplated that the key trench would be sealed. This was described on page 16 of the Design Considerations.

The entire (downstream portion) of the zone 2 embankment served as a filter and a drainage blanket. Tests indicated that the zone 2 material ranged from 100 to 1,000 times as pervious as the zone 1 material and was considered to be adequate for the anticipated seepage. This material is in excess of 1,000,000 cubic yards and was purposely extended up both the left and right abutments beneath the zone 3 material providing for abutment drainage.
Question No. 10

At 8:30 a.m. on June 5, 1976, it was recorded that a muddy flow was issuing from the right downstream toe of the dam. According to the Independent Panel's report, the Project Construction Engineer believed the situation to be critical but felt it could be remedied and elected not to alert residents downstream at that time.

What criterion does the Bureau employ to prescribe under what conditions citizens should be alerted to a potential hazard?

Would an alert at 8:30 a.m. rather than 10:30 a.m. have decreased the loss of life or property?

Answer to Question No. 10

The Bureau prepares a manual called "Standard Operating Procedures" and a supporting document "Communications Directory" for each dam. The manual and directory include the names, addresses, telephone numbers, and radio calls of persons to be contacted in various situations, unusual conditions, and emergencies. Such documents are prepared for use of operating personnel. During construction similar emergency procedures are employed by the Construction Engineer. The person in charge must use his best judgment in deciding on the specific conditions which require alerting the
public. It is speculative whether an earlier alert would have
decreased the loss of life or property. Consider the facts that
Idaho Falls had some 24 hours advance warning and Blackfoot 36 hours,
and yet there was property damage in these two areas because people
elected not to remove property adjacent to the river.
Question No. 11

The zone 2 material was intended to form "a blanket and chimney drain in the downstream shell." Test results on this material appear to indicate that it is not adequately permeable.

In view of this, why was this material used?

Was adequate consideration given to the implications of this material not having properties required to permit appropriate drainage?

Answer to Question No. 11

The material for the zone 2 embankment fill was used because it was judged to be adequately permeable to handle the small volume of seepage anticipated in the design. It was available in large quantities in the upstream borrow area. In addition, it is a strong statically and dynamically stable material of a type used in many Bureau dams. The Bureau feels that adequate consideration was given to the use of this material. Seepage quantities through the embankment which the zone 2 was to accommodate were not envisioned to be large, concentrated flows.
Question No. 12

According to the Review Panel:

"Large open joints or cracks in the bottom of the key trenches and cutoff trench were to be treated by (1) clearing out the crack with air and/or water jets, (2) setting grout pipe nipples in the crack, (3) sealing the surface by caulking and/or grout, (4) drilling, if required, and (5) low-pressure grouting through the nipples. Evidently little of this treatment was actually done, at least in the part of the key trench exposed by the Panel's investigations."

What is the explanation for this?

Was the contractor at fault?

Why wasn't this determined through routine inspection and construction supervision?

Answer to Question No. 12

Only limited areas of this treatment were required in the bottom of the key trench because the technique used to form the grout curtain
automatically sealed the majority of the open joints and cracks. Those large joints that remained did receive the prescribed treatment. The contractor performed the work in a competent and workmanlike manner under the Bureau's direction. Close inspection insured that the treatment intended was provided.
Question No. 13

The Review Panel stated that in view of the maze of open joints under all of the zone 1 material, it would not have concurred with the decision to limit blanket grouting essentially to the bottoms of the key and cutoff trenches. Please explain the rationale for the extent of blanket grouting actually employed.

Answer to Question No. 13

Blanket grouting is required in areas which contain open joints not treated in any other manner. Specifications required that the foundation beneath the zone 1 material be cleaned of all loose, soft, and disintegrated materials. Thus, the Bureau felt that a suitable zone 1 contact was being created without the use of blanket grouting. The positive cut-off expected to be provided by the key trench eliminated the need for extensive blanket grouting.
Question No. 14

In 1967, a magnetometer survey was made along the line of the proposed cutoff trench, to determine if any large cavities were present in the left abutment. Results were reported to be unconclusive.

Why weren't gravity surveys conducted in addition to this?

Answer to Question No. 14

The statement in the Independent Panel's Report, page 4-8, lines 20, 21, and 22 is incorrect. In a memorandum to the Geology Files dated November 6, 1967, Noel Bivens, Geologist for the USBR who conducted the 1967 magnetometer survey, states: "The purpose of the survey was to delimit an intracanyon basalt flow." Near the end of the report he states further, "The magnetometric survey was successful, in combination with drill hole control, in delimiting an intracanyon basalt flow along the grout cap - cutoff trench." The survey was not intended to define voids in the left abutment bedrock, nor was it inconclusive. Since it was successful, other geophysical surveys such as a gravity survey were not necessary.
Question No. 15

Interflow zones between basalt flows were being studied in the late 1960's and early 1970's with new bore hole geophysical surveying equipment. Because the Bureau knew of the leakage significance of such interbeds, was there any attempt to include such investigations as part of the study of the Teton damsite?

Answer to Question No. 15

The deposit of interflow sediments between the intracanyon basalt and the underlying rhyolite was investigated as to its seepage potential. Inasmuch as this deposit accepted grout during the pilot grouting program, the decision was made that this deposit could be effectively grouted to control seepage and that the overlying basalt would not have to be excavated in order to remove this alluvial deposit. No borehole geophysical surveys were made of this deposit nor were borehole television camera surveys made of this section. The Bureau's borehole television camera, which had been operated in many differing circumstances by Bureau geologists for 8 years prior to the Teton examinations, was used to examine open and grout-filled joints in the rhyolite bedrock at the damsite.