UNC MINING AND MILLING

Division of United Nuclear Corporation
A UNC RESOURCES Company

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July 20, 1979

Mr. Thomas E. Baca
Director, New Mexico Environmental Improvement Division
P.O. Box 968
Santa Fe, New Mexico 87503

Dear Mr. Baca,

Pursuant to the request of the New Mexico Environmental Improvement Division, United Nuclear Corporation presents this report to the Division concerning the breach of the tailings impoundment at UNC's uranium milling facility located near Church Rock, New Mexico, Monday, July 16, 1979. The report includes a determination as to the cause of the breach, a review of sampling procedures, a plan for clean-up and decontamination based upon the sampling results, and a proposal for the resumption of operation of the milling facility.

The report is based upon the results of all investigative data available at this time. I trust you will find it complete and satisfactory to the Division.

UNC is grateful for the Division's complete cooperation and assistance in helping the company to deal most effectively with this difficult incident.

Sincerely,

D. D. Turberville
President

DDT:ga

Report #10

AGENDA

1. Explanation by United Nuclear Corporation of what happened.

2. Analysis of dam failure.

3. Proposals for resumption of operations.

BREAK

4. Extent of contamination.

5. Measures to limit contamination.

6. Proposals for cleanup.

UNITED NUCLEAR CORPORATION

MINING AND MILLING DIVISION

REPORT

STABILITY AND INTEGRITY ASSESSMENT

of

NORTHEAST CHURCH ROCK TAILINGS DAM

July 20, 1979

INDEX

INTRODUCTION

In response to the official request of Mr. Al Topp of the Environmental Improvement Division, State of New Mexico, the Mining and Milling Division of the United Nuclear Corporation has diligently, and with dispatch, initiated an intensive and vigorous investigative program into the cause, or causes, of this most unexpected breach of a segment of the Church Rock earthen embankment tailings dam located near the south abutment. This approach included the immediate marshalling of UNC's top management forces and backup staff to institute a most comprehensive cleanup program to minimize, as far as practicable under the circumstances, the ensuing tailings spill effects upon the surrounding community and its environment.

To this end, the Mining and Milling Division of UNC immediately commissioned independent and respected professional engineering expertise in the endeavor, to assist in pinpointing the cause or causes surrounding this most unfortunate occurrence, and the exploration of consequential and potential developing effects thereof, if any, upon the remainder of the present dam structure, including the dam expansion construction program presently underway.

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This well-planned investigative program and in-depth probing for the pertinent facts was also initiated to establish whether the present dam structure has or has not been compromised in any other manner, or that the dam has or has not suffered any consequential structural effects or deleterious stability consequences thereof in any fashion.

In addition, the vigorous review of the cause and effects of the breach was also targeted to establish for all concerned whether this occurrence could not possibly be experienced again, and where found prudent by the results of this review, to implement an immediate refinement and bolstering of the present tailings deposition operations and tailings dam surveillance monitoring procedures.

Further, the long-range planning of UNC along this vein is under review and evaluation, and will conform to the latest proven techniques.

Concurrently with the above activities, UNC initiated an in-depth plan of action to pinpoint the potential contaminating effects of the tailings spill upon the surrounding environment. This program entailed the prompt development of a detailed sand deposition and water sampling procedure for immediate implementation in areas where tailings sand depositions were most likely to take place, including the taking of water samples at appropriate locations to pinpoint the areas along the spill route requiring cleanup attention. Thus, UNC was able to bring to bear all of its available forces in a concerted and meaningful cleanup operation.

As each sample was taken in a potentially contaminated area, its location was recorded before cleanup activities commenced, and associated test results of each sample were recorded accordingly. Upon the completion of cleanup operations of each affected area, resampling and retesting of the cleaned up areas was made once again for the recording and comparison of the effectiveness of the cleanup efforts associated with each area. Where test readings of a specific area did not meet expectations, a re-cleanup of the area was conducted.

To assure that proper lab testing procedures were conducted and coordinated with the above activities, UNC implemented a detailed and appropriate lab analyses program.

At the same time, a planned course of action was established by UNC to properly dispose of all collected contaminants and lab waste samples within the confines of the tailings dam.

All appropriate data resulting from the above program is duly recorded and included in this report to attest to the effectiveness of the cleanup efforts of UNC.

The culmination of the above efforts was directed ultimately to the resumption of milling operations at Church Rock and in keeping with this thrust, a detailed plan for the Resumption of Operations was developed and stands ready for immediate implementation upon the approval to do so by your office and associated governing agencies.

The orderly and detailed steps to resume operations in the north area of the tailings dam, the related timing for activation of the two-cell containment areas therein and methods of deposition and protective arrangements for these areas are provided for in the planning by UNC. In addition, a constant surveillance program was developed to insure that the integrity of the dam can be monitored and any required actions to improve developing conditions can be immediately addressed.

The United Nuclear Corporation Mining and Milling Division is convinced that all of the above planning and associated efforts assure that the present dam stability has not been impaired, is structurally sound, and considerable safeguards are incorporated not only in the new construction of the dam but in the north portion of the dam to insure a safe return to operations. A plan by UNC, in association with Sergent, Hauskins & Beckwith, for repairing the breached portion of the dam is underway and as soon as it is available, UNC will present the results thereof to your office and associated governing offices for review.

The appendices included within this report will support in detail all of the items noted above.

ENCAPSULATED OBSERVATIONS, CONCLUSIONS, AND PLANNED OPERATIONS AND MONITORING SURVEILLANCE IMPROVEMENTS

1. CAUSE OF TAILINGS DAM BREACH

The cause of the dam breach near the south abutment was due to a unique combination of conditions:

A. The breach that occurred near the southern end the dam is a unique situation inasmuch as it is located in a transition zone between nearly incompressible bedrock and deep compressible alluvial foundation conditions and where an abrupt change in bedrock and thickness of alluvium occurs.

B. A vertical crack, or a system of cracks, occurred perpendicular to the dam, which was created by a differential settlement of an unexpected magnitude located in the transition zone noted above and underlying the breached segment of the dam.

C. Compounding this condition was the occurrence of erosion through these differential settlement cracks caused by the untimely presence of a shallow depth of free liquids contacting the upstream face of the dam in that general vicinity.

Since it was necessary to use cycloned sands to produce a sand drainage blanket for the new dam lift construction at the downstream face of the dam, it was felt that the small time intervals during which interruptions in the maintaining of a continuous sand frontage beach along the upstream face of the dam during spigoting operations would occur, would not compromise the earthen containment dam. This appeared to be a valid approach since no other outside compromising conditions were anticipated to occur simultaneously to compound this temporary condition. This combination, and the lack of a complete fronting sand beach, thus precluded the healing-sealing effect of this missing portion of the sands beach at the settlement crack area noted. The breach of the dam thus ensued.

2. DISCHARGE DESCRIPTION, CLEANUP, AND MONITORING

The breach resulted in a discharge of approximately 288 acre-feet of tailings solution and 1100 tons of tailings solids into the surrounding area. The impact of this release is being assessed through analysis of numerous samples taken of the flow and the stream sediments. Present data show a total of 100 miliCuries of radium-226 and 60 mili-Curies of uranium in the solids which escaped from the impoundment.

Cleanup activities commenced on Wednesday evening and have proceeded throughout the daylight hours since that time. Initial gross alpha results indicated higher concentrations in side arroyos where eddying occurred, therefore cleanup has been concentrated in those areas. More recent results show radium-226 levels well below those allowed, under Appendix A, Part 4 of the New Mexico "Regulations Governing the Health and Environmental Aspects of Radiation," for discharges to unrestricted areas. We now propose to utilize a cleanup criteria of 3.0×10^{-5} microCuries of radium-226 per gram of sediment. Detailed sampling of side arroyos will allow identification of localized contamination and hence precise efficient cleanup.

Monitoring activities will be expanded to a more comprehensive program which will involve additional groundwater monitoring wells adjacent to the toedam, four (4) new surface water sampling locations, and two (2) alluvial well sampling points.

3. RESUMPTION OF OPERATIONS

In order to resume operations as expeditiously as possible at the Church Rock mill, and to give assurances that all possible refinements and necessary safeguard and backup additions are incorporated, not only into the reactivation of the north half of the dam but also the entire containment dam structure, UNC developed a very detailed sequence of startup operational procedures contained in an appended compilation.

In summary, the detailed sequences include in-depth planning for the safe resumption of operations as follows:

An operating plan covers the physical description of the north impoundment area followed by a detailed description for the initial deposition area preparations which include various methods for providing a protective and continuous sand beach adjacent to all earthen constructed and compacted splitter dikes contained within the north portion of the dam, plus the fronting of all dam upstream faces in use.

Included in this plan is a description of how the continuing lifting of the dam construction operations will be coordinated in these areas.

Additionally, a comprehensive tailings dam surveillance format was developed, including responsive communication method groundrules, reporting methods, and the inauguration of a more responsive reaction format to be followed in the event of the spotting of unusual conditions occurring at the dam.

This detailed plan also provides for periodic aerial photo reconnaissance and recording of mill throughput rates of depositions to monitor the rate of growth of the tailings pond depositions for comparison means.

SAMPLING PROCEDURE

Samples were taken in the arroyo in areas where deposition was most likely to take place. These locations were selected randomly.

Procedure

1. Visually inspect locations for signs of lighter colored sands.
2. Determine extent of flow during runoff.
3. Determine number of samples needed. This is based on the size of the area exposed.
4. Survey area near the surface (1 foot) with Micro-R survey meter. Use any anomalies in the readings as sample selection points. If anomalies do not exist, take sample an equal distant apart beginning at water's edge and ending at edge of flood plain if previous flow is indicated. Samples were taken parallel to stream flow where possible.
5. Using a 250 ml plastic beaker sample was scooped along the surface at a depth of 1 inch until beaker was full. Sample was then placed in a plastic bag and sealed.
6. Areas where backflow occurred i.e. side arroyos were sampled due to the fact that at flood stage these areas had the calmest water thereby allowing for greater deposition.

Sample Preparation

1. Samples were taken to lab where a portion was removed, placed on a planchet and dried. The remainder was then dried in an oven and later pulverized for chemical analysis.
2. The dried planchet sample was analysed for gross alpha and compared to river sample taken upstream of the spill.
3. A Ra-226 standard was used to determine gross alpha activity of the planchet per surface area of the planchet.

BREACH WATER

Sample Location	pH	
	7-16-79	7-19-79
Upstream at Ford in Road	8.87	8.66
Falls above spill	8.90	8.68
Tailings Solution above Toe Dam	1.05	
Pinedale Road Crossing	1.40	5.07
State Road 566 Bridge	1.41	4.48
Arroyo behind El Paso Refinery	2.49	5.62
Hogback on East end of Gallup	2.69	6.28
Maloney Avenue backflow	6.01	6.56
Weigh Station 9 miles east of Arizona border	8.18	6.00

BREACH WATER

Sample Location	U (mg/l) 7-16-79	7-19-79
Upstream at Ford in Road	0.71	0.81
Falls above spill	0.79	0.80
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Tailings Solution above Toe Dam	6.17	
Pinedale Road Crossing	6.49	0.02
State Road 566 Bridge	7.49	0.03
Arroyo behind El Paso Refinery	6.81	0.01
Hogback on East end of Gallup	6.31	0.04
Maloney Avenue backflow	5.24	0.24
Weigh Station 9 miles east of Arizona border	0.51	0.01

BREACH WATER

Sample Location	Ra - 226 (pCi/l) 7-16-79
Upstream at Ford in Road	2.5
Falls above spill	5.5
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Tailings Solution above Toe Dam	1262.1
Pinedale Road Crossing	160.2
State Road 566 Bridge	545.9
Arroyo behind El Paso Refinery	53.0
Hogback on East end of Gallup	23.0
Maloney Avenue backflow	14.8
Weigh Station 9 miles east of Arizona border	3.4

DAM BREACH
STREAM SEDIMENT SAMPLES
7-17-79

Site Number	Sample Number	Radium-226 x 10^{-5} uCi/gm	Description
1	1	1.0	10 miles below property line
	2	1.1	
2	3	1.3	7.5 miles below property line
	4	1.2	
	5	1.1	
3	6	1.3	6.5 miles below property line
	7	0.6	
	8	0.5	
	9	0.2	
	10	0.5	
4	11	0.4	566 Bridge, 5 miles below property line
	12	0.7	
	13		
	14	1.1	
	15	1.4	
5	16	2.2	Pinedale Bridge, 4 miles below property line

DAM BREACH
STREAM SEDIMENT SAMPLES
7-17-79

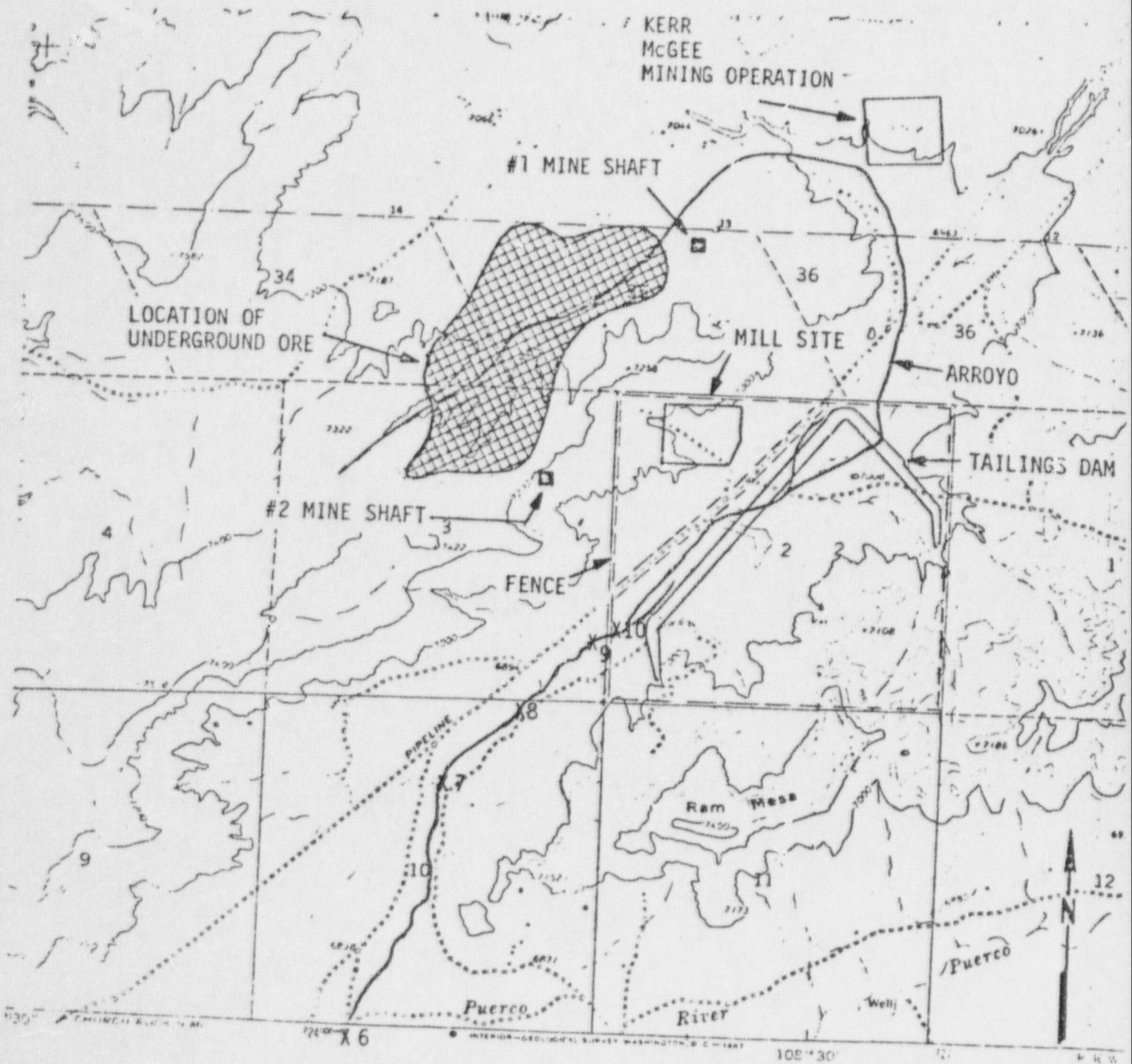
(Continued)

Site Number	Sample Number	Radium-226 x 10^{-5} uCi/gm	Description
6	17	2.4	Below Puerco confluence, 1.5 miles below property line
	18	1.4	
	19	1.5	
	20		
	21		
	22		
7	23	5.0	3/4 mile below property line
	24	1.3	
	25	0.4	
	26	11	
8	27	9.5	1/2 mile below property line
	28	8.1	
	29	14	
	30	4.1	
9	31	8.7	500 yards below property line
	32	2.6	
	33		
	34		
	35	10.6	

DAM BREACH
STREAM SEDIMENT SAMPLES
7-17-79

(Continued)

Site Number	Sample Number	Radium-226 x 10^{-5} uCi/gm	Description
10	36	7.5	Above and below the spill inside property lines
	37		
	38		
	39		
	40		
	41		
	42		
	43		
	44		
	45		
11	46	0.4	Upstream above tailings area
	47	0.6	



Sample #7. Three-fourths (.75) miles below property line.

Sample #8. One-half (.5) miles below property line.

Sample #9. Five hundred (500) yards below property line.

Sample #10. Above and below the spill inside the property line.

DAM BREACH STREAM SEDIMENT SAMPLES

Sample #1. Ten (10) miles below property line.

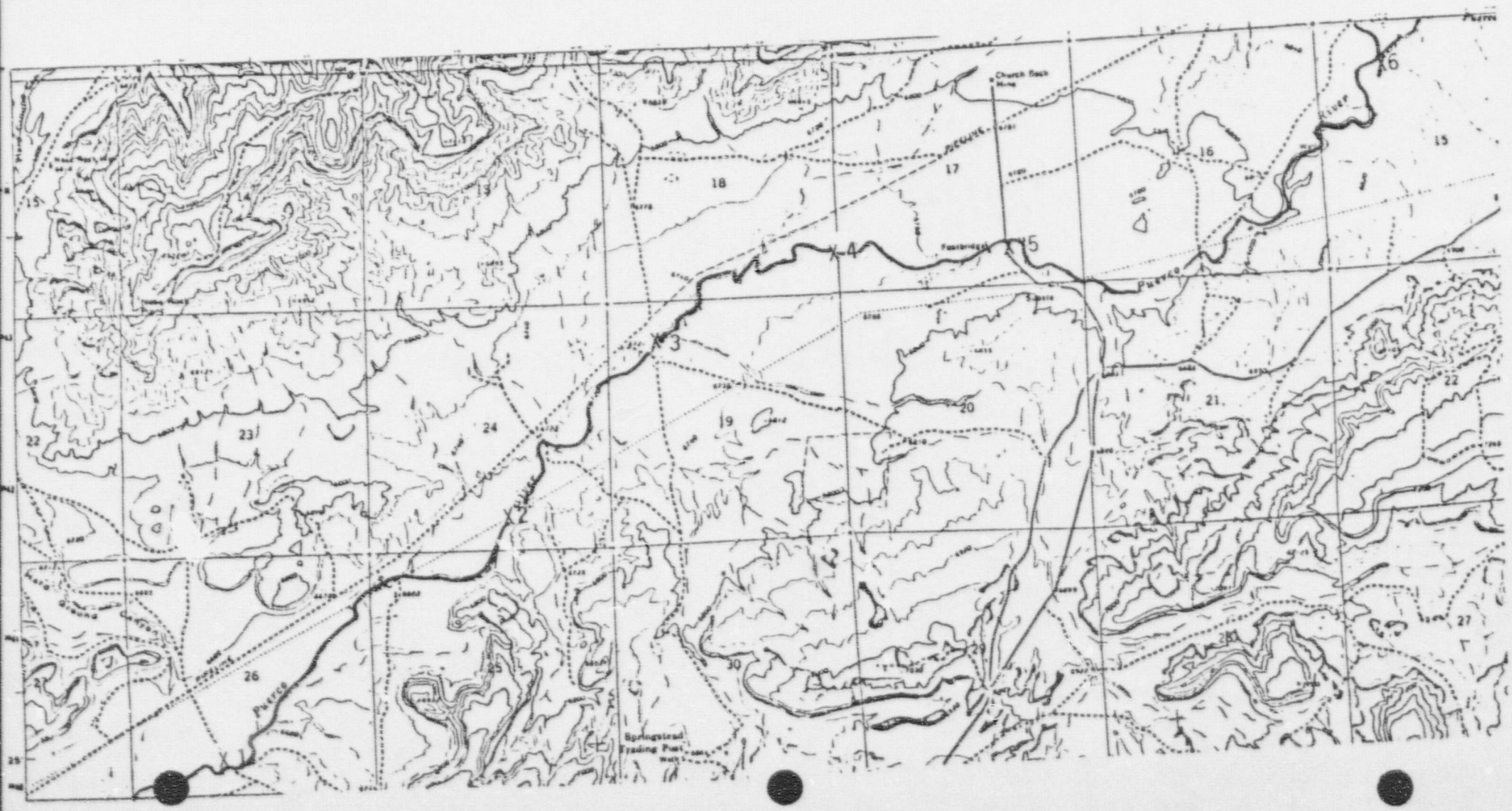
Sample #2. Seven and one-half (7.5) miles below property line.

Sample #3. Six and one-half (6.5) miles below property line.

Sample #4. 566 Bridge, Five (5) miles below property line.

Sample #5. Pinedale Bridge, Four (4) miles below property line.

Sample #6. Below Puerco confluence, one and one-half (1.5) miles below property line.



CLEANUP PROCEDURE

Utilizing data obtained in initial sampling, cleanup has been initiated upstream of the Pinedale Road crossing. The following procedure is being used.

Procedure

1. Identify side arroyos where tailings may have been deposited.
2. Sample middle of area as per sampling procedure.
3. Using shovels, skim top four (4) inches of material into five (5) gallon buckets. Remove material from the entire area up to the high water line and down to the mouth of the side arroyo.
4. Deposit the mud into 55 gallon drums on the back of a flatbed or pickup truck.
5. As each location is cleared, sample the area as closely as possible to the original sites.
6. Use a cherry picker to dump the full drums of mud into the tailings area .
7. Samples will be prepared and analyzed following the sampling procedure. Follow-up analysis for Uranium, Radium-226 and Thorium-230 will also be performed.
8. Locations will be considered clean when Radium-226 levels are below 3.0×10^{-5} microcuries per gram.

MONITORING PROGRAM

Groundwater

Number of Locations: Five (5) additional wells for a total of 11. New wells to be located adjacent to the toe dam.

Frequency: Quarterly, with analysis for the parameters in List A (Attached).

Method: Bailed sample

Reporting: Quarterly, as complete analysis is available.

Surface Water

Number of Locations: Four (4) additional locations downstream for a total of six (6) sites ranging from one (1) mile above the dam to thirty (30) miles below.

Frequency: Quarterly, with analysis for the parameters in List B (Attached).

Method: Grab sample

Reporting: Data will be available from the Manager of Environmental Operations on request.

Alluvial Wells

Number of locations: Two (2), downstream of the tailings area.

Frequency: Quarterly, with analysis for the parameters in List B (Attached).

Method: Dictated by pumping apparatus at each location.

Reporting: Data will be available from the Manager of Environmental Operations on request.

LIST A

Aluminum
Arsenic
Barium
Boron
Chloride
Chromium
Cobalt
Copper
Cyanide
Fluoride
Iron, Total
Lead
Manganese
Mercury
Molybdenum
Nickel
Nitrate
pH
Selenium
Silver
Sulfate
Total Dissolved Solids
Uranium
Zinc
Radium - 226
Radium - 228

LIST B

Arsenic
Barium
Cadmium
Chloride
Chromium
Copper
Cyanide
Fluoride
Iron, Total
Lead
Manganese
Mercury
Nitrate
pH
Selenium
Silver
Sulfate
Turbidity
Uranium
Zinc
Gross Alpha
Radium - 226
Radium - 228

RESUMPTION OF OPERATIONS

SUMMARY

In order to resume operations, tailings deposition can be accomplished in the north area. This area is divided into roughly two (2) equal halves, central and north. The central part can be ready for operation by Thursday evening, July 19, 1979. This will give an operating life of nineteen (19) days. The north tailings structure will be raised 5 feet in order to utilize all the northern part of the north tailings impoundment area. The raising of this structure increases the operating life by thirty (30) days for a total of forty-nine (49) days. This work can be completed by Wednesday, July 25, 1979.

Twenty-four (24)-hour surveillance of the tailings structure and the tailings line is proposed to insure safe operating conditions.

Cyclone deposition of coarse sands is recommended for good segregation to utilize the underflow sands for the continuing placement of the sand drainage blanket during the present dam expansion-construction phase.

OPERATING PLAN

The north tailings area can be used for tailings deposition and containment upon notification by the State agencies that operations can be resumed.

1. Physical Description of North Area

The north half of the total tailings area is bounded to the south by the central dike now being used by the construction subcontractor as a haulage road trending approximately N30°W, to the west by the tailings containment structure which runs approximately N50°E, to the north by the continuing tailings containment structure in a W-E orientation, to

the east by the natural sloping terrain.

The north area is further divided into two approximately equal areas by previous sand deposition and by a natural hill near the center of this area. An equipment access road has been built over the sand beds which delineates the division sharply. The area immediately adjacent and north of the central structure, hereafter designated as the central part, has an area of 15 acres, and the extreme north area 12 acres. The extreme north area has a free board of 5'1" and therefore is not immediately usable as a deposition area.

2. Initial Deposition Area Preparation

In order to safely contain tailings in the central area, a protective sand beach must be established adjacent to the center dike on the tailings deposition on inboard and outboard sides. The sand can be deposited with a drag line extending 50 feet from the dike and averaging approximately 5 feet thick by 700 feet long for a total of approximately 3,000 yd^3. The critical sand beach deposition lies mainly to the east where tailings solution contacts the center dike. This critical volume to be filled with sand will require approximately 1,000 cubic yards. This work was completed Thursday, July 19, 1979.

The second work item for initial area preparation consists of building a ramp 10 feet high for cyclone placement over the existing access road which parallels the tailings dam and is approximately 100 feet east of the dam. The ramp and the cyclone placement were also completed Thursday, July 19, 1979. The cyclone operation will continue to provide coarse sands for the sand blanket construction once operations are resumed. By placing the cyclones at an elevated position, setups can be minimized. A cyclone bypass line shall be provided as well as an auxiliary tailings line to spigot in the central area.

In summary, the critical item of initial area preparation is to place the 3,000 cubic yards fronting the east half of the central

structure. Once this is done, the area can safely receive tailings. The remaining 4,000 tons can be placed on the cyclone July 20th. Placement is for optimization of coarse sands segregation. Thus, milling operations can be safely resumed by Friday, July 20, with a potential tailings deposition life of 19 days.

3. Secondary Deposition Area Preparation

The central structure and the north structure will be raised a minimum of 5 feet to increase the deposition life by 30 days more for a total of 49 days, allowing time for the remedial work at the south end of the tailings containment structure. This work is presently underway and is scheduled for completion July 25.

After these structures have been raised, sand beach placement can commence at the extreme north end.

At the center section of the tailings structure and fronting it for approximately 600 feet, a trench has been excavated to remove the sands for mine backfill. This trench is now flooded with tailings solution and will be pumped out before filling with sands to establish a beach. This trench will then be filled with sands to establish a beach fronting the north tailings structure. This work is to be accomplished within the 19-day operating life of the central pond.

Once this work is done and while cyclone operations continue at the center pond, the crossroad can continue to be lifted so that a two-cell operating mode can continue where cyclone underflow deposition is carried out predominantly to the central pond and the cyclone overflow can be directed predominantly to the extreme north pond.

4. Tailings Containment Area Surveillance

4.1 The tailings dikes shall be continually patrolled. A complete round consists of a starting point at the east end of the central structure to the intersection of the main tailings structure, then

north on the main structure to the extreme north end. Then continuing south on the toe dam so that any seepage emanating from the main structure can be readily observed, then continuing south out of the main structure to inspect the temporary plug, to the original point of departure. It shall be necessary at the south end to establish a ramp parallel to the tailings line to gain access from the toe dam to the main tailings structure.

This surveillance shall be performed by the tailings operator in the Four Wheel Drive tailings truck equipped with a spotlight for night surveillance and a CB radio for communications with the duty officer at the mill guardhouse.

The tailings operator shall call the duty officer once every hour on the hour to signal all clear. If this communication is not performed as directed every hour, the duty officer is directed to try to make radio contact with the tailings operator. After five minutes, if this attempt fails, the duty officer is to contact the security roving patrol to drive to the tailings area and investigate the delay of communications on the part of the tailings operator. A log will be kept at the guard-house of all radio communications with the tailings operator. This log will be transmitted daily to the Operations Superintendent. The tailings operator is also directed to relate any problems to the duty officer so that this information can be relayed to the Mill Foreman on afternoon or night shift and to the General Mill Foreman on day shift so that corrective action can be initiated by these supervisors.

Each round will last approximately one hour under normal conditions. The tailings operator will submit a shift report to the Mill Foreman, a copy of which will be transmitted to the Environmental Coordinator. The purpose of the surveillance rounds is to note:

FREEBOARD
SAND BEACH

1. Conditions of sand beach extent to assure a minimum of 10-ft. width;
2. Tailings pipe, so see that leaks have not developed;
3. Cyclone overflow discharge to avoid close proximity to the sand beach to prevent erosion of the sands;
4. Be on the lookout for seepage at the toe of the main

embankment;

5. Inspect the temporary interceptor dike at the south end for potential leakage.

The Mill Foreman on duty has at his disposal all the maintenance and work force of the mill. In addition, he has at his disposal two 4-1/2 cu. yd. loaders which can be used for earth work should it become necessary to prevent spillage. The Mill Foreman is to contact his supervisors for all incidents that cannot be adequately corrected by forces under his disposal.

Training of the tailings operators and supervisors will continue to be conducted further to instill awareness of immediate response to correct any deficiencies that could become serious if not acted upon immediately.

The Maintenance Superintendent is directed to make a general inspection of the tailings area daily and to note any particular condition of the tailings line so that corrective action can be initiated.

4.2 Aerial photographs will be taken on the day of resumption of operations and weekly thereafter until the time the south area is in service.

4.3 Rate of deposition will be recorded as indicated by mill throughput.