40-3453

TUBA CITY TAILINGS RECLAMATION PLAN

TUBA CITY SITE
TUBA CITY, ARIZONA

JUNE 1979

PREPARED FOR

THE NAVAJO

ENVIRONMENTAL PROTECTION COMMISSION

OF THE NAVAJO TRIBAL COUNCIL

BY

Ford, Bacon & Davis Utah Inc.

375 CHIPETA WAY SALT LAKE CITY UTAH 84108 801 583 3773

IN COOPERATION WITH

ATLAS CORPORATION

MOAB, UTAH

withdrawn - Oct 10/79 ltr: no licensing action

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CONTENTS

CONTENTS (Cont)

CONTENTS (Cont)

CONTENTS (Cont)

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION AND SUMMARY

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INTRODUCTION AND SUMMARY

1.1 INTRODUCTION

At the present time, approximately 800,000 tons of uranium mill tailings are situated in the vicinity of Tuba City, Arizona. These tailings are not covered and represent a source of radiation. Because the tailings are exposed, they are also subject to wind and water erosion and subsequent transport from the disposal area.

Atlas Minerals Division of Atlas Corporation is proposing to process these tailings to recover the uranium and copper values present.

At the conclusion of the project, the processed materials previously deposited in lined ponds will be covered with soil and gravel to minimize future erosion and radiation exposure.

The benefits of this program include the following:

1. The adverse impacts of the present tailings pile will be mitigated, including elimination of further windblown tailings, reduction of radon emanation, and reduction of gamma radiation to background levels.

2. The process provides for the recovery of uranium and copper metals.

3. Through royalty considerations, the Navajo Tribe will

receive monies during the life of the project.

4. Through employment opportunities, Navajo human resources will be developed.

On June 1, 1978, Atlas Corporation and the Navajo Tribe entered into an agreement for the purpose of processing the uranium mill tailings situated in the vicinity of Tuba City, Arizona. The agreement was authorized by the Advisory Committee of the Navajo Tribal Council, by Resolution ACAP-53-78 on April 24, 1978. The resolution is entitled, "Granting the Exclusive Right to Process and Market the Uranium and Related Metal Values Contained in the Tuba City Tailings, Tuba City, Arizona to Atlas Corporation, Moab, Utah."

The agreement stipulated that Atlas Corporation, upon determining their desire to exercise the right to process the tailings, submit a reclamation plan to the Navajo Environmental Protection Commission of the Navajo Tribal Council for their approval.

This reclamation plan is therefore provided to the Navajo Environmental Protection Commission for that approval.

1.2 SUMMARY AND CONCLUSIONS

Based upon an analysis of the existing environmental conditions near the Tuba City, Arizona tailings disposal site, the proposed recovery process, and the project environmental impacts of operations and reclamation, the following major conclusions can be reached.

1.2.1 Existing Environmental Impacts

1. Air quality in the vicinity of the site is affected both by airborne radioactive particulates and by radon gas. (Sec. 4.1.1)

2. Gamma radiation levels are elevated in the vicinity of the tailings piles. (Sec. 4.1.2)

3. Gamma measurements in drill holes through the existing tailings and in the evaporation pond areas indicated that radioactive contamination does not extend below 5 feet. (Sec. 4.1.4)

4. The previous mill operations disturbed the vegetation and wildlife at the site, and thus, only minimal vegetation and wildlife have reestablished themselves on these disturbed areas since mill operations ceased. (Sec. 4.1.9)

1.2.2 Environmental Impacts During Operations

1. Air quality during operations should not be greatly affected. (Sec. 4.2.1)

2. Overall gamma radiation levels on the site will not change significantly during processing operations. (Sec. 4.2.2)

3. In view of the fact that most of the area involved in

the project has been previously disturbed, there will be little effect on natural soils. (Sec. 4.2.3)

4. No long-term effects on ground water levels are expected from the two years of use during tailings processing. (Sec. 4.2.4)

5. During the initial period of processing operations there will be negligible changes in the present health impact to the off-site population but as the reclamation program proceeds, the health impact will decrease. (Sec. 4.2.5)

6. The largest effects on the socioeconomic conditions will be the creation of some 30-35 jobs, with approximately 15 of these requiring skilled labor, and the payment of royalties to the Navajo Tribe for the recovered uranium. (Sec. 4.2.6)

7. Since much of the area has been previously disturbed, the ecological impacts should be minimal. (Sec. 4.2.9)

1.2.3 Environmental Impacts after Operations

1. The air quality in the vicinity of the site should be greatly improved after reclamation. (Sec. 4.3.1)

2. After the processed tailings are stabilized with 5-1/2 feet of cover material, gamma radiation will be reduced to background levels. (Sec. 4.3.2)

3. After reclamation, no contaminated soil will remain exposed on the surface in the previous tailings area or in the leach pit area. (Sec. 4.3.3)

4. Once operations are completed there would be no further tapping of the aquifers. The ground water level at the site then would return to the pre-operational level, as the water level in the Rare Metals Well #2 has. (Sec. 4.3.4)

5. After reclamation of the site gamma radiation from the processed tailings will be reduced to background levels by the stabilization cover. Therefore, there will be no health impact to off-site population due to gamma radiation from the processed tailings.

   The stabilization cover will reduce radon emanation to about 25% of the present level. This will also reduce the radon concentration from the tailings pile by a factor of 4 at the housing area. (Sec. 4.3.5)

6. Following reclamation, a long-term benefit would be derived from elimination of the health impact of the processed tailings on the nearby population. (Sec. 4.3.6)

7. While some natural flora and fauna will be disturbed during operations, they will re-establish themselves on the site after reclamation to better than present levels. (Sec. 4.4.6)

CHAPTER 2

SITE DESCRIPTION AND EXISTING ENVIRONMENT

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SITE DESCRIPTION AND EXISTING ENVIRONMENT

The information presented in this chapter is useful in determining impacts of the present conditions at the Tuba City millsite and impacts during and after the proposed processing and reclamation operations. Much of the information and data in this chapter was taken from the Engineering Assessment of Inactive Uranium Mill Tailings, Tuba City Site.[1] More recent information now available also is included and referenced where used. The existing radiological conditions are presented in Chapter 4 where environmental impacts are discussed.

2.1 SITE LOCATION AND BOUNDARIES

The Tuba City site is located approximately 70 mi north of Flagstaff and 5 mi east of Tuba City, Arizona, on the Navajo Reservation. The site is along the south side of U.S. Highway 160, which connects Tuba City and Kayenta, Arizona. More specifically, the site location is at 36 deg 08 min 42 sec north latitude, and 111 deg 08 min 02 sec west longitude. It is situated in Sections 17 and 20, Township 32 North, Range 12 East, from Gila and Salt River Meridian, Coconino County, Arizona. This project will involve primarily the evaporation ponds and the tailings area. Figure 2-1 shows the site boundaries for the proposed processing and reclamation project.

2.2 HISTORY OF PRIOR OPERATIONS

The Tuba City uranium mill was constructed in 1955 by Rare Metals Corporation to process ore from Arizona locations such as Cameron, Monument Valley, Congress Junction, the Orphan Lode Mine near Grand Canyon, and from an ore buying station near Globe.

The original site consisted of the housing area, about 16 acres, which is on both sides of U.S. Highway 160; the mill, office and ore storage area, about 30 acres, which is south of the highway and east of the housing area; the tailings area, about 22 acres, and the evaporation pond area, about 20 acres, totaling 88 acres.

Ore processing began in 1956 at the rate of 300 tons/day. An acid leach process was used until 1962 when the mill was temporarily shut down. Rare Metals Corporation was merged into El Paso Natural Gas Company in 1962 and the mill was converted to a carbonate leach process. It then operated at 200 tons/day until 1966 at which time operations ceased. During the life of the mill about 800,000 tons of ore were processed and deposited in the tailings area with an average depth of 16 ft.

The operating license was terminated by the Arizona Atomic Energy Commission in 1968 and control of the site reverted to the Navajo Nation, the current owner.

2.3 TOPOGRAPHY

The site is located on a gently sloping area which drains south into the Moenkopi Wash. The uneven terrain of the area is characterized by gullies, washes, cliffs, and mesas. The surrounding area is covered with the typically sparse vegetation found in many parts of the Four Corners area. The elevation of the site is about 5,000 ft above sea level. The tailings site is approximately 340 ft higher than Moenkopi Wash. Figure 2-2 is a topographic map of the site area.

2.4 GEOLOGY AND SOILS

Unconsolidated alluvial and aeolian deposits from 0-30 feet thick cover the surface. The underlying bedrock at the site is the Navajo Sandstone. The Navajo Sandstone is a medium to fine grained, well sorted, large scale crossbedded, very friable sandstone. An outcrop about 100 to 200 feet from the southeast corner of the evaporation ponds shows the Navajo to be light yellow to white and noncalcareous in this area. A promontory about 1/5 of a mile southeast of the site has outcroppings of several thin beds of pisolitic, calcareous, light gray, medium grained sandstone. These thin beds are found approximately 30 feet below the surface of the bedrock. The more characteristic light red, cliff forming Navajo Sandstone beds can be seen to the south in the outcrops along Moenkopi Wash. Below the Navajo at approximately 500 feet (estimated from logs of nearby wells)[2,3] is the Kayenta Formation. The Kayenta Formation, a series of silty mudstones, is intertongued in its upper 200-300 feet with the Navajo Formation.

Bedrock at the site dips at a low angle (2 deg) away from the town of Tuba City towards the axis of the Tuba City syncline. The axis runs in a northwest-southeast direction about 1 mi east of the site and plunges to the southeast towards Moenkopi Wash. For a simplified stratigraphic cross section see Figure 2-3.

The tailings site is in a Zone 2 earthquake risk region.[4] This is due largely to an earthquake belt west of Tuba City. This belt seems to follow along Echo Cliffs and down into the San Francisco Mountains. Risks for Tuba City and the site area would be considerably lower.

The site lies in an area described on the Coconino County soils map as having a Sheppard-Rock Outcrop association.[5] The Sheppard soils are reddish brown to reddish yellow and range from loamy fine sand to sand with a depth of 60 inches or more. Drilling on the site in the evaporation ponds during March 1979 indicated an average depth of 72 inches for these soils in this area. Below this depth there was a poorly sorted, coarse grained alluvial deposit which extended to at least 20 feet below the surface. One drill hole indicated that the bedrock underlies this deposit at about 26 feet below the general surface of the evaporation ponds.

Rock outcrops can be seen in other areas of the site; for example, between the mill and U.S. 160 and off the the southeast corner of the site. However, drilling in the evaporation ponds showed no bedrock within 20 feet of the original surface in this area.

2.5 SURFACE AND GROUND WATER

The potential for surface water contamination is low because the nearest surface water (Moenkopi Wash) is 2 miles south of the site, as shown in Figure 2-4. Study of the features in Figure 2-4 indicates that east-west Highway 160, about 0.25 mi north of the tailings, is located along the top of a low ridge. To the north of the highway, a large depression known as Greasewood Lake collects any surface runoff which may occur north of the highway. Surface drainage from the Greasewood Lake depression would drain to the west-southwest and would not cross the highway until well past the site. There is some drainage potential from precipitation falling in the area between the highway and the tailings pile. There is evidence of some sheet erosion of this steeply sloping land due to thunderstorm runoff, but the amount of erosion has been small. The tailings piles are effectively isolated from inflow or outflow of surface water by the original tailings dikes. The only water that can reach the tailings piles comes from precipitation directly onto the site.

The principal ground water aquifer in the Tuba City-Moenkopi area is a multiple aquifer system consisting of the Navajo Sandstone and some sandstone tongues in the underlying

Kayenta Formation. Figure 2-3 shows these aquifers in the simplified stratigraphic cross-section. The water table under the site, as measured on March 3, 1979, was approximately 38 feet below the general level of the evaporation ponds. This aquifer is recharged largely by winter and spring precipitation in the Kaibito Plateau highlands some distance north of Tuba City. (See Figure 2-5.) Water in the multiple aquifer system moves generally southward from the highlands to Moenkopi Wash. From the site, groundwater probably moves northeast to the Tuba City Syncline before moving southeast down the syncline to Moenkopi Wash. The regional principal discharge area is along Moenkopi Wash. Thus the tailings are situated in the discharge rather than the recharge area of the aquifer system. Water in the multiple aquifer system is unconfined because the Navajo Sandstone is covered only by unconsolidated alluvial and aeolian deposits in the site vicinity. The water moves by gravity flow to where the water table intersects the land surface along Moenkopi Wash and its tributary gullies.

There is a shallow well at a farm about 1.5 mi southeast of the site near Moenkopi Wash but no wells were found directly south of the site. Four wells that furnished water for the mill when it was in operation are located north of the highway. Water for the housing area is furnished by these wells.

2.6 METEOROLOGY

The average annual precipitation at Tuba City, Arizona, as reported by the U.S. Department of Commerce(6) is 6.1

in. based on a 62-yr period of record. The maximum 24-yr precipitation recorded at Tuba City (over a 70-yr period of record) was 3.4 in. measured on September 27, 1926.(7) Measured against the 100-yr 24-hr precipitation estimated from these figures, the storm on September 27, 1926, exceeded the 100-yr projected amount by 0.27 in. The 24-hr precipitation would be expected to be at a rate of 1.3 in. once every 2 yr, with a "maximum observed" 24-hr storm at Tuba City of 4.0 in.

Analysis of the records at Tuba City over a 25-yr period indicates that the maximum daily precipitation usually occurs during the 3-mo period of August through October. This pattern is typical of much of the southwest desert area, being the time of most frequent thunderstorm activity.

There are no records of wind velocity measurements at the Tuba City site or at any other nearby location. Since no wind direction measurements have been made, some method of estimating the direction of winds, as related to possible wind erosion of the tailings material, is necessary. Cooley and others state that strong winds are common throughout the Colorado Plateau[8] and postulate that the distribution and orientation of dunes and the directions of cross-beds in other eolian deposits indicate regional wind patterns during Quaternary and Tertiary ages. Figure 2-6 is a map showing that past and present wind directions prevail from southwest to northeast, as indicated by dune and cross-bed orientation. Wind records kept at Grand Canyon, 54 miles WSW of Tuba City for January 1940 to December

1944 show the prevailing wind direction to be from the southwest 18 percent of the time.[9]

Examination of the existing tailings pond dikes shows a number of locations where wind erosion of the dike material has taken place. The cuts in the dikes and the windblown tailings that have been deposited outside of the eastern and northeastern boundary of the tailings substantiate the observation that the transport of materials by wind is mainly from the southwest toward the northeast. The light-colored tailings material can be seen over an area more than 0.5 mi away from the existing tailings pile. The extensive wind erosion is due not only to the magnitude of the winds, but because of the fineness of the tailings resulting from the alkaline-leach process which was used during the last 3 years of operation. The material which has been transported from the tailings piles has been primarily in a northeasterly direction, away from the residences along U.S. Highway 160 and away from Tuba City. There are no residences nearby in the direction of the prevailing winds.

2.7 SOCIOECONOMIC PROFILE AND REGIONAL DEMOGRAPHY

Tuba City and the site are located in the Tuba City Agency (or Western Navajo Agency), which is divided into five districts. The site and Tuba City are in the Tuba City Chapter (Unit 2) of District 3.

In the 1978 Overall Economic Development Program,[10] Tuba City is described as the westernmost of the seven communities designated as primary growth points in the Navajo Nation. These communities have been singled out as having the greatest potential for various forms of development and as centers for educational, health, and welfare services. Tuba City is an administrative center and the site of a major hospital; it also has extensive educational facilities on the elementary and high school levels and has a variety of other public services available.

There are approximately 2,037 Navajos in the work force in the Tuba City Chapter. According to the Office of Program Development 74 percent of these people are unemployed.(11) The employed labor force is concentrated in services, government, wholesale and retail trade and "other" fields.

Population trends were examined to provide an estimate of the significance of the tailings to the growth of Tuba City, particularly in an easterly direction towards the tailings. The primary centers of population concentration in the Tuba City Chapter are in and to the east of Tuba City in the vicinity of the new high school.

The Bureau of Indian Affairs estimated that there were 26,071 persons living in the Tuba City Agency in 1976. A special study by the Census Bureau in late 1976 showed the number of people residing in the Tuba City Chapter to be 6,149 people, of which 1,836 or 30% are non-Navajos.

Population growth rates were estimated based upon factors mentioned earlier. For the long run, a 2.5% and a 4% steady growth rate appear to be the most reasonable; although, for the next 20 yr, a 6.4% rate may be the best fit if industrialization succeeds, or if commercial development accelerates. Support for the higher growth rate comes from a 1978 U.S. Office of Revenue Sharing figure of 29,767 people in the Tuba City Agency which is close to the 6.4% rate for these 2 years. Figure 2-7 shows the projected population growth factors for steady and declining rates of growth. There is a fairly high probability that a 6.4% declining rate, a declining 4% rate, or the constant 4% rate will hold. There apparently are too many pressures on the area to opt for any form of the lower rates. In any case, the 4% and 6.4% projections indicate that there will be pressures on the community to expand its commerce, industry, services, and residential areas and that the population will at least double over the next 50 yr and may even quadruple.

The land use and population projection information lead to the conclusion that while Tuba City is expanding eastward along U.S. Highway 160 toward the site, growth at these rates will have little effect at the site.

Within a mile of the site there are four scattered dwellings and nine occupied houses in the housing area. Assuming an average of four people per household, there would be about 50 people within a mile of the site. Since the remaining 17 homes have just been renovated and since up to 50 trailer hookups are projected in the area, there is a good possibility that the population could rise as high as 320 in the foreseeable future.

2.8 LAND USE

The buildings that remain at the site are unoccupied and in poor condition and the site itself is abandoned. There are residents in nine of the houses in the housing area. Renovation is planned or has been completed for those houses presently unoccupied. The land surrounding the site is used for low density grazing. There are six dwellings within 2 mi of the site.

During the last five years, the east side of Tuba City has experienced considerable growth, including the construction of a high school and the development of three new subdivisions. However, even with the eastward growth, there is no reason to expect major changes in land use within a 1-mi radius of the site. Tuba City probably will continue to grow towards the site with primarily residential developments, but the population projections for the area do not justify an expectation that the residential area will expand to within 1 mi of the site in the foreseeable future.

2.9 ECOLOGY

2.9.1 Plant Community

The site is situated in a rocky sandy loam to sandy silt occupied with a mixed desert shrub community. Dominant plant species in the vicinity include four-wing saltbush, green

Mormon tea and greasewood.[12]

The following indigenous (N) and introduced (I) species were observed in the environs of the tailing pile:

Green Mormon tea (N)	Willow (N)
Four-wing saltbush (N)	Milkvetch (N)
Greasewood (N)	Yucca (N)
Globe mallow (N)	Russian thistle (I)
Indian ricegrass (N)	Salt Grass (N)
Tamarix (I)	

None of these species are of a rare or endangered nature.

2.9.2 Animal Community

The vertebrate community is comprised of species typically associated with the desert shrub community for the area.[12] The predominant mammalian species found within the Tuba City desert shrub community include the deer mouse and Ord's kangaroo rat with the coyote functioning as a transient. The lark sparrow, black-throated sparrow, and house finch are the predominant avian species. Reptiles and amphibians are in sufficiently low numbers to be of little consequence.

A list of dominant mammalian species include the following:

Black-tailed jackrabbit	Apache pocket mouse
Coyote	Rock pocket mouse
White-tailed antelope squirrel	Ord's kangaroo rat
Silky pocket mouse	Northern grasshopper mouse

Canyon mouse	Deer mouse

A list of common avian species include:

Mourning dove	Turkey vulture
House finch	Lark sparrow
Western mockingbird	Desert sparrow

None of these species are of a rare or endangered nature.

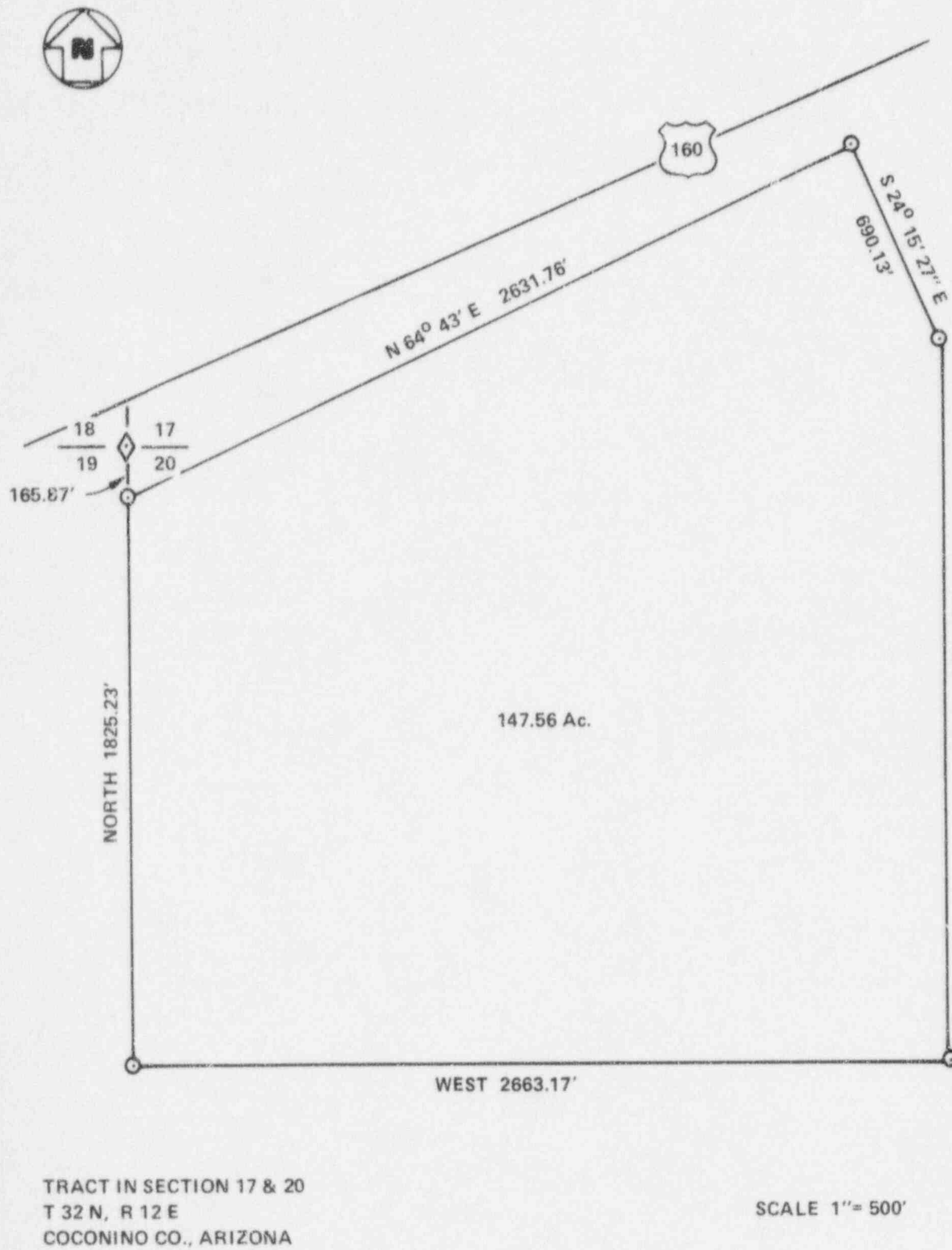


FIGURE 2-1. ATLAS SITE BOUNDARIES

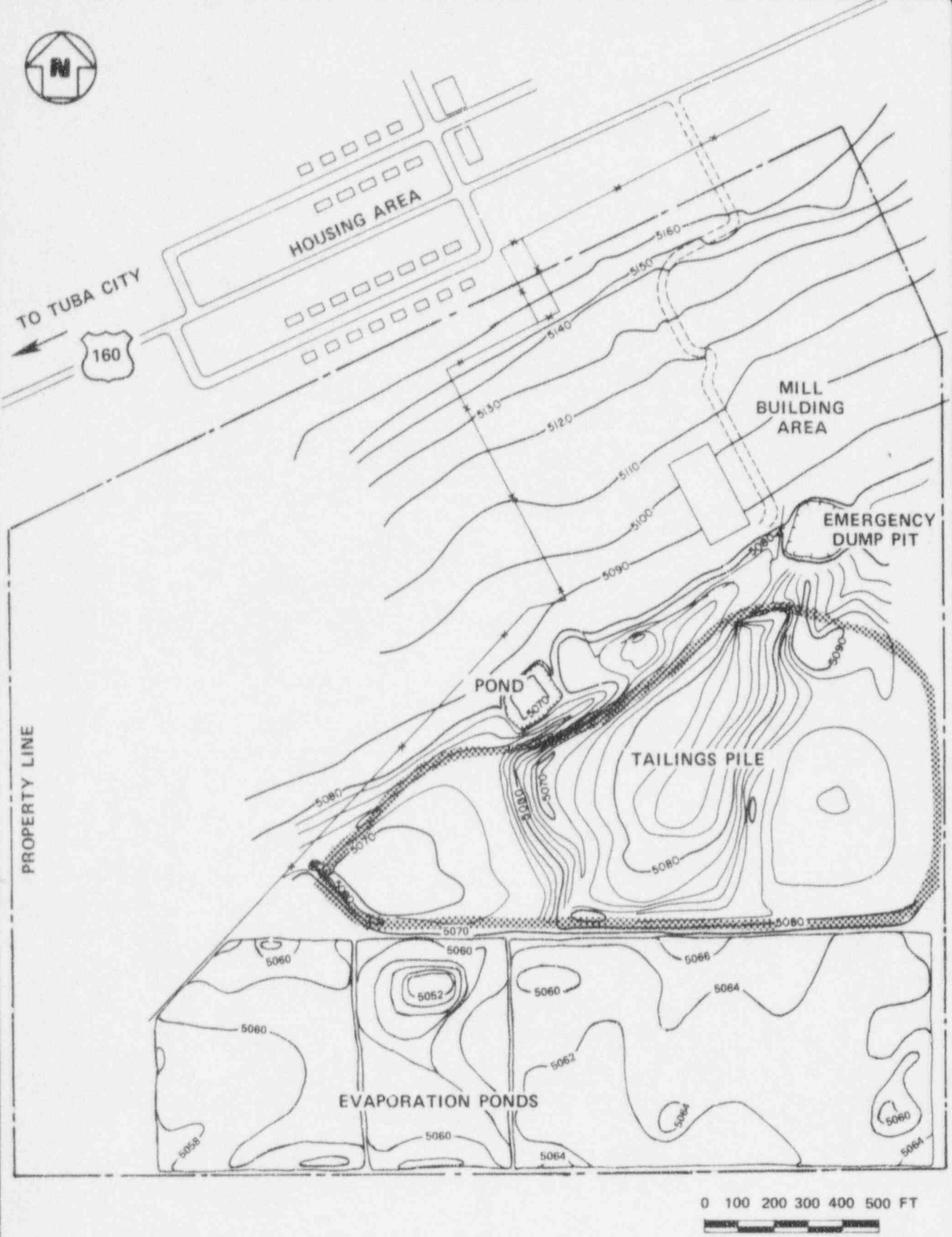
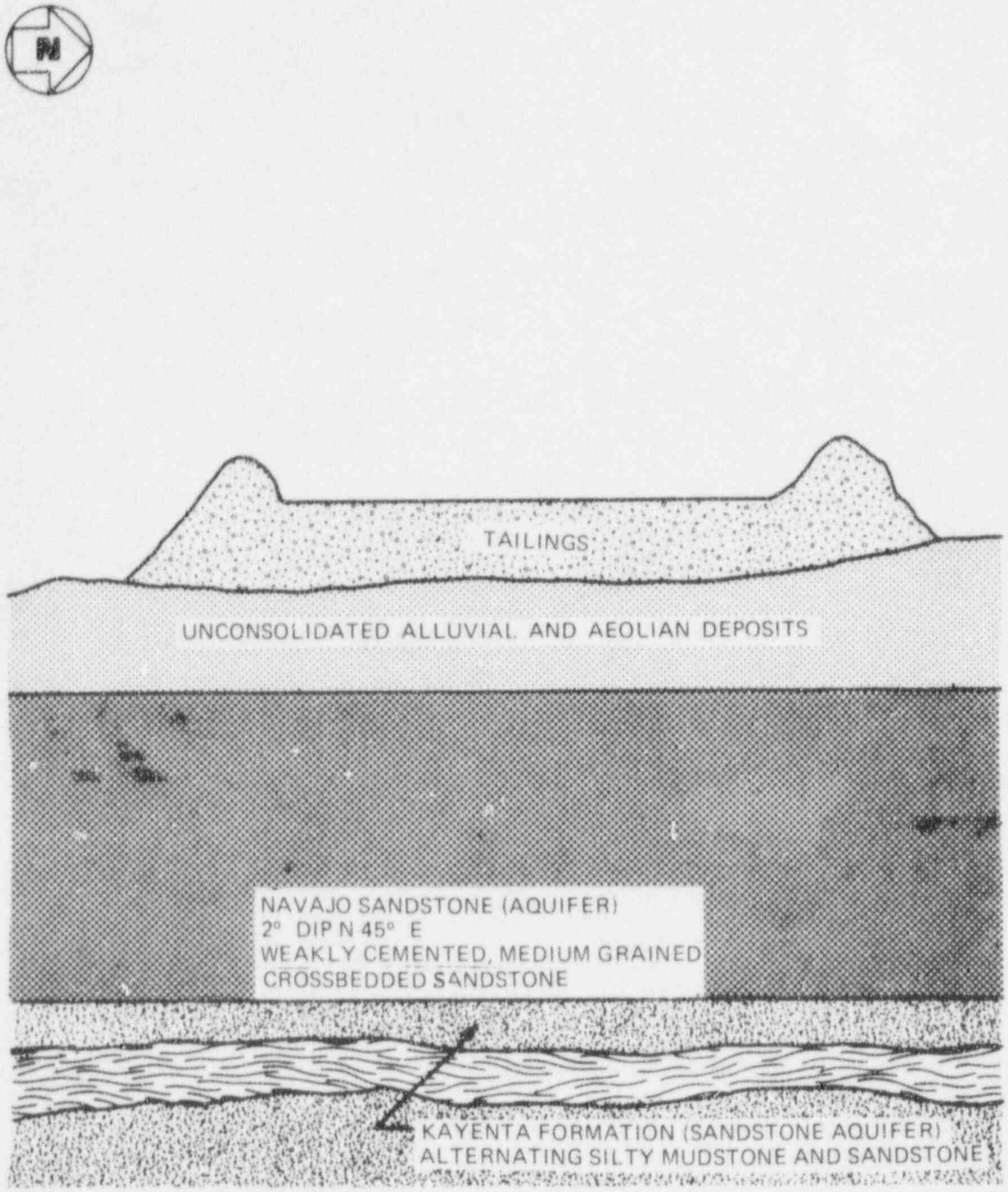


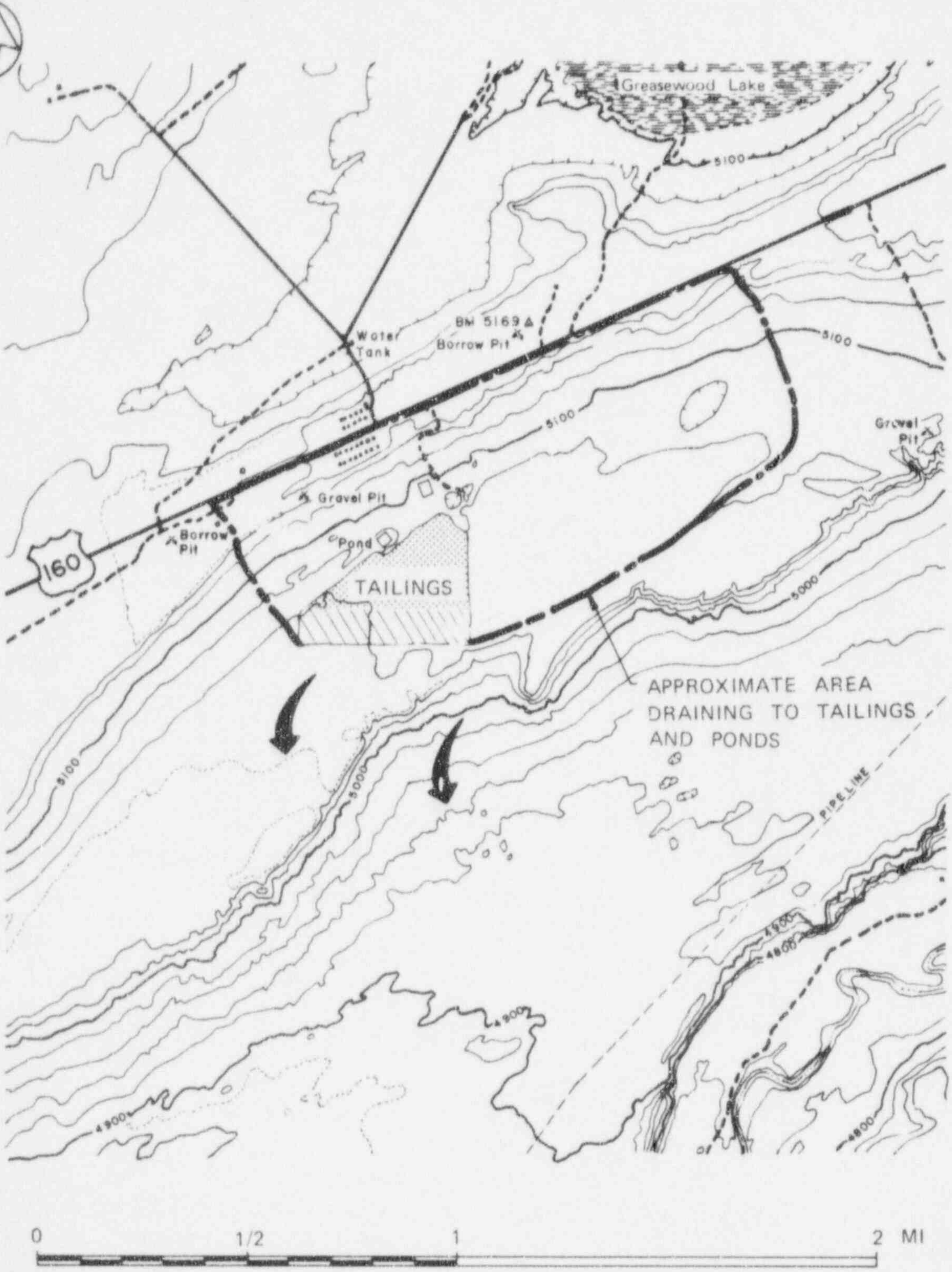
FIGURE 2-2. TOPOGRAPHIC MAP



NOTE:
GROUND WATER FLOWS N 45° E TO THE
TUBA CITY SYNCLINE AND THEN S E
DOWN THE SYNCLINE TO MOENKOPI WASH

FIGURE 2-3. SIMPLIFIED STRATIGRAPHIC CROSS-SECTION

130-04



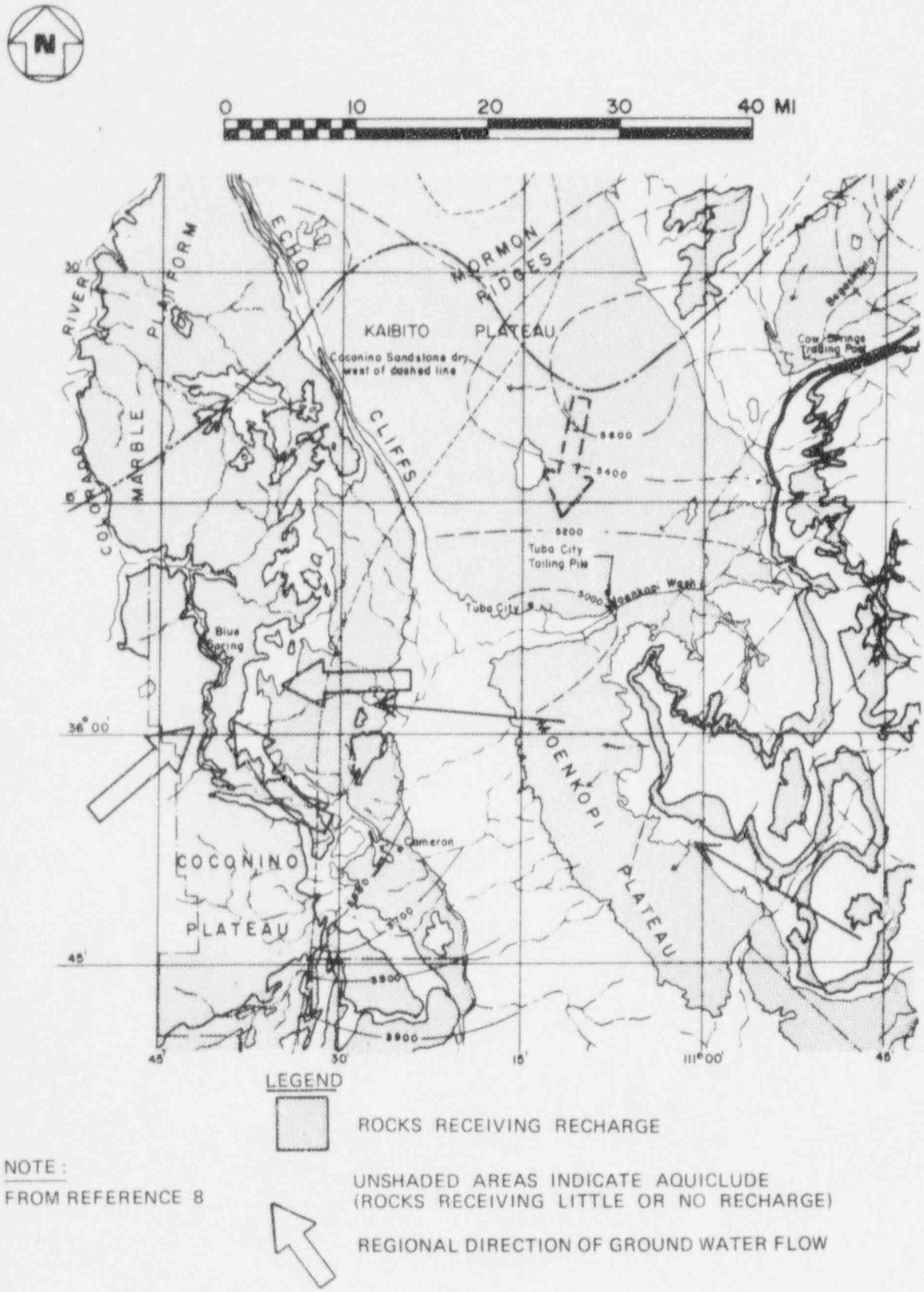
(MAP TRACED FROM U.S. GEOLOGICAL SURVEY, TUBA CITY AND TUBA CITY NE QUADRANGLES.)

LEGEND

GENERAL DIRECTION OF SURFACE WATER MOVEMENT

FIGURE 2-4. SURFACE DRAINAGE PATTERNS

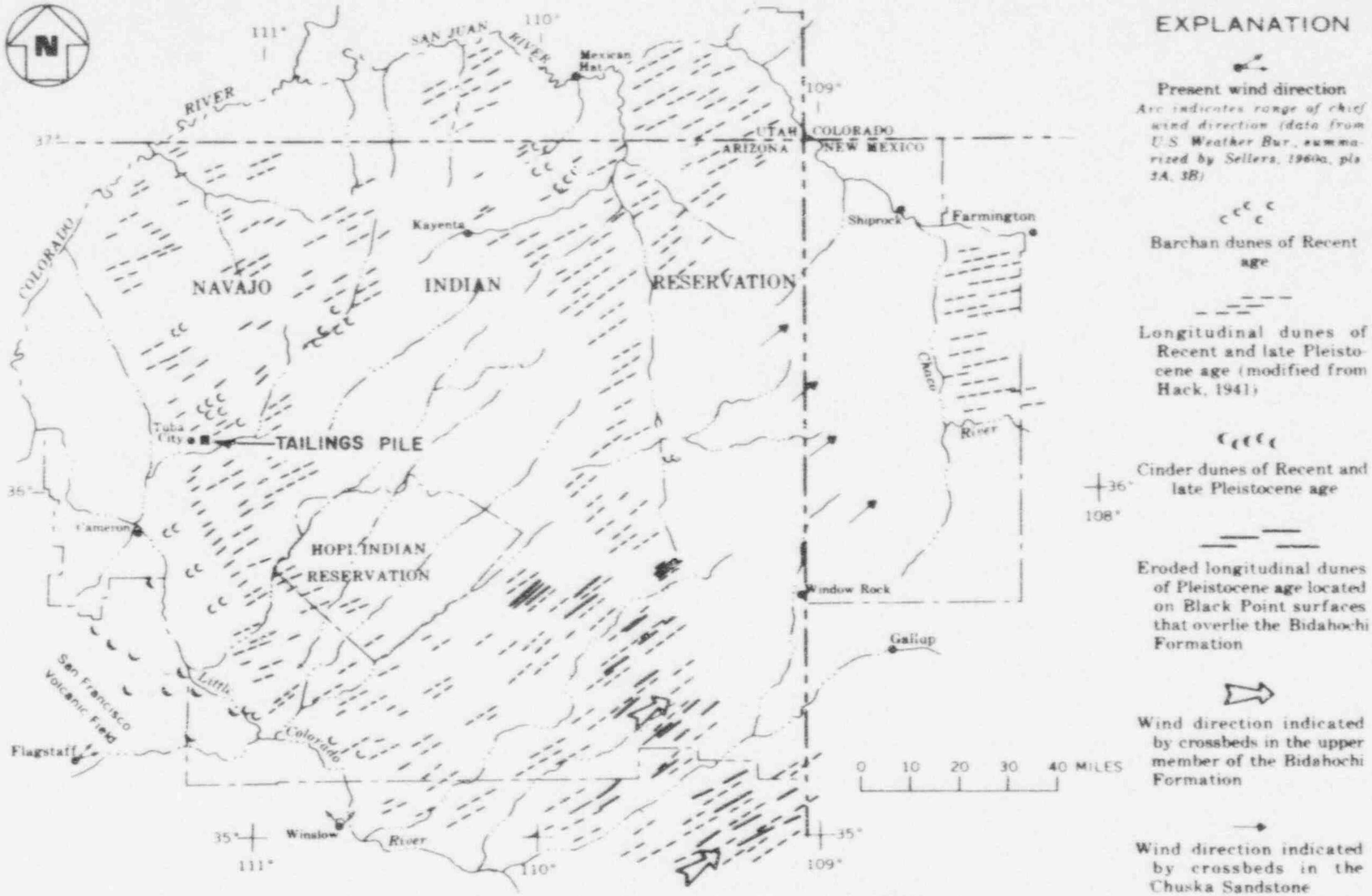
130-04



NOTE:
FROM REFERENCE 8

FIGURE 2-5. REGIONAL DIRECTION OF GROUND WATER FLOW

130-04



MAP SHOWING PAST AND PRESENT PREVAILING WIND DIRECTIONS

NOTE:

FROM REFERENCE 8

130-04

FIGURE 2-6. PREVAILING WIND MAP

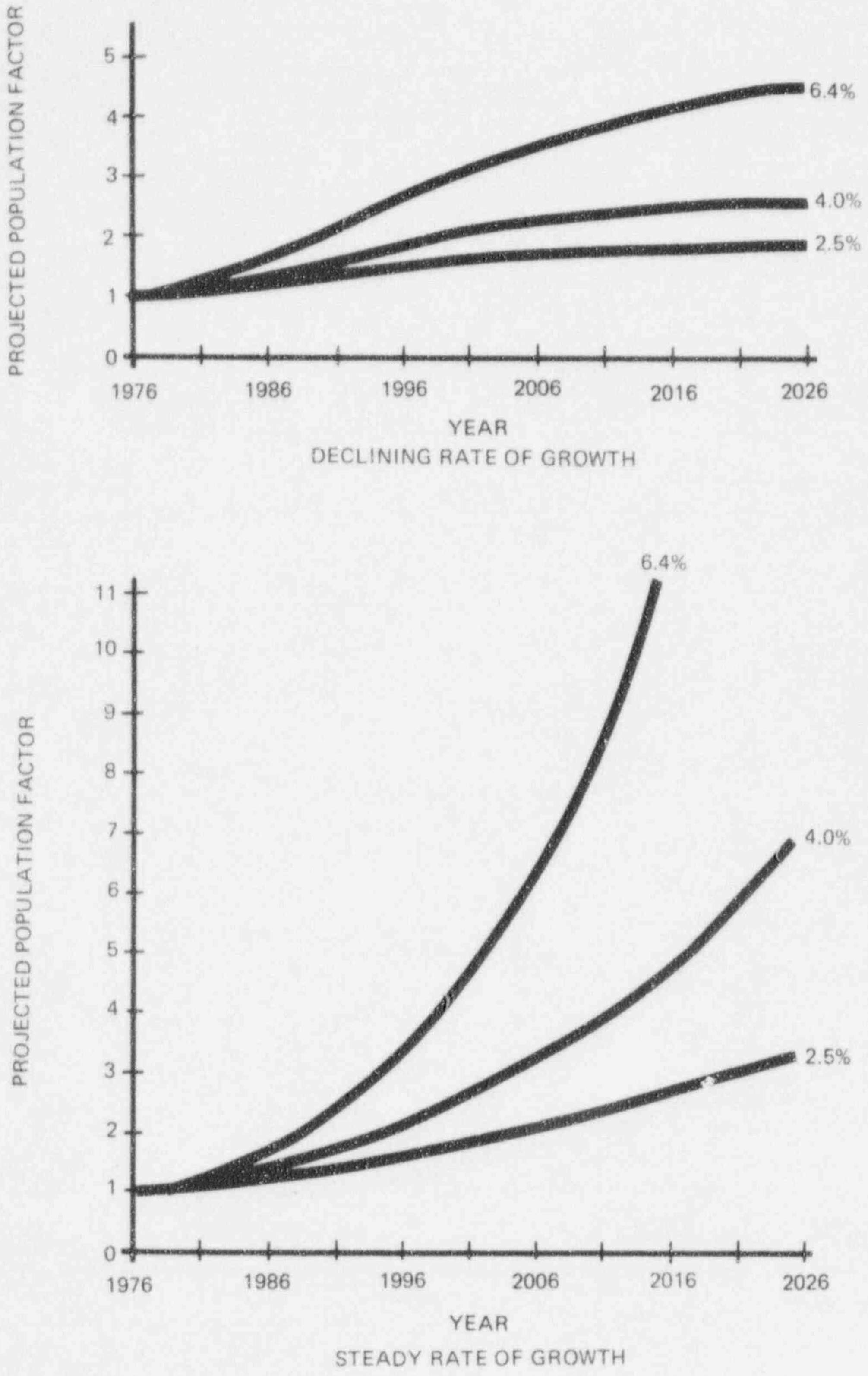


FIGURE 2-7. POPULATION PROJECTIONS

130-04

CHAPTER 2 REFERENCES

1. "Phase II - Title I Engineering Assessment of Inactive Uranium Mill Tailings, Tuba City Site"; GJT-5; Ford, Bacon & Davis Utah Inc.; Salt Lake City, Utah; Mar 1977.

2. "Geohydrologic Data in the Navajo and Hopi Indian Reservations, Arizona, New Mexico and Utah, Part I and Part II"; Arizona State Land Department; Water Resources Report #12-A-B; Apr-May 1963.

3. Well Records for Rare Metals Wells 1-4; USGS Water Resources Division; Flagstaff, Arizona.

4. "Earthquake History of Arizona"; Earthquake Information Bulletin; USGS; May-Jun 1970.

5. "General Soil Map, Coconino County, Arizona"; U. S. Dept. of Agriculture in Cooperation with Coconino Soil Conservation; District and Coconino County Planning and Zoning Commission; May 1972.

6. U. S. Department of Commerce; Climatological Data, Arizona; Vols 53-79; 1950-1976.

7. A. H. Jennings, Maximum 24-Hour Precipitation in the United States; U. S. Weather Bureau Technical Paper No. 16, 1952.

8. M. E. Cooley, J. W. Harshbarger, J. P. Akers, and W. F. Hardt; "Regional Hydrology of the Navajo and Hopi Indian Reservations, Arizona, New Mexico and Utah"; USGS Professional Paper 521-A; 1969.

9. "Wind and Blowing Dust and Sand"; Records for Grand Canyon 1940-1944 (less November 1942); Department of the Air Force, Air Weather Service, Directorate of Climatology Data Control Division; North Carolina.

10. "Navajo Nation Overall Economic Development Program 1978"; The Division of Economic Development, the Navajo Tribe; June 30, 1978.

11. "Future Land Use Planning, Tuba City, Arizona"; Office of Program Development, The Navajo Nation; 1977.

12. S. L. Welsh and H. D. Smith; "Biotic Assessment of Inactive Uranium Mill Tailings, Tuba City Site, Tuba City, Arizona"; Center for Health and Environmental Studies; Brigham Young University; Provo, Utah; May 1978.

CHAPTER 3

PROCESSING PROGRAM

CHAPTER 3

PROCESSING PROGRAM

3.1 PROCESSING PROGRAM

3.1.1 Tailings Description

3.1.1.1 Extent and Quantity

The tailings area covers approximately 22 acres and contains 800,000 tons of tailings with an average depth of 16 ft.

3.1.1.2 Amenability to Heap Leaching

Test work performed by Hazen Research, Inc., Golden, Colorado, has shown the tailings to be amenable to a heap leach process after proper preconditioning with sulfuric acid.

3.1.2 Processing Operations

3.1.2.1 Lixiviant Chemistry

Laboratory test data show that up to 72% of the contained uranium is soluble in an acidic leach solution if the tailings are blended with 225 pounds of sulfuric acid (100% basis) per ton of tailings prior to leaching. The acid leach also solubilizes up to 70% of the copper contained in the tailings.

3.1.2.2 Process Description

A descriptive flow sheet of the process is illustrated in Figure 3-1. The existing tailings will be blended with concentrated sulfuric acid solution (93% H_2SO_4). The acidified tailings, containing approximately 14% moisture, will then be stockpiled for a one week curing period. After curing, the tailings will be loaded into a heap leach pit. Anticipated depth of tailings in each pit is approximately 20 ft. After loading is completed, the pit is flooded with fresh water and/or waste solution recycled from solvent extraction and/or copper cementation. Depth of pit flooding is maintained at approximately 3.0 ft. As the solution percolates through the tailings, the uranium and copper are dissolved in the acidic solutions. The solutions, containing uranium and copper, are then collected in the perforated pipes at the bottom of the pit and pumped to a solution holding pond. Approximately 150 gallons of solution per ton of tailings must percolate through the heap to obtain the desired recovery of uranium and copper. The total time cycle from start of loading a pit with tailings to completion of percolation is estimated to be 120 to 140 days. The leached and drained tailings should now contain 20 to 25% moisture. To assure that the leached tailings have been drained thoroughly and stabilized to a minimum moisture content, the solution collection sump in each individual pit will remain open until all drainage has reasonably stopped. The leach solutions will then be filtered and treated by solvent extraction for recovery of uranium. The product solution from solvent extraction is a non-corrosive basic solution which will contain up to 100 grams per liter of sodium carbonate and 25 grams per liter of U_3O_8. This solution will be transported by truck to the Atlas uranium mill at Moab, Utah. The waste solutions from solvent extraction will be fed to concrete tanks for recovery of the copper. Iron shavings are added to these tanks and copper precipitated as "cement copper". After the waste solutions are pumped from the tanks to a solution holding pond, the copper precipitate is removed with a loader and placed on a curbed cement pad for draining. After draining, the precipitates will be shipped to a copper smelter for further treatment. The waste solutions will be recycled to the next heap leach pit for start of a new leaching cycle.

3.1.2.3 Tailings Excavation and Transportation

The existing tailings pile will be "mined" with track type crawler tractors and front end loaders. Up to 4,000 tons per day of tailings will be transported and stockpiled near the feed point of the acid pugging drum. This will be a working pile, with tailings continually being added to and removed from the pile. The tailings will be fed to a feed hopper with a front end loader at the rate of up to 2,500 tons per day. A belt conveyor will transport the tailings into the acid pugging drum, and a second belt conveyor will transport the drum discharge to stockpile. The discharge of the pugging drum contains 14% water and is agglomerated as a result of pugging with acid. The agglomerated and acidified tailings will be fed to a feed hopper with a front end loader at a rate of up to 4,000 tons per day. A portable belt conveyor will transport the material to the feed point of the tripper conveyor. The tripper conveyor will continuously move back and forth across the width of the pit and evenly distribute the material. As the pit loading progresses from the end of the pit, the tripper conveyor is periodically moved ahead along the length of the pit until the pit is loaded.

3.1.2.4 Operating Plans and Schedules

The planned life of the project from start of field engineering to completion is approximately 24 months.

Since the heap leaching of tailings is basically a batch type operation rather than a continuous operation, it is not possible to define a specific daily tonnage for plant capacity. The acid pugging operation will be the most continuous unit operation in the process and equipment for this operation is designed to handle up to 2500 tons per day of tailings throughput. Overall the project is rated as a nominal 2,000 tons per day capacity operation.

The "mining" and acid pugging of tailings will be the first units in operation. Loading of the first heap leach pit will follow in about 30 days. Leaching will commence after the first pit is loaded. The solvent extraction operation will commence about 60 days after leaching is started on the first pit. The last process units in operation, prior to plant shutdown, will be solvent extraction for uranium recovery and copper precipitation for copper recovery.

Following is an estimated operating time schedule for each unit operation.

(a) "Mining"of tailings: 2 shifts per day, 5 days per week

(b) Acid pug of tailings. 3 shifts per day, 7 days per week

(c) Loading heap leach pits: 2 shifts per day, 5 days per week

(d) Heap leaching: 3 shifts per day, 7 days per week

(e) Solvent extraction: 3 shifts per day, 7 days per week

(f) Copper precipitation: 3 shifts per day, 7 days per week

3.1.2.5 Product Transportation

Uranium

Approximately 1,500,000 gallons of product solution (6,685 tons) will be shipped from the Tuba City millsite to Moab, Utah during the life of the project. The distance from the millsite to Moab, Utah is approximately 245 miles. Since each truck anker will haul approximately 25 tons, approximately 268 truck loads will be shipped from the property. Frequency of shipping should be four to five truck loads per week over a 15-month period.

The product solution will contain up to 100 grams per liter of Na_2CO_3 and up to 25 grams per liter U_3O_8. The solution is basic (above 7.0 pH) and non-corrosive.

Copper

Approximately 2,000 tons of wet cement copper precipitate will be shipped from the Tuba City millsite to the Hayden, Arizona area, a distance of 300 to 350 miles. Since each truckload will haul approximately 25 tons, 80 truckloads are anticipated over the project life. Frequency of shipping should be about one truck per week for 18 months.

3.1.3 Processing Facilities

3.1.3.1 Buildings

The following buildings will be on site during operations:

a) Two (2) 14 ft x 70 ft office trailers

b) One (1) 10 ft x 36 ft laboratory trailer

c) One (1) 10 ft x 42 ft personnel change trailer

d) One (1) 10 ft x 35 ft heavy equipment contractors trailer

e) One (1) 20 ft x 50 ft maintenance shop

All of the buildings on site will be temporary and portable. All buildings erected for this project will be removed upon completion of operations.

3.1.3.2 Process Equipment

Process equipment and other process related facilities are shown on Figure 3-2 and in Table 3-1. The equipment numbers for each item of process equipment correspond to the equipment numbers on the flow sheet (see Figure 3-1).

3.1.3.3 Heap Leach Pits

Fourteen pits will be constructed, with each pit having a nominal capacity of 60,000 tons. All pits will be adjacent with common dikes and will cover an overall area of 940 ft x 2026 ft. Each individual pit will measure 70 ft wide x 928 ft long at the bottom and 116 ft wide x 974 ft at the top (see Figure 3-2). The depth of each pit will be 23 ft from top of the dike to the bottom of pit. Internal dike slopes will be 1:1 and external slopes will be 2:1. The top of the dikes will be 10 ft wide. Cut and fill calculations show that of the 23 ft depth approximately the top 12 ft of the dike will be compacted fill.

Each pit, including side slopes, will be lined with 20 mil PVC sheet. Four-inch perforated PVC drain pipes will be laid on 20 ft centers over the liner on the pit bottom to collect leach solutions. A 3 ft diameter x 23 ft high concrete pipe will be installed in each pit as a collection sump for the solutions. A vertical centrifugal sump pump will be used to pump solutions from the sump to a solution holding pond.

Since a tripper conveyor will be used to load the pits, access to the conveyor loading points must be maintained. Thus, no more than two individual pits will be under construction at one time. Paddle wheel scrapers, dozers, and front end loaders will be the heavy equipment employed for pit construction. Prior to start of pit construction approximately 80,000 yd^3 of contaminated soil will be removed and placed in stockpile. Approximately 386,000 yd^3 will be excavated during construction of the 14 pits. Of the total excavated, 181,000 yd^3 will be used for dike construction and 205,000 yd^3 will be stockpiled and used for final leach pit reclamation cover after process operations are completed.

3.1.4 Sources and Disposal of Liquids and Solids

3.1.4.1 Sources of Liquids

The following liquids, with estimated quantities as shown, will be introduced into the operation over the life of the project.

Water in existing tailings	28.7 MM gallons
Fresh Water	49.7 MM gallons
Sulfuric acid	1.6 MM gallons
Kerosene	29,000 gallons

3.1.4.2 Disposal of Liquids

The following liquids, with estimated quantities as shown, will be disposed of over the life of the project.

Water

Remaining with leached tailings	64.0 MM gallons
Shipped with uranium product	1.5 MM gallons
Shipped with copper product	0.1 MM gallons
Evaporated during operations	12.8 MM gallons

Sulfuric Acid

Remaining with leached tailings	1.6 MM gallons

Kerosene and Amine

Shipped to Atlas mill at Moab, Utah, at completion of project	38,000 gallons

3.1.4.3 Sources of Solids

The following solids, with estimated quantities as shown, will be introduced into or generated for the operation over the life of the project.

Existing tailings	615,000 yd^3
Contaminated soil from area of new heap pits	80,000 yd^3
Cleanup under existing tails pile	75,000 yd^3
Material moved to construct heap pits	386,000 yd^3
Material excavated to construct solution holding ponds	15,000 yd^3

Soda ash	532 tons
Iron shavings	1,075 tons

3.1.4.4 Solid Disposal from the Operation

The following solids, with estimated quantities as shown, will be disposed of over the life of the operation.

Existing tailings	615,000 yd^3 to heap leach pits
Contaminated soil from area of heap pits	80,000 yd^3 for approximately first foot of cover for heap pits
Cleanup under existing tailings pile	75,000 yd^3 for approximately second foot of cover for heap pits
Material moved to construct heap pits	181,000 yd for dike construction
Material excavated to construct solution holding ponds	205,000 yd for approximately 3-1/2 ft of top cover
Soda ash	532 tons shipped with uranium product
Iron shavings	1,075 tons to heap leach pits
Material excavated from solution pond construction	15,000 yd backfill to ponds for reclamation

3.1.4.5 Atmospheric Emissions

The operation will create two point sources of air emissions:

1. Soda Ash

A total of 532 tons of bulk soda ash will be delivered to a 30-ton storage bin. The bin will be equipped with a baghouse dust collector with a predicted collection efficiency of 99.8% for generated dust.

2. No. 2 Fuel Oil

An estimated total of 338,000 gallons of fuel oil will be burned over the life of the project for loaders, dozers, scrapers, graders, and generators.

3.2 SITE STABILIZATION AND CLEANUP

Upon completion of processing operations a stabilization and cleanup program which will encompass those areas used during operations will be instituted by Atlas Minerals.

This program will commence with the dismantling and removal to Moab of all process and related equipment from the site. All concrete foundations, pads, tanks, and other non-salvageable items will be removed and disposed of in the heap leach pits. After removal of the equipment and structures, the land used for the process operation will be cleaned up and contaminated soil disposed of in the heap leach pits.

After cleanup of the land used for process operations, the heap leach pits will be covered and stabilized. This will be accomplished by providing a 5-1/2 ft stabilization cover over the entire heap leach area. The cover will consist of the following make up of materials: The first foot will be obtained from removal of an average of 2.5 ft or 75,000 yd^3 of contaminated soil from the area previously covered by tailings. The second foot will consist of 80,000 yd^3 of contaminated material removed from the evaporation ponds and stockpiled. The next 3 ft will consist of 205,000 yd of uncontaminated material removed from the evaporation ponds during pit construction and stockpiled for cover. A final 0.5 ft gravel cap will be added to minimize erosion.

As a result of the process program, a depression will result between the stabilized heap leach pits and the northern limit of the tailings excavation. It is expected that this depression will serve to contain any runoff from those areas to the north, such as around the old mill building, ore pad and wind blown area. It is anticipated that this area will act in much the same manner as the present evaporation ponds.

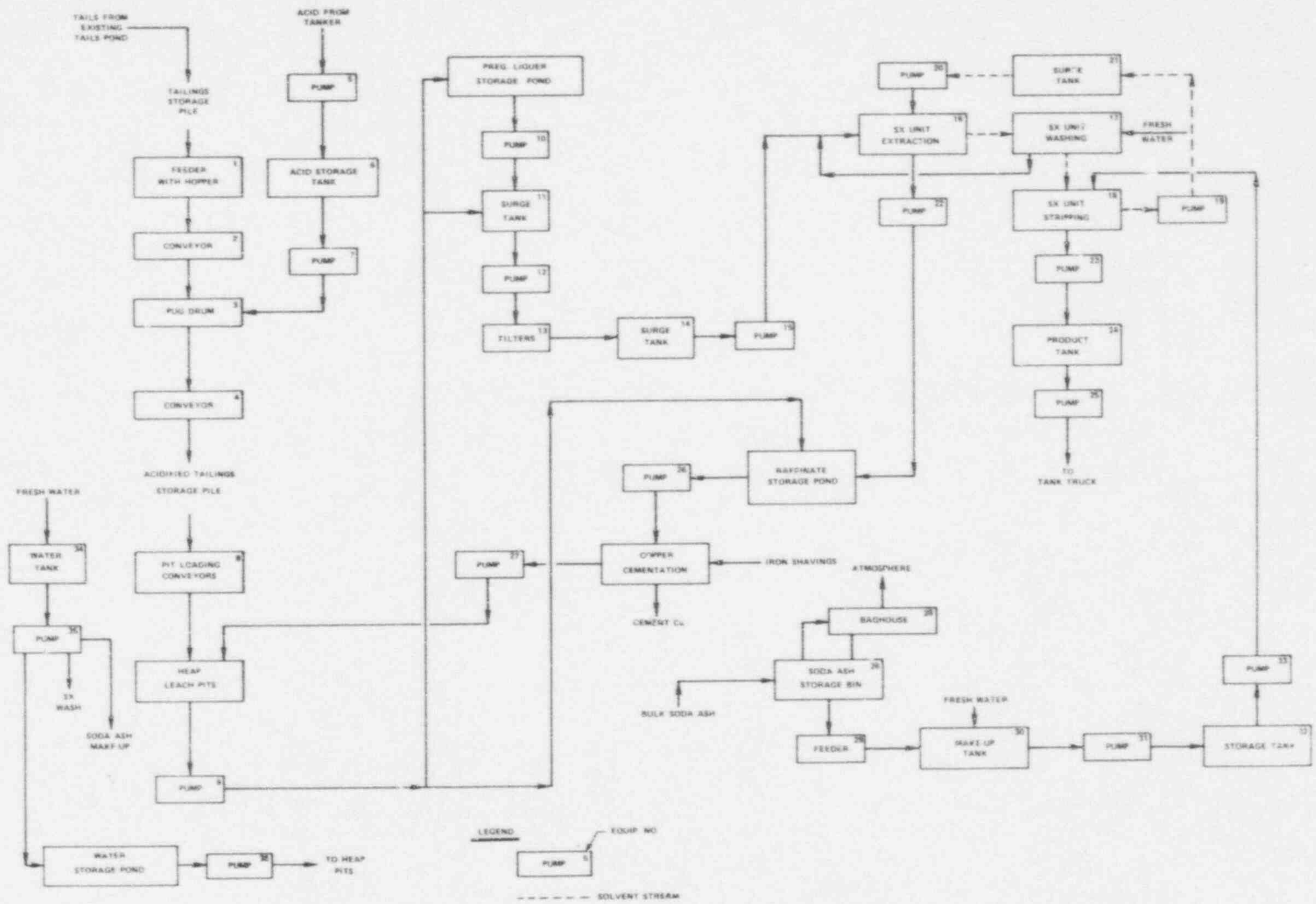


FIGURE 3-1. PROCESS FLOWSHEET 2,000 TPD URANIUM HEAP LEACHING

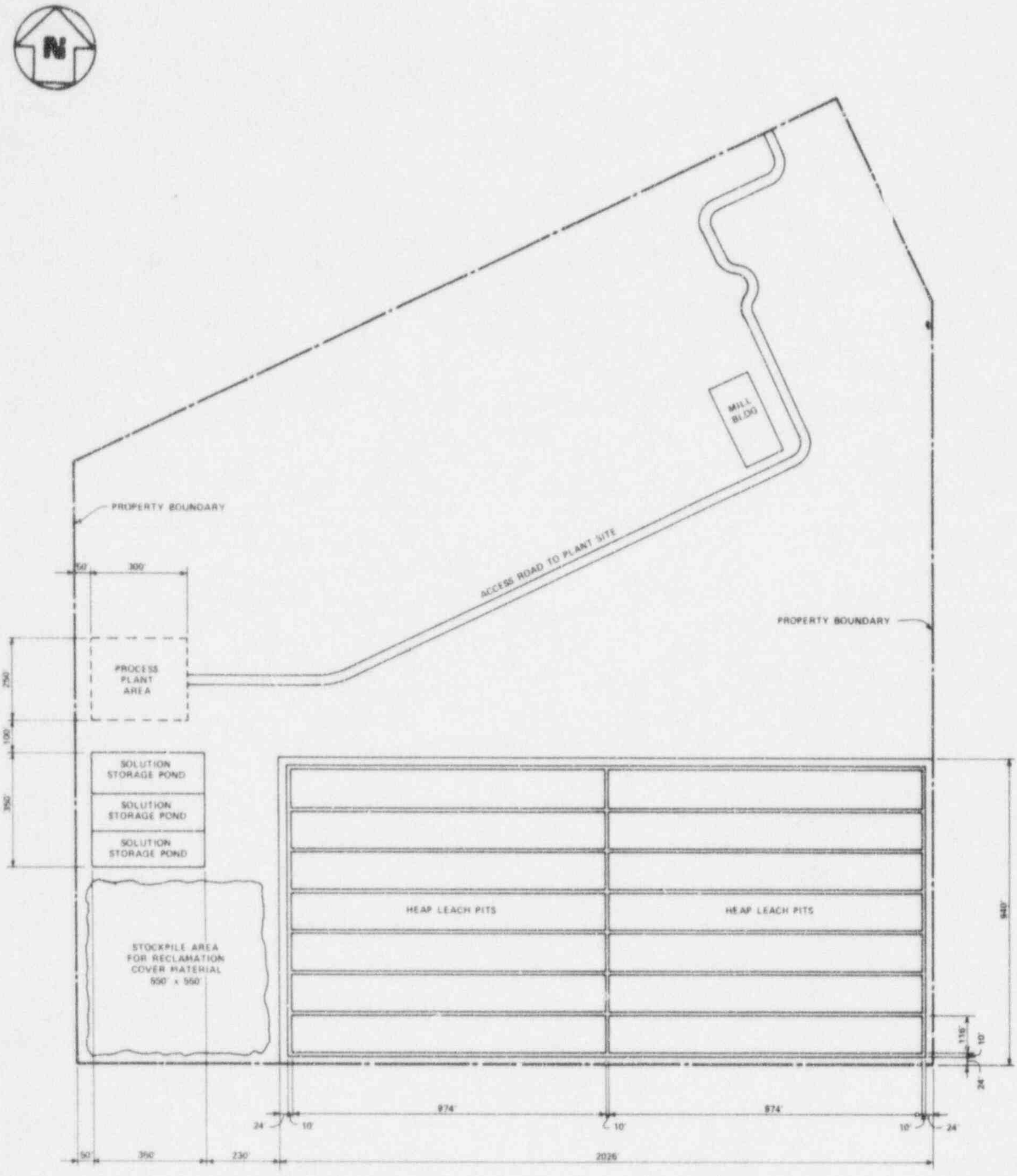


FIGURE 3-2. SITE PLAN

TABLE 3-1

Process Equipment
2000 TPD Uranium Heap Leaching
Tuba City, Arizona, Tailings
Atlas Minerals

Equip. No.	Description	Parameters	Approximate Size and Type	Materials of Construction	hp
1	Tailings feeder with 30-ton hopper and 12" x 12" stationary grizzly	93 TPH wet tailings, 100% minus 1", 13% moisture	36" wide belt feeder, 8' long, variable speed	Rubber belt and mild steel bin	2
2	Tailings conveyor with weightometer	93 TPH wet tailings, 13% moisture	Belt conveyor, 24" width, 40' long	Rubber belt, mild steel frame	3
3	Acid pug drum	93 TPH capacity, approximately 6 minutes mixing time	8' diameter x 30' rotating drum	Rubber lined	15
4	Acidified tailings conveyor	98 TPH wet tailings, 100% minus 1-1/2", 14% moisture	Belt conveyor, 24" width, 80' long	Rubber belt, epoxy coated mild steel frame	5
5	Acid unload pump	80 gpm, 93% H_2SO_4, 1.24 specific gravity 30' TDH	3" x 1-1/2" centrifugal	Cast iron	5
6	Acid storage tanks, six	93% H_2SO_4, 1.84 specific gravity, 6-day supply	11' diameter x 48', horizontal tanks, 32,000-gallon/tank 1-1/2" x 1" centrifugal	Mild steel	-
7	Acid feed pumps, two	22 gpm, 93% H_2SO_4, 1.84 specific gravity, 50' TDH	1-1/2" x 1" centrifugal	Cast iron	2
8	Pit loading conveyors:				
	a. Portable conveyor	295 TPD, 14% moisture	Belt conveyor, 36" width, 100' long	Rubber belt, epoxy coated mild steel frame	7-1/2
	b. Tripper conveyor	295 TPH, 14% moisture	Belt conveyor, 30" width, 130' long	Rubber belt, mild steel frame	80

TABLE 3-1 Cont

Process Equipment
2000 TPD Uranium Heap Leaching
Tuba City, Arizona, Tailings
Atlas Minerals

Equip No.	Description	Parameters	Approximate Size and Type	Materials of Construction	hp
9	Solution sump pumps, four	180 gpm, 1.1 specific gravity, 60' TDH	2-1/2" vertical centrifugal	Rubber covered	60
10	Pond pump for pregnant liquor	50 gpm, 1.1 specific gravity, 50' TDH	2-1/2" vertical centrifugal	Rubber covered	7-1/2
11	Surge tank	5200-gallon capacity, 30-minute surge time	10' diameter x 10'	FRP	-
12	Filter feed pump	240 gpm, 1.1 specific gravity, 150' TDH	4" x 3" centrifugal	316 stainless steel	30
13	Filters, two	240 gpm, 1.1 specific gravity	22" diameter x 52" high in-line filters, 81 cartridges, two in paralles	304 stainless steel	-
14	Surge tank	5200-gallon capacity, 20-minute surge time	10' diameter x 10'	FRP	-
15	Solvent extraction feed pump	240 gpm, 1.1 specific gravity, 40	4" x 3" centrifugal	316 stainless steel	1-
16	Solvent extraction unit, extraction, three stages	600 gpm, 1.1 specific	60" diameter x 72", mixers, 3 hp, 13' x 48' settler	FRP tanks and piping, 316 stainless steel agitators	9
17	Solvent extraction unit, washing one stage	100 gpm total flow	36" diameter x 32" mixer, 5' x 18' settler	FRP tanks and piping, 316 stainless steel agitators	1
18	Solvent extraction unit, stripping, two stages	100 gpm total flow	36" diameter x 32" mixer, 1 hp, 5' x 18' settler	FRP tanks and piping, 316 stainless steel agitators	2

TABLE 3-1 Cont

Process Equipment
2000 TPD Uranium Heap Leaching
Tuba City, Arizona, Tailings
Atlas Minerals

Equip No.	Description	Parameters	Approximate Size and Type	Materials of Construction	hp
19	Solution pump with sump	80 gpm, 0.83 specific gravity, 30' TDH	3" x 1-1/2" centrifugal	316 stainless steel pump and sump	3
20	Solvent pump	80 gpm, 0.83 specific gravity, 30' TDH	3" x 1-1/2" centrifugal	316 stainless steel	3
21	Solvent surge tank	5200-gallon capacity, 1-hour surge	10' diameter x 10'	FRP	-
22	Raffinate pump	240 gpm, 1.02 specific gravity, 50' TDH	4" x 3" centrifugal	316 stainless steel	10
23	Strip liquor pump	5 gpm, 1.07 specific gravity, 40' TDH	1-1/4" x 1" centrifugal	Cast iron	1
24	Product storage tank	32,000-gallon total storage, 4 days storage	11' diameter x 48' horizontal tank	Mild steel	-
25	Product pump	100 gpm, 1.07 specific gravity, 40' TDH	3" x 2" centrifugal	Cast iron	5
26	Pond pump for raffinates	470 gpm, 1.02 specific gravity 50' TDH	3-1/2" vertical centrifugal	Rubber covered	25
27	Solution pump	270 gpm, 1.02 specific gravity	4" x 3" centrifugal	316 stainless steel	15

TABLE 3-1 Cont

Process Equipment
2000 TPD Uranium Heap Leaching
Tuba City, Arizona, Tailings
Atlas Minerals

Equip. No.	Description	Parameters	Approximate Size and Type	Materials of Construction	hp
28	Sod ash storage bin with baghouse and fan	30-ton storage at 60 lb/ft^3, 10-day supply	10' diameter x 14' straight side, cone bottom, 65 ft^2 bag area	Mild steel bin and baghouse	1
29	Soda ash feeder	1800 lb/hr at 60 lb/ft^3	4" diameter screw, 14' long, variable speed	Mild steel	1/2
30	Soda ash makeup tank with agitator	10% solution, 1.1 specific gravity, 4600-gallon	10' diameter x 10' agitator	Mild steel tanks and agitators	3
31	Soda ash solution transfer pump	60 gpm, 1.1 specific gravity, 30' TDH	2-1/2" x 2" centrifugal	Cast iron	1-1/2
32	Soda ash storage tank, insulated and electrically heated	10% solution, 1.1 specific gravity, 7200-gallon	10' diameter x 14'	Mild steel	-
33	Soda ash solution feed pump	5 gpm, 1.1 specific gravity, 30' TDH	1-1/4" x 1" centrifugal	Cast iron	1
34	Fresh water tank	5200-gallon capacity	10' diameter x 10'	Mild steel	-
35	Water pump	350 gpm, 1.0 specific gravity, 50' TDH	4" x 3" centrifugal	Cast iron	15
36	Pond pump for water	350 gpm, 1.0 specific gravity, 50' TDH	3-1/2' vertical centrifugal	Rubber covered	20
	Total				343

CHAPTER 4

ENVIRONMENTAL IMPACT ASSESSMENT

CHAPTER 4

ENVIRONMENTAL IMPACT ASSESSMENT

4.1 EXISTING ENVIRONMENTAL IMPACTS

The radiological d.ta included in this section were obtained during surveys by the Southwestern Radiological Health Laboratory (now EPA-ORP/LV) in 1967,[1] by EPA in 1975,[2] by Oak Ridge National Laboratory and FB&DU for DOE in 1976,[3,4] and by EG&G in 1977.[5] The health impacts are taken from the FB&DU Engineering Assessment of the Tuba City Site.[4]

4.1.1 Air Quality

Air quality in the vicinity of the site is affected both by airborne radioactive particulates and by radon gas. Both of these are somewhat elevated in the vicinity of the tailings as discussed below.

As the result of measurements in 1967,[1] it can be concluded that airborne radioactive contamination exceeds the concentration guides (set for individuals in the general population) both on the tailings pond and in a downwind direction. Radium-226 concentrations were about 6 times the most restrictive guideline of 1 pCi/m^3 1200 feet downwind from the tailings pond. However, during the same time period the concentration in the housing area was 0.02 pCi/m^3 or 1/50 of the most restrictive guideline value. Assuming the same relative concentrations of other radionuclides in the downwind air as are found in the tailings pile it is unlikely that the concentration guides for thorium-230, natural uranium, lead-210, and polonium-210 will be exceeded except directly on the pile and directly downwind from the pile as with the radium 226.[1]

Radon has been monitored at several different times.[1,4] Results indicate that during strong winds the radon is quickly dispersed and levels are unlikely to exceed the concentration guide of 3.0 pCi/l except at locations on the pile and directly downwind and then only slightly. During calmer periods, levels were seen to rise above background reaching values of 2.1 pCi/l 0.13 mi from the site. On top of the pile values reached as high as 70 pCi/l, but averaged 21.5 pCi/l during a 24 hour period. A 24-hr radon measurement at the housing area south of the highway averaged 1.3 pCi/l or about twice the background level measured in Tuba City.

4.1.2 Ambient Radiation

The highest gamma radiation rates on the original millsite were measured on the westernmost tailings pile where the rates ranged up to 2.6 mR/hr.[3,4] The other two tailings piles have major areas above 1 mR/hr. The measurements are shown in Figure 4-1.

The westernmost evaporation pond also has the highest gamma radiation rates of the three evaporation ponds with a maximum rate of 1.3 mR/hr. The middle pond has slightly elevated gamma radiation rates but these are largely due to shine from the nearby tailings piles. The large evaporation pond at the southeastern corner of the site has an area with gamma rates up to 0.8 mR/hr.

Outside the site, there are windblown tailings in a northeasterly direction for a distance of nearly 1.9 mi (3 km) as determined by an aerial survey.[5] The background gamma radiation rates were determined to be 7 to 9 μR/hr at 1 m above the surface. The aerial survey results also indicated slightly elevated gamma radiation (9-11 μR/hr) extending south of the site and small areas of higher readings (13-15 μR/hr) in Moenkopi Wash directly south of the site.

Two gamma radiation measurements in the housing area south of the highway in 1967 were 30 μR/hr at the west end and 40 μR/hr at the east end.[1] Background radiation rate was given as 20 μR/hr, therefore the gamma radiation was 1.5 to 2 times the natural background rate. The 1975 EPA gamma radiation survey showed most of the housing area in th natural background range with only the southeastern corner above the natural background range. This is consistent with measurements at the time of the DOE assessment.[3] The EG&G aerial survey showed 18 μR/hr at the eastern end of the housing area and 35-40 μR/hr in the center of the area. In summary, the measurements indicate that gamma radiation in the housing area south of the highway averages about twice the natural background rate.

4.1.3 Soils

The large area to the northeast of the site with elevated gamma radiation is the result of windblown tailings. Soil analyses have been performed which indicate the magnitude and depth of contamination.(3-5) The aerial survey results(5) also were analyzed in terms of ^{226}Ra concentration and the plots show contamination extending nearly 2 mi (3 km) to the northeast and 0.7 mi to the south of the site. Contamination to the south could be the result of wind or water erosion from precipitation. The ^{226}Ra contamination level was about 10 times the natural background in a surface sample taken about 300 ft south of the evaporation ponds.(5) The highest ^{226}Ra concentration in Moenkopi Wash is calculated to be up to 3.3 pCi/g of soil from aerial survey data or about 5 times the natural background concentration.(5)

Soil contamination beneath the tailings piles averages 2 to 3 ft to the depth where ^{226}Ra contamination is twice natural background levels.(4) Portions of the evaporation ponds show contamination to a maximum depth of 4.5 ft, resulting in approximately 80,000 yd^3 of contaminated soil. Some of this contamination is the result of windblown tailings.

4.1.4 Water Quality

Two shallow wells south and southeast of the site and two samples from Moenkopi Wash were checked in 1967 by the U.S. Public Health Service for radioactive contamination, and results of this sampling showed natural background levels of radioactivity.[1] Gamma measurements in drill holes through the tailings and in the evaporation pond areas indicated that contamination does not extend below 5 feet and the ground water level is about 38 ft below the surface of the evaporation pond area.

During the engineering assessment, two surface water samples were taken from Moenkopi Wash. One sample taken from the groundwater discharge area for the syncline (see Figure 2-4) contained 1.24 pCi/l of ^{226}Ra. A downstream sample was shown to contain 0.37 pCi/l of ^{226}Ra. A sample taken from a spring about 1 mi east of the tailings had a ^{226}Ra concentration of 0.46 pCi/l. Another sample obtained from a well 2 mi northeast of the tailings contained 1.09 pCi/l of ^{226}Ra.[3] This sample also contained selenium eight times higher than specified in the EPA Drinking Water Regulations. The well should not be influenced by the tailings because it is located on the other side (east) of the syncline that runs east of the tailings site. The upstream sample from Moenkopi Wash also contained a high selenium content (18 times the specified limit). The high selenium content found in the well water sample indicates a natural condition, which is a common occurrence on the Colorado Plateau where high alkalinity and selenium occur together, but is not attributable to the presence of the tailings.

Because groundwater movement is relatively slow and radionuclides move even more slowly, it is not yet possible to determine if contamination is occurring by sampling these distant wells.

Under this program wells would be installed around the site for monitoring purposes.

4.1.5 Radiological Health

Health impacts of the present site conditions were calculated as part of the engineering assessment.[4] The primary health impact is from inhalation of radon daughters resulting from decay of radon emanating from the tailings. The method of calculating the potential health effects from radon inhalation (lung cancer) is described in reference 6. Basically two risk estimators are used in calculating the health impact.

For radon daughter inhalation the risk estimator, derived from data in the BEIR report,[7] is:

180 health effects per year for 10^6 person-WLM* annual exposure.

Gamma radiation exposure can lead to leukemia. The risk estimator for gamma exposure[7] is:

100 health effects per year for 10^6 person-rem continuous exposure.

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*WLM - working level month, a unit of radon daughter cumulative exposure.

For the purposes of health impact calculations, it is assumed that the radon concentration in the housing area is the same both indoors and outdoors but that inside structures, the radon daughter concentration reaches 50% equilibrium, therefore, 1 pCi/l of ^{222}Rn is equivalent to 0.005 WL.

The exposure rate in terms of WLM/yr is obtained from a continuous concentration of 0.005 WL (equivalent to 1 pCi/l of ^{222}Rn for 8766 hr/yr and 170 working hr/mo). This concentration results in an exposure of 0.25 WLM/yr, which can be used as a conversion factor for other concentrations.

Based upon a radon concentration of 0.6 pCi/l above natural background concentration, the number of health effects were calculated for the estimated present and projected population within 0.5 mi from the tailings. The results are shown in Table 4-1 from the engineering assessment.(4) Also shown in that table are the estimated number of background health effects (lung cancers) in the same population.(8) The calculated health effect risk is about equal to the normal lung cancer risk for all causes.

For comparison purposes, the health effects from gamma radiation exposure also were calculated. Using a natural background gamma radiation value of 10 μR/hr, the average of twice background in the housing area is 20 μR/hr or 10 μR/hr above background. If the same population of 70 people were all living in the housing area south of the highway, continuous exposure to 10 μR/hr of gamma radiation would result in 0.0006 potential health effects per year or about one third of the potential impact of radon daughter inhalation.

4.1.6 Socioeconomic

The presence of tailings at the site has a minor socioeconomic impact on the area. The former mill housing area would be more desirable if the radiation were reduced to background levels in that area and the source of windblown tailings was eliminated. There is no impact upon employment.

4.1.7 Land Use

The land at the site has no special economic value or use. It is remote from Tuba City and other similar land is readily available for development closer to Tuba City.

4.1.8 Mineral Resources

Under present conditions there is no impact on use of mineral resources. However, the unrecovered uranium in the tailings is a mineral resource that is not being utilized. It is a mineral resource that could be recovered and at the same time result in an improvement in the environmental conditions of the present site.

4.1.9 Ecology

The previous mill operations disturbed the vegetation and wildlife at the site, and thus only minimal vegetation and wildlife have reestablished themselves on these disturbed areas since mill operations ceased. The tailings areas are devoid of vegetation which has allowed wind erosion to take place.

4.2 ENVIRONMENTAL IMPACTS DURING OPERATIONS

4.2.1 Air Quality

Air quality during operations should not be greatly affected. Air particulates and radon concentration may be increased slightly during preparation of the leaching area and subsequent tailings transfers. Such increases will be minimized by limiting the working area of tailings excavation, by the presence of moisture in the tailings beneath the surface, by water spraying as necessary, and by curtailing excavation operations during windstorms. Air particulate monitoring will be conducted during operations to ensure that radioactive particulate concentrations in the housing area do not exceed guidelines.

The acid used in the process has an extremely low vapor pressure and will not be a problem. There will be a soda ash storage bin, with a 65 ft^2 baghouse dust collector. These filters have a 99.8% efficiency and should, therefore, essentially eliminate particulate emissions from this source. There will be an increase in exhaust emissions during operations at the site. Any air quality degradation during operations will be of short-term duration and no long-term adverse impacts will result.

4.2.2 Ambient Radiation

Overall gamma radiation levels on the site will not change significantly during processing operations. Since the tailings are not covered, excavation will cause no increase in gamma radiation. Gamma radiation levels will increase in the leach pit area (present evaporation ponds) as tailings are placed in the pits, but gamma radiation will be reduced when the leaching water covers the tailings. Gamma radiation will be reduced in the tailings area as tailings are removed to the leach pits. A slight reduction in gamma radiation is expected at the housing area as the tailings are moved farther away to the leach pits.

4.2.3 Soils

In view of the fact that most of the area involved in the project has been previously disturbed, there will be little effect on natural soils. In the area where the process equipment will be situated some soil will be disturbed. In reclaiming the area, contaminated soil beneath the present tailings will be removed.

4.2.4 Water Use and Quality Impacts

The ground water beneath the site will be tapped to provide the water required for the processing operations. Approximately 50 million gallons of water will be used during the two-year operation. This water will be supplied by a well drilled on the lease. Pumping tests[9,10] run on nearby wells indicate that there will be sufficient recharge to supply the needed water.

The supply for the houses will continue to be drawn from the old Rare Metals wells and should not be affected by the use of water on the site. Ground water levels at the site may be lowered slightly during operations. In 10 years of use during previous milling operations the water level in the Rare Metals well #2 was lowered 29 feet. The plant was decommissioned in 1966, and the water returned to prepumping levels by 1977. Water usage at the mill averaged 60 million gallons per year as compared with an expected 25 million gallons per year for this project. Therefore, no long-term effects on ground water levels are expected from the 2 yrs of use during tailings processing.

Since the leaching process will occur in pits lined with 20 mil PVC sheet, which has permeability in the 10^{-12} range, there should be no effect on ground water quality during operations. A drying out period will occur before the tailings are covered and sumps at each leach pit ean be pumped as liquid accumulates. After covering the tailings with soil, leaching to the ground water will be prevented by the upward soil moisture gradient characteristic in this region. This gradient is caused by a large moisture deficiency in the soil and a high rate of evaporation.

4.2.5 Radiological Health

During the initial period of processing operations there will be negligible changes in the present health impact to the off-site population. As processing proceeds, radiation levels and radon from the tailings will gradually decrease thereby decreasing the health impact to the off-site population.

Workers on site will experience gamma radiation exposure during excavation of the tailings. An approximation for calculating worker exposure developed at FB&DU is the following:

$$D_r = 0.92\ C_{ra}$$

where

D_r = exposure rate in μR/hr

C_{ra} = radium concentration in pCi/g

The ^{226}Ra concentration in the tailings from AEC records is 670 Ci in 800,000 tons or an average of 920 pCi/g. A worker could receive an annual dose up to 1.7 rem, which is less than the limit of 5 rem established for workers in the nuclear industry.

Approved respirators will be required for workers engaged in excavation of the tailings to reduce inhalation of dust and radon daughters.

4.2.6 Socioeconomic

The largest effects on the socioeconomic conditions will be the creation of some 30-35 jobs, with approximately 15 of these requiring skilled labor, and the payment of royalties to the Navajo Tribe for the recovered uranium. The people to fill these jobs will be selected in accordance with the Navajo Preference Clause. These factors will create an economic benefit to the Navajo community. Equipment induced noise in the housing area will be a short-term impact only and of only minor consequence when compared with the noise from automobile and truck traffic on the highway running directly through the housing area.

4.2.7 Land Use

Since the site is presently abandoned, reprocessing the tailings at the site will result in a productive use of presently unused land. A small portion of the site will be used for processing equipment but all such equipment will be removed at the completion of operations. Soil stockpiles will also occupy a portion of the site but both of these uses have only short-term impacts on land use. The present evaporation ponds are not usable land at present and this area will be used for leach pits. After operations have been completed, a stabilization cover of soil and rock will be placed over the leach pits.

4.2.8 Mineral Resources

The major effect on mineral resources will be the recovery of the uranium from the wastes of a previously processed mineral ore. Approximately 50 million gallons of water will be used in the process of reclaiming this wasted resource. Fuel, chemical and other raw materials will also be consumed during the project as indicated in Section 4.5.3.

4.2.9 Ecological

Since much of the area has been previously disturbed, the ecological impacts should be minimal. Some flora and fauna will be disturbed during the process operations, but similar habitat is available adjacent to the site. Effects on the regional overview will be undetectable.

4.2.10 Accidents

4.2.10.1 Process

Following is a review of potential process plant accidents during operations.

a) Acid Pugging System

Except for sulfuric acid solution addition, this process is a non-fluid operation. However, the potential does exist for a pipeline or pump leak during acid transfer operations.

b) Heap Leach Solutions

Pipe line and pump leaks are possible during leach solution tranfers.

c) Solvent Extraction

Pipe line, pump and tank leaks are a potential source of accidental spills.

d) Copper Cementation Tanks

The possibility exists for a tank leak.

e) Sulfuric Acid Storage Tanks and Pumps

Pipeline, pump and tank leaks could possibly result in an acid spill.

4.2.10.2 Heap Leach Pits

There are two potential sources of accidental releases related to the heap leach pits. The first possibility is a dike failure and the second is failure to the PVC liner.

4.2.10.3 Transportation

Accidents involving transportation of both uranium and copper are a possibility. The statistical potential for such accidents is indicated below. Total Interstate Commerce Commission (ICC) regulated motor carrier freight traffic in the United States for 1976 was 490 billion tons.(11) The corresponding accident statistics were 25,666 accidents involving all material shipped with 2,520 associated fatalities and 1,427 accidents involving shipment of hazardous materials(12) for an accident and fatality frequency of 5.24×10^{-8} accidents per ton-mile involving all materials shipped, 5.14×10^{-9} fatalities per ton-mile and 2.91×19^{-9} accidents per ton-mile involving shipment of hazardous materials. Based on these statistics, the range of probabilities for similar incidents in transporting the Tuba City products are 0.09 accidents involving all materials shipped, 0.008 fatalities involving all materials shipped, and 0.005 accidents involving shipment of hazardous materials.

4.3 ENVIRONMENTAL IMPACTS AFTER OPERATIONS

4.3.1 Air Quality

The air quality in the vicinity of the site should be greatly improved after reclamation. Radioactive particulates from the reprocessed tailings would be eliminated since they would be under five and one half feet of cover material. Since one of the major problems created by the tailings at the present time is the spread of contamination by airborne radioactive particulates, the reclamation plan would be an important factor in eliminating airborne particulates and spread of contamination by the processed tailings. Non-radioactive particulates should also be reduced considerably after the gravel is placed on the surface of the cover material.

The radon released by the tailings will also be reduced considerably after reclamation. Radon emanation should be reduced by a factor of approximately 10. While the emanation would still be higher than background emanation rates, the radon in the housing area from the tailings pile is calculated to be 0.15 pCi/l well below the guideline limit of 3 pCi/l.

4.3.2 Ambient Radiation

After the processed tailings are stabilized with 5-1/2 ft of cover material, gamma radiation from the tailings will be reduced to background values. Removal of contaminated subsoil from the present tailings area also will reduce the gamma radiation essentially to background values at that location. At the housing area, the gamma radiation rate presently due to shine from the tailings piles will be eliminated.

4.3.3 Soils

After reclamation, no contaminated soil will remain exposed on the surface in the previous tailings area or in the leach pit area. Uncontaminated soil from the evaporation ponds will be used for cover material. Once plant life begins re-establishing itself on the cover material, soils will be formed. This will be an improvement over present conditions since plant life would not reestablish itself to normal levels on the tailings piles in their present condition.

4.3.4 Water Use and Quality Impacts

Once the operations are completed there would be no further tapping of the aquifers. The ground water level at the site then would return to the pre-operational level, as the water level in the Rare Metal Well #2 has.

The tailings will be allowed to dry before they are covered. This, combined with the upward soil moisture gradient, will reduce any adverse impacts on the ground water. The depth of radioactive contamination under the present unlined tailings area and evaporation ponds averaged 2 to 3 ft with a maximum of 5 ft. The present ground water level would be about

25 ft beneath the leach pits. Three monitoring wells will be installed east and southeast of the site to monitor water quality during operations, provided that the necessary drilling authorization is obtained. Once the operations are completed these wells will be available to the Navajo Tribe for further monitoring.

4.3.5 Radiological Health

After reclamation of the site gamma radiation from the processed tailings will be reduced to background levels by the stabilization cover. Therefore, there will be no health impact due to gamma radiation from the processed tailings to off-site population.

The stabilization cover will reduce radon emanation to about 25% of the present level. This will also reduce the radon concentration at the housing area from the tailings pile by a factor of 4 to 0.15 pCi/l.

If a population of 70 people reside in the housing area, the potential lung cancer risk is 0.0005 health effects per year compared to 0.0022 health effects per year from background radon concentration. Lung cancer risk from all causes would lead to 0.007 health effects per year. Thus, the potential risk of lung cancer from the stabilized tailings is about 7% of the normal lung cancer risk for members of the Navajo Tribe.

4.3.6 Socioeconomic

Following reclamation, a long-term benefit would be derived from elimination of the health impact of the processed tailings on the nearby population. There also will be an improvement in the appearance of the site, thereby increasing the desirability of the housing area. As indicated previously, an economic benefit will accrue to t e Navajo Tribe from royalities paid by Atlas Minerals.

4.3.7 Land Use

Once this area is reclaimed, possibilities for land use in the area should be increased over present levels. With the natural soils being used as a cover, vegetation should return over a much more extensive area than at present, since conditions on the presently exposed tailings are not conductive to plant growth. Therefore, the area should be more productive for grazing purposes.

Also with the elimination of the present unsightly tailings piles and the concurrent improvement of air quality, the major adverse impacts of the tailings would be removed and the surrounding area would become more acceptable. While the stabilized tailings area will revert to more natural conditions with the passage of time, building should not be permitted on the area because of the possibility of elevated radon daughter concentrations in structures over tailings. The present housing area would be more desirable once the reclamation program is completed.

4.3.8 Mineral Resources

Once reclamation is completed there will be no further impact on any mineral resources.

4.3.9 Ecological

Since the material taken from the site will be used to cover the tailings, eventually the natural flora and fauna will be able to re-establish thenselves on the site. There will be a long-term beneficial impact since the disturbed flora and fauna could never be re-established on the present tailings piles.

4.4 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

4.4.1 Air Quality

Operations will cause a short-term decrease in air quality in the vicinity. There will be a slight increase in particulates, radon concentration, and exhaust emissions. All of these effects are short-term and no long-term adverse effects due to this operation will result.

4.4.2 Land Use

There should be no adverse impacts due to this operation since present land use is already severely limited due to the presence of the tailings.

4.4.3 Water Use and Quality

While some water will be permanently withdrawn from the aquifer, this will not have a long-term effect on water levels in the vicinity. Since leaching will take place on a PVC liner, there should be no adverse impacts on water quality.

4.4.4 Mineral and Raw Material Resources

Approximately 50 million gallons of water, 338,000 gallons of fuel oil, 532 tons of soda ash, 1075 tons of iron filings and 1.6 million gallons of sulfuric acid will be consumed during operations. Also 38,000 gallons of kerosene and amine will go through the system; however, these will be reclaimed for further use by the Moab mill. No other mineral or raw material resources should be affected.

4.4.5 Soils

The soils excavated from the evaporation ponds will be replaced during reclamation. The only area where soils will be disturbed is where the plant area will be located. This is a small area on which vegetation will re-establish itself. Therefore, no long term adverse effects are expected.

4.4.6 Ecological

While some natural flora and fauna will be disturbed during operations, they will re-establish themselves on the site after reclamation to better than present levels. Therefore, there will be very minor short-term adverse effects on the ecology and no long-term adverse effects.

4.4.7 Radiological

There may be a slight increase in ambient radiation during initial operations. However, as operations continue and reclamation preoceeds, the ambient radiation will be decreased. Therefore, there will be no long-term adverse effects in this area.

4.4.8 Socioeconomic

There may be a slight disturbance to residents of the housing area during operations. This effect will be a short-term condition only during the actual operations and long-term socioeconomic effects will be beneficial.

4.5 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

4.5.1 Land and Minerals

4.5.1.1 Land

Land which will be used for leach operations will be reclaimed and available for grazing after vegetation is re-established.

4.5.1.2 Mineral

The uranium and copper which will be recovered during operations may be considered as irreversible and irretrievable. However, portions of the extracted uranium can be recycled if the appropriate technologies are implemented.

4.5.2 Water and Air

4.5.2.1 Water

Approximately 50 million gallons of water will be used during the two-year operating period. Because of the large volume of water available in the regional aquifer system, the amount used for operations is not considered irreversible and irretrievable.

4.5.2.2 Air

No irreversible or irretrievable commitments of air resources are expected.

4.5.3 Raw Materials

Major raw material resources which will be used during operations include 338,000 gallons of fuel oil, 532 tons of soda ash, 1075 tons of iron filings and 1.6 million gallons of sulfuric acid. These resources will be consumptively used and are therefore considered irreversible and irretrievable commitments.

4.6 MONITORING PROGRAMS AND MITIGATING MEASURES

4.6.1 Air Quality

Air particulate sampling will be initiated as soon as electric power is available at the site for project operations.

Air samplers will be installed at the northern boundary of the lease near the housing area, at the southwest corner or the leach pit area, and in Tuba City as a control or background monitor. Samples will be analyzed for natural uranium, thorium-230, radium-226, and lead-210 until proper correlations are established between particulate and radionuclide concentrations.

The sampler near the housing area will indicate if excessive levels of radioactive particulate concentrations are present in the housing area. The sampler at the southwest corner of the leach pit area will be less affected by particulates from the bare tailings and will provide an indication of particulate concentrations in the leach pit area. No sampler is specified for the eastern boundary of the site because it would not be possible to separate particulate concentrations from excavation operations and those from the bare tailings due to resuspension by wind erosion. Erosion of the bare tailings cannot be controlled until all tailings are moved into the leach pits.

Increases in air particulate concentrations during excavation of the tailings will be limited by keeping the working area to a minimum, by natural moisture in the tailings, beneath the surface, and by curtailing excavation operation during wind storms. Workers performing tailings and leach pit excavation will be required to wear approved masks to prevent radioactive particulate inhalation.

4.6.2 Water Quality

Three monitoring wells will be drilled east and south of the site soon after project initiation. One well will be drilled east of the tailings, one east of the evaporation ponds and one south of the evaporation ponds assuming permission to drill the wells is granted. The wells will be located about 100 ft outside the site so the changes in radionuclide concentration may be detected relatively quickly. Water samples will be collected quarterly and will be analyzed for natural uranium, thorium-230 and radium-226. A sample will be collected from Rare Metals Well #2 at the same time and analyzed in the same manner as the other well water samples.

Groundwater contamination will be avoided by the use of a PVC liner in the leach pits and periodic pumping of the sump in each pit to remove the maximum amount of leaching liquid after leaching operations are completed.

4.6.3 Radiological Monitoring

Previous gamma radiation surveys have determined the gamma rates on the tailings pile and in the evaporation pond area. The radiation monitoring program is designed primarily to measure gamma exposure to workers on the site. Each worker will be issued a personnel radiation exposure badge to ensure that individual exposures do not exceed exposure limits for workers. Because gamma radiation is about twice the natural background level in the housing area from tailings pile shine and from windblown contamination, no mitigation measures can be taken as part of the processing operation to reduce this radiation. Therefore, no gamma radiation monitoring program in the housing area is proposed during operations. Excavation will not increase gamma radiation in the housing area but as the tailings are moved the gamma radiation from the tailings will decrease at the housing area.

At the conclusion of operations a gamma radiation survey of the processing areas will be performed to confirm that stabilization has reduced gamma radiation to background levels and that contamination beneath the present tailings area has been satisfactorily removed.

4.6.4 Accidents

4.6.4.1 Process

The following is a review of those mitigating measures which may be employed in the event of a process plant accident.

a) Acid Pugging System

If a leak or spill of sulfuric acid should develop, the acid feed pump will be immediately shut down by the operator in attendance. Hydrated lime will be spread over the area for neutralizing the acid. The area will then be cleaned up and the contaminated soil fed to the heap leach pits.

b) Heap Leach Solutions

If a line break should occur when transferring solution from the leach pits to the solution holding ponds, the same lime neutralization procedure will be followed as described above.

c) Solvent Extraction

The SX installation will be located on a curbed cement pad. Any spills will collect in a sump within the curbed area and the solutions pumped back to the SX system.

d) Copper Cementation Tanks

The precipitation tanks and cement product drying pad will be curbed with a collection sump as described in (c) above.

e) Sulfuric Acid Storage Tanks

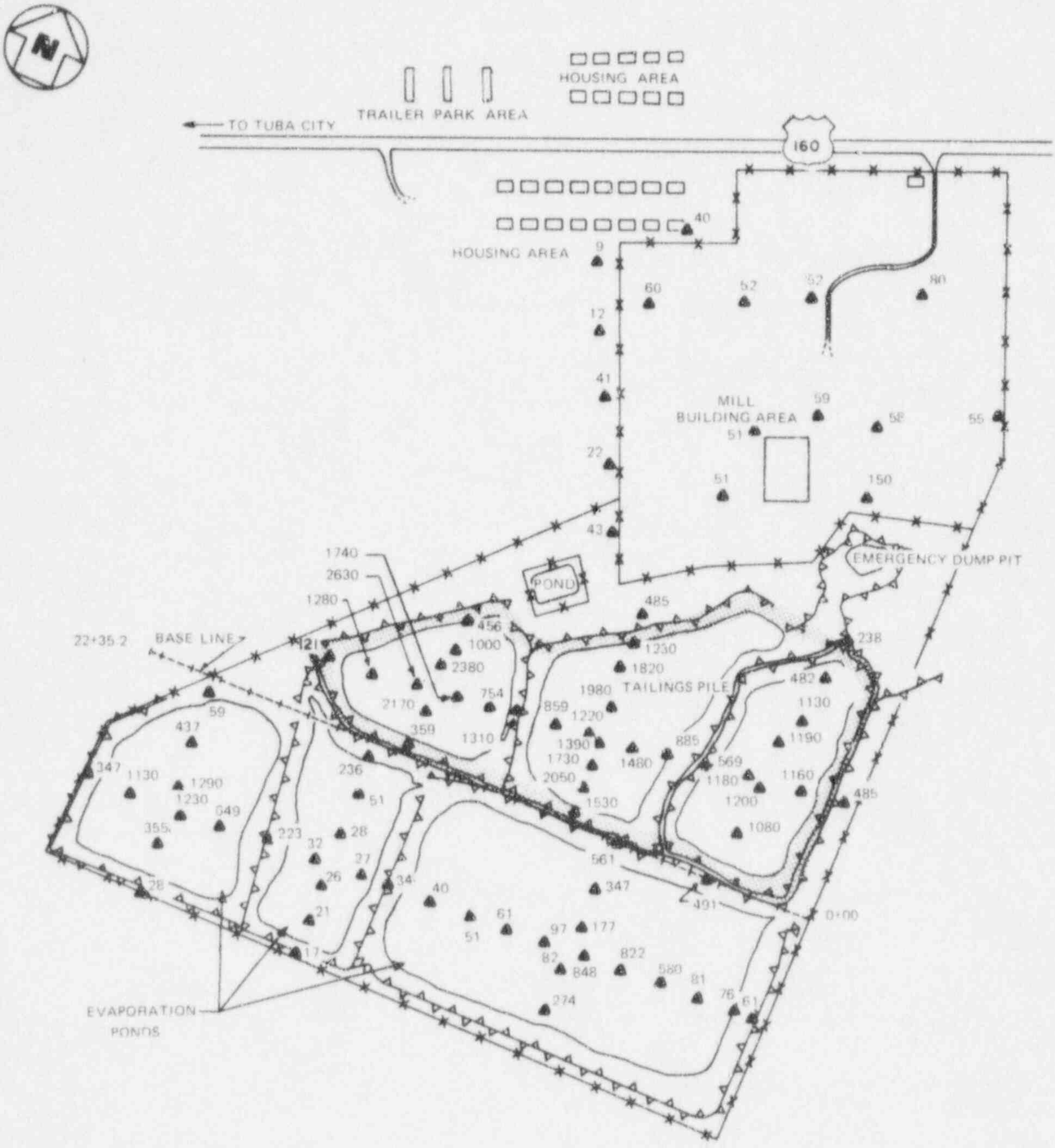
These six tanks will be installed on concrete support foundations. A bed of limestone rock will be placed on the surface under all storage tanks. Any acid spills will be neutralized by the limestone, thus preventing acid contamination of the soil.

4.6.4.2 Heap Leach Pits

A weekly inspection program will be instituted to monitor the heap leach pits and retaining dikes. Each inspection will be recorded in an inspection log book. In the event of a major failure, the Navajo Environmental Protection Commission will be notified immediately and a course of action will be decided upon jointly with Atlas Corporation.

4.6.4.3 Transportation

In an effort to minimize the potential for a transportation accident, standard trucking industry practices such as proper operator training and vehicle maintenance will be employed. In the event of a transportation accident, a quick response clean up team would be dispatched to the scene. The team would be equipped and trained to handle all aspects of clean up and decontamination operations related to a transportation accident.



NOTES

1. NUMBERS SHOWN ARE GAMMA LEVELS IN μR/hr (1)
2. MAP DEVELOPED FROM AERIAL PHOTOGRAPH

LEGEND

EDGE OF TAILINGS

0 200 400 600FT

FIGURE 4-1. GAMMA LEVELS 3 FT ABOVE GROUND

TABLE 4-1

ESTIMATED HEALTH IMPACT FROM TUBA CITY TAILINGS
FOR AN AREA 0-0.5 MILE FROM TAILINGS EDGE

Time Period	Population (Persons)	Total Pile-Induced RDC Health Effects/yr	Background RDC Health Effects/yr
1975	70	0.0018	0.0022
2000 (4% growth rate[a])	148	0.0037	0.0046
2000 (6.4% growth rate[a])	230	0.0058	0.0071
25-yr Cumulative Effect		Pile Induced RDC	
Static population		0.05	0.06
4% growth rate[a]		0.07	0.09
6.4% growth rate[a]		0.09	0.11

[a]The growth rate decreases linearly with time

CHAPTER 4 REFERENCES

1. R. N. Snelling and S. D. Shearer, Jr.; "Environmental Survey of Uranium Mill Tailings Pile, Tuba City, Arizona"; Radiological Health and Data Reports; Nov 1969.

2. R. L. Douglas and J. M. Hans, Jr.; "Gamma Radiation Surveys at Inactive Uranium Mill Sites"; EPA Tecnical Note ORD-LV-75-5, Aug 1975.

3. F. F. Haywood, et al; "Assessment of Radiological Impact of the Inactive Mill Tailings Pile at Tuba City, Arizona"; ORNL-TM-5583.

4. "Phase II-Title I Engineering Assessment of Inactive Uranium Mill Tailings, Tuba City Site, Tuba City, Arizona"; GJT-5, Ford, Bacon & Davis Utah Inc.; Salt Lake City, Utah; Mar 1977.

5. "An Aerial Radiological Survey of the Area Surrounding the Tuba City Uranium Mill Site, Tuba City, Arizona"; EGG-1183-1732, EG&G Energy Measurements Group; Las Vegas, Nev; Sep 1978.

6. GJT-22, Health Effects Calculation FB&DU.

7. BIER Report, "The Effects of Population of Exposure to Low-Levels of Ionizing Radiation"; Report of Advisory Committee on Biological Effects of Ionizing Radiation; NAS, National Research Council; Nov 1972.

8. H. Siegle; Indian Health Service; Private Communication, Oct 1976.

9. "Geohydrologic Data in the Navajo and Hopi Indian Reservations, Arizona, New Mexico and Utah, Part I and Part II", Arizona State Land Department; Water Resources Report #12-A-B; Apr-May 1963.

10. Well Records for Rare Metals Wells 1-4; USGS Water Resources Division, Flagstaff, Arizona.

11. Yearbook of Railroad Facts - 1976; Association of American Railroads.

12. 1976 Accidents of Motor Carriers of Property, U.S. Department of Transportation, Federal Highway Administration, Bureau of Motor Carrier Safety.

CHAPTER 5

ALTERNATIVES

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ALTERNATIVES

5.1 ALTERNATIVE PROCESS SITES

The use of any alternative sites for process and leaching operations would significantly reduce environmental impacts at the present site. However, additional new environmental impacts would be created at a new site, transportation accident risk would increase, and the cost of obtaining a new site and transporting the tailings would be prohibitive.

5.2 ALTERNATIVE PROCESS OPERATIONS

5.2.1 No Operations

Under this alternative no action would be taken to process the Tuba City tailings.

5.2.2 Reprocessing at an Existing Mill

This alternative considers removal of the tailings to an existing conventional mill for reprocessing.

5.2.3 Reprocessing at a New On-Site Mill

The third alternative is to build a new conventional mill on-site to reprocess the tailings.

5.3 EVALUATION OF ALTERNATIVE PROCESS OPERATIONS

5.3.1 No Operations

Evaluation of the no operations alternative shows that little or no benefit would be derived from pursuing this course of action. All the negative environmental impacts presently associated with the site would continue to exist, no mitigating measures would be implemented and no social or economical benefit would accrue to any of the interested parties. Based on a preponderance of negative impacts, this alternative is not considered to be viable.

5.3.2 Reprocessing at an Existing Mill

The benefits associated with this alternative would be mainly associated with the removal of the present tailings to another site, therefore significantly reducing current and future environmental problems. Also some social and economic benefits could be realized by the local population during removal operations. However, of greater magnitude would be the negative aspects of such an alternative. The major problem is that of economics in that the transportation costs would far outweigh any gain derived from the recoverable resources. The other major negative impact is the accident potential, both in terms of a spill of contaminated material and injury or loss of life because of highway accidents associated with the movement of the large amount of material under consideration. In weighing both the positive and negative aspects of this alternative it has been determined that the transportation cost would be prohibitive and the accident potential would be unacceptable.

5.3.3 Reprocessing at a New On-Site Mill

While this alternative would result in approximately the same impacts and benefits as the proposed heap leach process, the attendant increased cost for decommissioning after operations cease make this an unacceptable alternative.