Environmental Report
For
Shootaring Canyon Uranium Processing Facility, Revision 1

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Environmental Report
Table of Contents

List of Figures

List of Tables

Appendixes

1. Introduction

The Shootaring Canyon Uranium Processing Facility (mill) is located in Garfield County in Southeastern Utah. It is about 21 km (13 miles) north of Bullfrog Basin Marina and 77 km (48 miles) south of Hanksville as shown in Figure 1.0-1 A small town, Ticaboo, is located 5.6 km (2.6 miles) south of the site. It is owned by Plateau Resources, Limited (PRL).

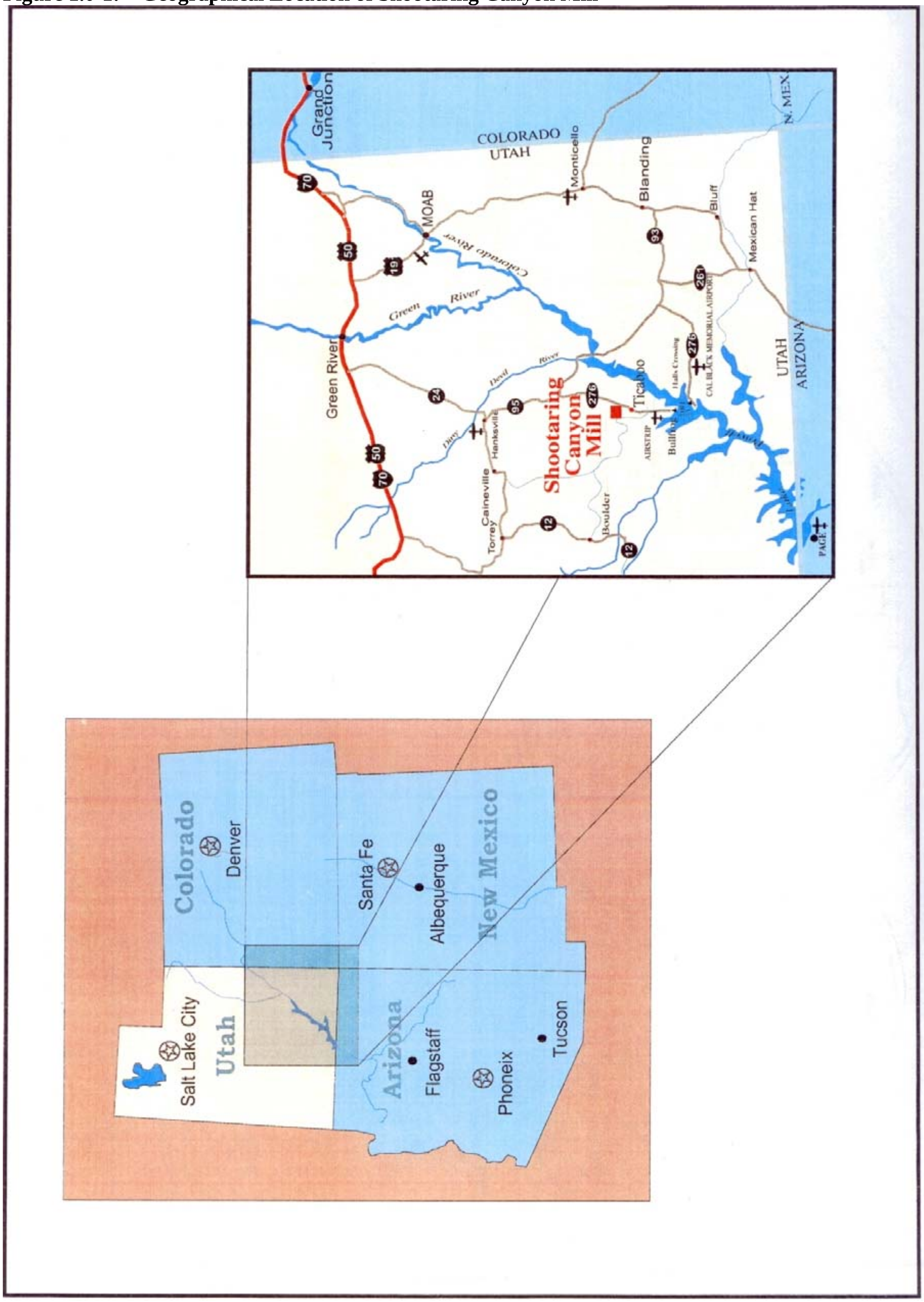
Plateau began start-up testing of the uranium processing facility on April 13, 1982, and continued this testing through May. The plant capacity and metallurgical performance were as expected. Plateau started commercial operations on June 1, 1982, but, due to the continued decline in the market for yellowcake, suspended operations at the facility on August 18, 1982. During the limited time the facility was in operation, 27,825 pounds of U_3O_8 or yellowcake were produced and sold.

The facility was placed on a standby basis. Cleanup operations were completed and solids were removed from all circuits except the calciner and product thickener. The doors to the calciner room were welded shut and doors to the 600 area were locked. Plans for decommissioning were prepared and approved by the U.S. Nuclear Regulatory Commission (NRC). Recently, some of the process components were sold in anticipation of decommissioning. One employee is currently employed at the facility to maintain equipment and conduct environmental and radiological monitoring. A Radiation Safety Officer (RSO) is also present on an as-needed basis

A recent market analysis by PRL indicates that a favorable uranium market is anticipated. PRL is planning to resume operations as soon as approval of the Renewal License Application is obtained from the Division of Radiation Control, Utah Department of Environmental Quality and the mill and associated equipment and facilities are fully restored and functional.

This environmental report(ER) supports the application to amend Radioactive Materials License (RML) No. UT 0900480 to allow the resumption of milling. Under the State of Utah's regulatory authority, source materials licensees are required to submit environmental reports (ER) for each new application, renewal, or major amendment describing the proposed action, a statement of its purposes, and the environment affected. The requirements are specified in Utah Administrative Code, Rule R-313-24 and 10 CFR Part 51, Section 51.60. For license amendments or renewals, regulatory agencies encourage licensees to provide a supplement to an ER and include by reference previously submitted information.

Figure 1.0-1: Geographical Location of Shootaring Canyon Mill



Rule R-313 requires that the ER present a discussion of a) an assessment of the radiological and non-radiological impacts to the public health from licensed activities, b) an assessment of any impact on waterways and groundwater resulting from licensed activities, c) consideration of alternatives to the licensed activities, d) consideration of the long-term impacts including decommissioning, decontamination, and reclamation impacts associated with licensed activities.

Several environmental reports have been prepared over the years to support activities at the site (Woodward-Clyde, 1978; NRC, 1979; Plateau, 1997). This environmental report uses some of the information included in prior reports.

2. Proposed Processing Activities

The facility is designed to process approximately 1000 tons of ore per day. The ore grade is estimated to average approximately 0.25 percent uranium oxide (U_3O_8). The plant is expected to have an overall recovery rate of approximately 94 percent. Based on these operating parameters, the plant is capable of producing approximately 1,720,000 pounds of yellow cake in a calendar year. A vanadium extraction circuit designed to produce ammonium metavanadate and 99.5 and/or 99.9 percent vanadium oxide (V_2O_5) will be added to the processing facility.

The ore is principally sandstone obtained from various regional mines. The ore is ground to sand sized particles and the uranium leached from the particles using a conventional acid leach process. Uranium is recovered with the decanted liquid in countercurrent decantation (CCD) tanks. Solids are discharged from the CCD system as waste material to the tailings facility located in a natural basin enclosed by a dam. The decanted, acidic liquid is pumped to leaching tanks, processed and passed to a solvent extraction (SX) system. Ammonia is added to the solution to precipitate the uranium as yellowcake. The yellowcake is then dried, packaged, and shipped offsite to a uranium hexafluoride conversion plant for the next phase of the fuel manufacturing process.

The depleted aqueous solution from uranium solvent extraction serves as the feed for future vanadium processing. Anhydrous ammonia and sodium chlorate are used to adjust solution pH and oxidize tetravalent vanadium to the pentavalent state, respectively. Solids are removed and the clarified solution is conveyed to an SX system in which vanadium is concentrated and purified. The solution will be treated in heated, sodium hexavanadate (red cake), precipitation tanks to which sulfuric acid and sodium chlorate will be added. The red cake will be further treated with sodium carbonate and sodium chlorate. The clarified solution will be combined with ammonium sulfate solution and ammonium hydroxide to precipitate ammonium hexavanadate. After several mechanical processes, the ammonium hexavanadate cake will be packaged as is or further processed into 99.5 or 99.9 percent V_2O_5.

Solids and filtrates from the vanadium extraction circuit containing low concentrations of uranium and vanadium will be delivered to the tailings facility.

Processed ore, or tailings, is the major waste generated. Permanent disposal of the tailings is achieved by storing the material in an engineered, lined cell that utilizes a natural depression, or basin, located adjacent to the plant site. The tailings liquid is separated prior to tailings placement and stored in a process water storage/evaporation pond. The process water is recycled back to the mill circuit, used for dust control in the tailings facility, or evaporated. The plant and its support facilities also produce lesser quantities of other liquid and solid wastes and effluents which are recycled in the various process operations, discharged with the tailings and liquids, or discharged to a septic system and sanitary waste leach field. Gaseous and particulate emissions from the facility are discharged from eight stacks. Three of the stacks are exhaust stacks from diesel powered generators used to produce electricity.

3. Mill Process and Equipment

This section presents a description of the Shootaring Canyon Uranium Processing Facility, the facility effluents, and their controls.

The general arrangement of the ore processing facilities is shown in the original architectural plan of the plant (Figure 3.0-1).

Arrangement of the various ore handling and processing systems was based on economy in construction and efficiency in operation. All process units except the countercurrent decantation (CCD) tanks and the clarifier are housed or covered. The plant support buildings and facilities, such as an office, maintenance and warehouse building, laboratory, power house, and storage tanks, are located around the perimeter of the process units to yield a compact, well-integrated complex. The building exteriors are colored in earth-tone shades to blend with the high cliff to the west, as seen from State Highway 276. A short stretch of that highway, about 2 miles northeast of the site, provides the only convenient public view of the plant (except from the air). From the highway, the only signs of activity at the plant are vehicular movements.

The stacks, one rising about 100 ft and several others about 80 to 90 ft above plant grade, do not appear in silhouette from the highway. The largest building in the complex is about 140 ft by 180 ft in plan dimensions, and about 60 ft high. Other smaller structures, associated with the ore handling, preparation and conveying systems, have maximum heights of 60 to 70 ft above the general level of the plant site.

3.1 Mill Process

General Summary

The processing facility is designed to process approximately 1,000 tons of ore per day. The average ore grade is estimated to be 0.25 percent uranium oxide (U_3O_8). The plant is expected to have an overall recovery rate of approximately 94 percent. Based on these operating parameters, the plant is capable of producing approximately 1,720,000 pounds of product in a calendar year.

A series of operations is required to extract uranium from the ore. The is principally sandstone. The uranium minerals are present in the ore as coatings on sand grains; they also fill intergranular spaces. The uranium minerals are soluble in strong sulfuric acid solutions and will leach from the ore by a conventional acid leach process. Figure 3.1-1 presents a simplified process flow diagram for the plant, illustrating the pathway of ore to tailings and product. Table 3.1-1 lists reagents used in the process.

Figure 3.0-1: Architectural Arrangement of Shootaring Ore Processing Facilities

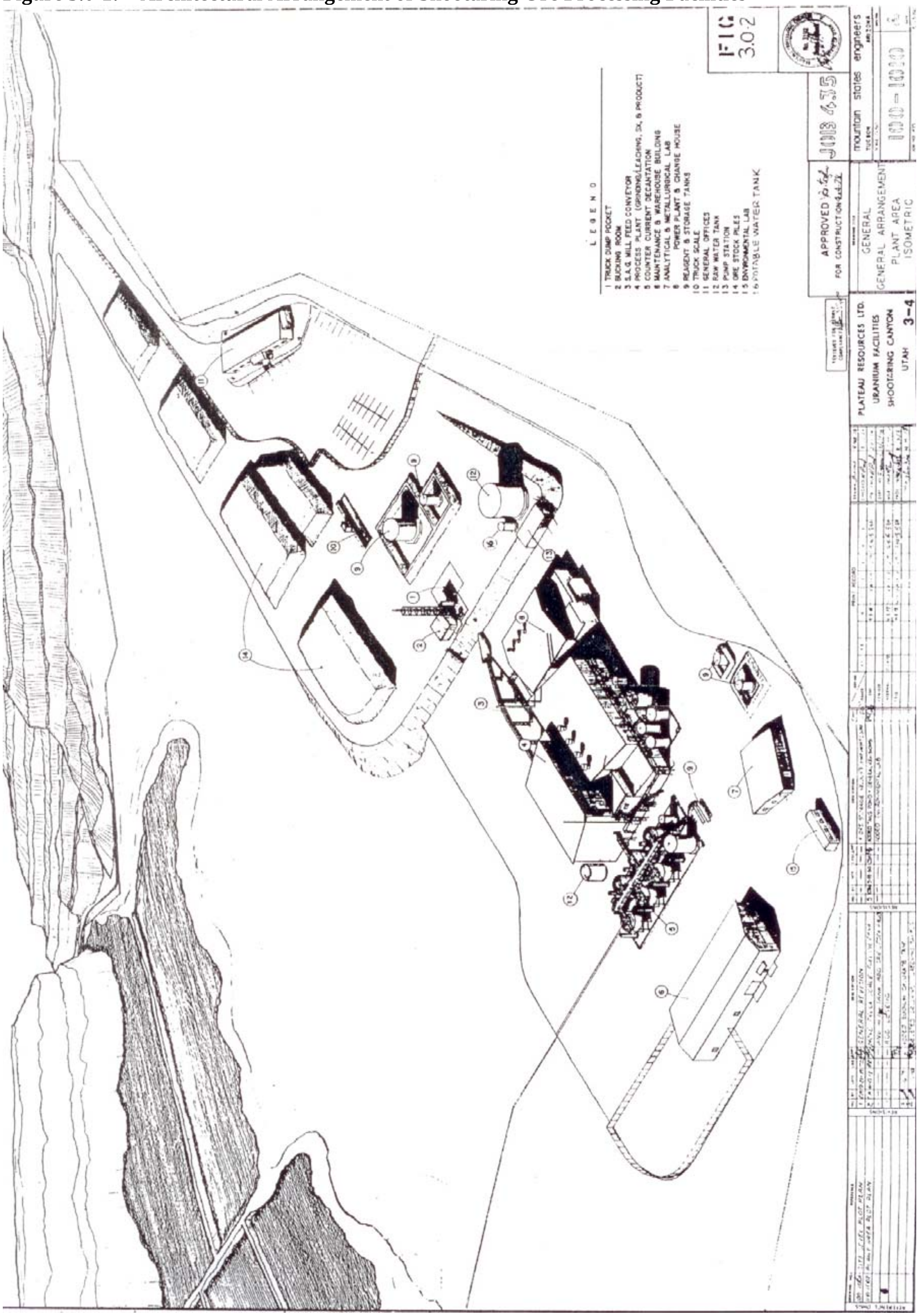


Figure 3.1-1: Flow Diagram for Process of Ore to Tailings and Product

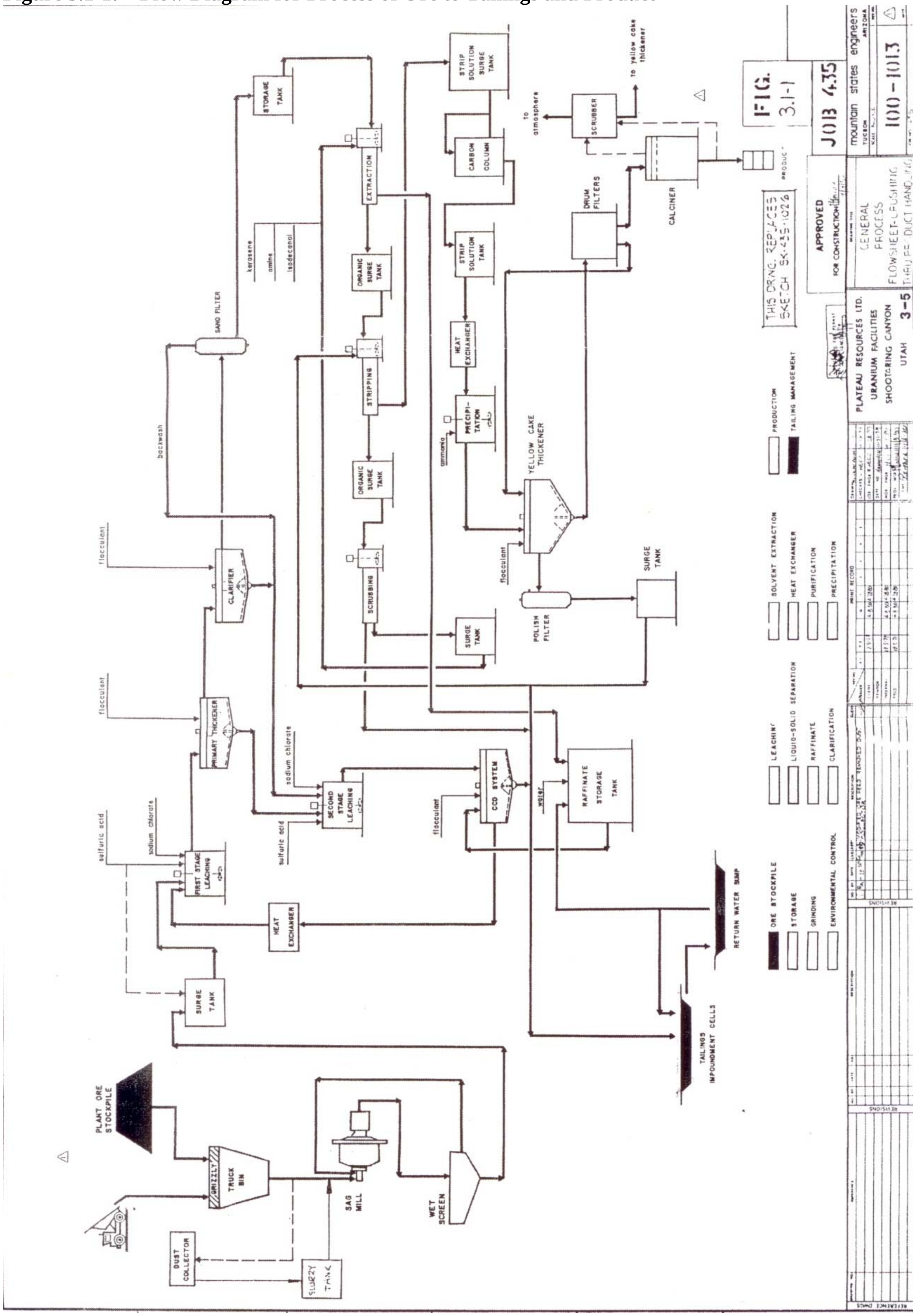


Table 3.1-1: Reagents used in the Milling Process

Reagents	Process
Sulfuric Acid	Leach
Sodium chlorate	Leach
Flocculant	Leach, CCD, Precipitation
Ammonia	SX, Precipitation
Tridecanol, Tertiary Amine, Kerosene	SX
Sodium bicarbonate	SX
Sodium hydroxide	Precipitation
Charcoal (carbon)	Precipitation

Notes:
CCD = countercurrent decantation
SX = solvent extraction

The ore is first ground to sand-size particles. This allows the acid to contact the grain surfaces during the leaching process. After grinding, the ore is delivered in slurry form directly to a two-stage, multiple-tank acid leaching system.

After leaching, the slurry is pumped to six (CCD) tanks where most of the soluble uranium is recovered with the decanted liquid. The CCD tanks are operated in series; solids pass through the tanks in one direction and the acid wash solution in the opposite direction. The solids are discharged from the CCD system as waste material to the tailings facility. The decanted, acidic liquid is pumped to the first-stage leaching tanks.

A thickener between the two leaching stages separates the uranium-bearing solution from the solids. The overflow liquid from the thickener passes through a clarifier and sand filters that remove suspended solids.

The separated solids from these two processes return to the leaching system. The filtered liquid is transferred to a solvent extraction (SX) liquid ion exchange system.

The uranium-bearing liquor passes through a series of stages in the SX system in which the uranium is transferred from the aqueous phase to an organic phase and then is stripped from the solvent by an ammonium sulfate solution. The ammonia is added to the stripped solution to precipitate the uranium as yellowcake. Finally, the yellowcake is dried, packaged, and shipped off site to a uranium hexafluoride conversion plant.

3.1.1 Ore Handling and Preparation

Ore is hauled by truck to the processing facility from various regional mines. The incoming ore is weighed on scales as it sits in the trucks. The net weight of the ore is calculated after the truck is emptied and re-weighed. Samples are collected at random from each load and analyzed on site for moisture and uranium/vanadium content. The ore is then deposited on various stockpiles and/or blended or dumped directly into the ore hopper through a 14-inch grizzly. An electronically-controlled water spray system is used at the dump pocket to control dust.

An electronically-controlled speed apron feeder, fixed under the truck hopper, discharges the ore onto the conveyor belt. The belt transports the ore up and out of the dump pocket and into grinding, the first stage of the process area.

All dust-generating points in the dump pocket are connected by a ducting system to a cyclone-type wet scrubber for dust control. The resulting slurry is pumped into the grinding circuit. All exposed conveyor surfaces are hooded from the dump pocket to the process building to further control dust.

The ore passes over an electronic belt scale and speed transducer used to control the speed of the apron feeder, as it moves on the conveyer belt.

3.1.2 Ore Grinding

The ore on the conveyor is discharged into the feed chute of a semi-autogenous grinding (SAG) mill. Water is introduced along with the ore to produce a slurry containing approximately 70 percent solids. The discharge end of the SAG mill is hooded and ducted to a de-mister that returns the liquid to the leach circuit.

Pumps at the discharge end of the SAG mill convey the slurry to a distributor box containing four screens. Oversize material is recycled back into the SAG mill. Undersize material flows to a storage sump. The slurry is pumped from this sump through an automatic sampler to two, large leach feed surge tanks. These two surge tanks have sufficient storage capacity to supply the leach circuit with feed and allow running the SAG mill intermittently.

3.1.3 Leaching

The leaching circuit dissolves uranium minerals from sandstone grains. A two-stage leaching circuit is used. A decant thickener is located between the leaching stages, The ore slurry from the two leach feed surge tanks is pumped to the first-stage leach (three tanks in series) where the ore is mixed and agitated with a sulfuric acid leach solution and sodium chlorate oxidant. Following the first-stage leach, the slurry is transferred to the decant thickener. The decanted liquid containing dissolved uranium is advanced from the thickener to the solvent extraction unit. The thickened solids are advanced to the second-stage leaching circuit (four tanks). Further leaching is accomplished at this stage by the addition of sulfuric acid with a small amount of oxidant. The second-stage leaching tanks are operated in series; the ore remains in contact with the leach solution for about 16 hours. Each tank has slow-moving propellers to keep the sand grains in suspension.

Discharge from the leach circuit is a slurry consisting of solids and a sulfuric acid solution with dissolved uranium. This slurry is fed to the countercurrent decantation stage.

3.1.4 Countercurrent Decantation Thickening

The slurry is transferred to the first of a series of six CCD tanks (thickeners). The solids settle to the bottom of the first thickener. Flocculant is added to each thickener feed to increase the settling rate of the solids. They are transferred to each of the subsequent CCDs until they are discharged from the sixth thickener. The liquid that overflows the sixth thickener advances to the fifth thickener, and continues through each of the CCDs to the first CCD tank. This countercurrent flow of liquid and solids washes the residual dissolved uranium compounds from the solids. The liquid that overflows the first thickener is collected and pumped to the first-stage leach.

3.1.5 Solvent Extraction Feed

The pregnant (uranium rich) acid solution decanted from the decant thickener following the first-stage leach is transferred to a clarifier. The liquid contains approximately 200 parts per million (ppm) solids. The clarified liquor, containing about 50 ppm solids, is pumped through sand filters to a storage tank which feeds the SX circuit. The filtered liquid is expected to contain less than 10 ppm solids. Settled solids from the clarifier are added to the second-stage leach circuit. Solids collected in the sand filters are removed by backwashing and discharged to the second stage of the leach circuit.

3.1.6 Solvent Extraction

The primary purpose of the SX circuit is to concentrate and purify uranium. This circuit has two steps. First, the uranium is transferred from the aqueous acid solution to an immiscible organic liquid by ion exchange. Then a reverse ion exchange process strips the uranium from the solvent, using aqueous ammonium sulfate.

In the first step, the clarified and filtered acid solution is mixed with an organic solvent in an extraction mixer tank. The two solutions are then separate in a settling tank. After going through a series of four mixing and settling tanks, almost all of the uranium is removed from the acid solution. The uranium-rich organic solvent is advanced to the stripping operation. The uranium barren acid solution (raffinate) is used as feed stock for the vanadium extraction circuit, returned for use as wash water in the CCD tanks, or discharged to the process tailings.

In the stripping process, the loaded organic solvent is mixed with an aqueous ammonium sulfate solution. Ammonia is added to the solution to control the pH. The ammonium sulfate solution strips the uranium from the organic solvent. After processing through four mixing and stripping tanks, the barren organic solvent is recycled to the beginning of the solvent extraction operation. The uranium-rich (pregnant) ammonium sulfate solution advances to the precipitation circuit.

3.1.7 Precipitation

The pregnant ammonium sulfate solution passes through a heat exchanger and into the reaction tanks. The heat exchanger is used to control the temperature of the solution.

Ammonia is injected into the reaction tanks to neutralize the solution and precipitate the uranium as ammonium diuranate. The barren ammonium sulfate solution is filtered and recycled to the stripping stage of the solvent extraction circuit.

3.1.8 Drying and Packaging

The precipitated yellowcake is washed to remove soluble impurities, dewatered, and dried in a multiple-hearth furnace. The dried product is then passed through a crusher for reduction to minus 0.25 in. The finished product is transported to a packaging station, where the yellowcake (uranium oxides) is packaged in steel drums at a design rate of about 583 pounds per hour. Product output from the plant is, however, expected to be only about 205 pounds per hour based on 350 days of operation. Filled drums will be stored until a sufficient quantity exists for transport off site, subject to sales schedule.

3.1.9 Vanadium Extraction Circuit

The depleted aqueous solution from the uranium solvent extraction, the uranium raffinate, serves as the feed for vanadium concentration. Three raffinate holding tanks will discharge into any of three pH/electromotive force (EMF**)** adjustment tanks. Anhydrous ammonia and a sodium chlorate solution will be added to these tanks to adjust pH and oxidize tetravalent vanadium to the pentavalent state, respectively.

A sludge thickener will be provided to enable settling and densification of particulate matter. The thickener underflow slurry will be discharged to the tailings facility. The thickener overflow solution will still contain a low concentration (about 100 ppm) of solids that would interfere with subsequent solvent extraction. A flotation column cell with a rising stream of finely dispersed air bubbles will separate the solids into a floating froth that will be pumped to the tailings facility. The clarified liquor will flow to the vanadium SX feed tank with a 45-minute retention time.

The SX process for vanadium concentrates and purifies the dilute and impure aqueous solution containing vanadium. This is accomplished with a recyclable organic solvent that typically contains an amine-type reagent (extractant), a long-chain alcohol (modifier), and kerosene (diluent). The extractant combines with the vanadium to form a specific complex. Amines are anionic in character and extract anionic complexes; only pentavalent vanadium forms anionic complexes, hence the oxidation step mentioned above.

There will be a maximum of six extraction stages: each comprising an agitated mixer box that overflows into a rectangular tank called a settler. Streams of aqueous solution and solvent enter the mixer and a suspension is formed of small droplets of one phase in a continuous liquid phase of the other. Whether that phase is “organic continuous” or “aqueous continuous” depends on the relative volumes of the two. The phases separate in the settler. The lighter organic solvent floats on the aqueous layer, allowing separation by an overflow/underflow weir arrangement. The vanadium raffinate from the extraction circuit, containing low concentrations of uranium and vanadium, is then delivered to the tailings facility.

The loaded solvent flows through a quiescent tank with 10-20 minutes retention time to allow entrained droplets of the aqueous solution to separate, coalesce, and sink to the bottom. It is then pumped back to the SX feed tank. The loaded solvent is then contacted with aqueous sodium carbonate. This solution strips most of the vanadium content.

Stripping requires fewer stages, typically 2-3, than extraction. The mixer/settler design is the same, although the sizes differ. The stripped solvent is recycled to the extraction circuit and the concentrated solution (vanadium pregnant liquor, VPL) flows to another flotation column in which entrained droplets in the solvent are separated. The clarified pregnant liquor is held in two tanks for up to 8 hours, isolating the extraction circuit from the purification and precipitation circuit during maintenance interruptions.

The VPL flows to either of two steam-heated sodium hexavanadate (red cake) precipitation tanks to which sulfuric acid and sodium chlorate is added. The red cake slurry is fed onto a belt filter, producing a water-washed filter cake and a filtrate that will be returned to the vanadium SX feed tank, or to tailings, depending on impurity content. The red cake is discharged into either of 2 steam-heated dissolving tanks along with sodium carbonate and sodium chlorate and held for approximately 3 hours. The resulting solution passes through a filter feed tank with 1-hour retention, then into a pressure filter that is pre-coated with diatomaceous earth, or equivalent. Solids periodically backwashed from the filter are sent to the tailings facility and the clarified solution is delivered through a water-cooled heat exchanger to the ammonium metavanadate (AMV) crystallizer feed tank.

Ammonium sulfate solution and ammonium hydroxide are combined with the clarified solution and fed into a series of three strongly-agitated crystallizer tanks. The slurry of AMV crystals is fed onto another water-washed belt filter and the crystals are conveyed to the AMV cake bin. The filtrate flows through a small propane-fired submerged combustion evaporator, then returns to the crystallizer feed tank.

The AMV cake is dried in a fuel-fired rotary dryer, then treated in one of three ways, depending on market requirements. The AMV may be:

- Packaged and sold;
- Fed directly to a multiple-hearth calcining furnace ("deammoniator"), melted in a fusion furnace, tapped into a water-cooled casting wheel, and packaged as 99.5%V_2O_5 (black flake); or
- Dissolved with dilute sulfuric acid in an "acidulation" tank, followed by addition of ammonium hydroxide to a neutralization tank, from which the liquor flows through a water-cooled heat exchanger to a crystallizer tank. The slurry of re-crystallized AMV is fed to a washing belt filter, thence to the deammoniator, fusion furnace, and casting wheel described above. This product would contain 99.9% V_2O_5 and would also be called black flake.

3.2 Sources of Plant Wastes, Control Equipment and Instrumentation

The predominant waste stream is processed ore, or tailings. Tailings are permanently disposed of by storage in an engineered, lined tailings cell that utilizes a natural depression, or basin, located adjacent to the plant site. The plant and its support facilities also produce lesser quantities of other liquid and solid wastes and effluents that are either recycled in process operations; or discharged to the tailings facility or a sanitary waste leach field.

Eight stacks discharge gaseous wastes and dust released by the plant. Three of the stacks are exhaust stacks from diesel powered generators used to produce electricity. The other five stacks are shown on Figure 3.0-1. Estimated emissions and physical characteristics of the mill stacks that could or do release radionuclides from the milling process are listed in Table 3.2-1.

Dust/mist control equipment at the processing facility consists of the following:

- Wet Dust Collectors. This collector will be a Ducon, or equivalent. These units operate on high-energy venturi principles. Dust and fume removal is greater than 99 percent efficient in the sub-micron range. An externally adjustable orifice permits maximum collection efficiency at varying gas flow.

- Mist Vapor and Fume Collector. This system will be an American Air Filter mist vapor and fume collector, or equivalent. This is a wet collector system that uses a perforated plate (acid resistant) and fluid bed to provide large areas of flooded contact surfaces and efficient scrubbing of exhaust air or gas.

3.2.1 Ore Stockpiles and Crushing

The ore processed at the Shootaring Canyon Uranium Processing Facility undergoes numerous transfer, screening, and temporary storage operations in preparation for the uranium extraction procedures described in Section 3.l. There are potential effluent discharges at each stage of the process, including particulates containing radionuclides. The following paragraphs describe the plans to control and limit discharges of effluents.

3.2.2 Ore Handling

Solid Effluents

The ore stockpiled on the ore pad during normal operations is used primarily as an inactive reserve. The stockpile is harvested when the mines cannot deliver sufficient ore to the plant.

Ore may be stockpiled on the ore storage pad in quantities exceeding a two week reserve, particularly when the mill is shutdown for longer than one month. For example, a 94,181-ton (94-day) supply was present on the ore pad during the summer of 1984.

Dispersal of dust from the stockpiles is controlled by water spray or other dust suppression techniques. Environmental air particulate sampling results and visual observations are used to indicate whether additional dust suppression efforts are required.

The ore dump pocket will be dust controlled by an automatic water spray system. From here the ore accumulates in the 75-ton hopper.

The next transfer is from the hopper via an apron feeder to the covered conveyor belt. Dust is collected at discharge and transfer points by a wet dust collector. Exhaust from the dust collector will be released through a stack about 100 feet above plant grade. The slurry from the dust collector will be pumped into the process circuit at the SAG mill.

A semicircular hood encloses the conveyor from the dump pocket to the process building. A continuous flow of water is introduced at the point of entry into the SAG mill, along with the ore feed. Effluent air from the wet dust collectors is expected to contain 0.03 to 0.05 g/m^3 of ore dust.

Table 3.2-1: Plant Stack Emissions

	Stack Location			
	Ore Dump Pocket	**SAG Mill Leach Tanks**	**Yellowcake Centrifuge and Calciner Product Drumming**	**Laboratory Fume Hood Manifold**
Stack Number	S-1	S-5	S07	S-11A S-11B
Emission Control Equipment	Wet dust collector	De-mister	Wet dust collector	Water wash down
Collection Efficient (percent)	99.8	>99.9	99.7 U_3O_8	-
Exit Flow Rate (cfm)	6000	5000	3000	2000
Exit Temperature (^oF)	Ambient	60-70	150-200	60
Exit Diameter (in.)	18	18	18	12
Release Height (ft)[a]	100	90	90	35
Effluent	Ore dust	Negligible	Yellowcake (90	Miscellaneous

Concentrations/Emissions	0.03-0.05 g/m^2	amounts of sulfuric acid mist and radon-222	percent U_3O_8) 0.02 lb/hr: ammonia 5 ppm	vapors

Notes:
[a]Feet above ground level
cfm = cubic feet per minute
°F = degrees Farenheit
ft = feet
g/m^2 = grams per square meter
in. = inches
ppm = parts per million

The sample preparation area, or bucking room, is entirely enclosed in its own building. All sample processing equipment is tied, via a ducting system, to the wet dust collector at the dump pocket.

Liquid Effluents

Limited rain water runoff from the ore stockpiles and ore stockpile pad is diverted to a temporary, lined collection pond. This temporary collection pond will be place downgradient of the tailings facility and receive storm water from the ore stockpiles and stockpile pads by gravity. The water will then be transferred to the solution storage/evaporation pond for recycle or evaporation.

Gaseous Effluents

Negligible concentrations of radon-222 escape from the de-mister controlling emissions from the SAG mill.

3.2.3 Leaching

Solid Effluent

No solid effluents are released from the leaching circuit.

Liquid Effluent

The leaching tanks contain a slurry of about 47 percent solids. These tanks are located on a sloping floor which drains to a floor sump. Spills from the tanks will drain into the sump and be pumped back into the process system. The recessed impoundment area of the floor is large enough to contain the entire volume of any one of the leaching tanks.

Gaseous Effluent

Each leaching tank is negative pressure vented to the demister collection system described in Section 3.2. Negligible concentrations of radon-222 escape from the de-mister controlling emissions from the leach tanks.

3.2.4 Countercurrent Decantation Thickening Effluents

Acid wash solution is separated from the ore slurry in the CCD tanks. The barren tailings are discharged to the tailings disposal facility as a slurry consisting of approximately 45 percent solids by weight. Estimated concentrations of cations, anions, and compounds assumed to be contained in the slurry water are given in Table 3.2-2

Table 3.2-2: Tailings Slurry Constituents

Element/Compound	Concentration (ppm)
U_3O_8	0.4
Fe (total)	1730
Al^{3+}	320
Ca^{2+}	26
Mg^{2+}	3500
SiO	520
$SO4^{2-}$	26,500
Cl^-	160
V_2O_5	530

Once the tailings slurry is within the seven-part lined tailings cell, a belt press or similar fluid extraction equipment will be used to extract most of the tailings solution from the tailings slurry yielding moist tailings in solid form and a liquid stream of tailings solution which will be placed in a lined process solution storage and/or evaporation pond, where it will be recycled to the mill or evaporated. All fluid storage ponds and the fluid extraction equipment will be located within the perimeter of the seven-part liner system. The target moisture content of the reduced moisture tailings is 35% by weight. Further details are presented in Plateau, 1998a, Plateau, 2005.

Another tailings fluid separation method being considered is to filter the tailings slurry at the CCD circuit and transport the dewatered tailings to the tailings cell. The tailings solution would then either be recycled or transported to the solution storage/evaporation pond.

The surface area of tailings available for dust generation will be minimized by progressively covering a portion of a cell with moist tailings. When not working in the area, an interim cover or dust suppression chemical will be applied to control dust. These dust suppression methods will be used to control radioactive particulate emissions prior to placement of the final clay and rock cap on the cell.

The countercurrent decant thickeners are located outdoors. The thickeners are placed on a curbed, sloped concrete slab. A catch basin and pumps are located at the lower end of the slab. The sloping slab and sump are designed to contain the contents of one thickener. Alternatively, the spill could be pumped to the CCDs. For leaks and spills, or possibly a tank rupture, the spilled material is normally returned to the decant thickeners for reuse.

Gaseous Effluents

Some water vapor, acid mist, and minor amounts of radon-222 escape into the atmosphere from the open thickeners. Natural air currents will dilute and disperse these materials.

3.2.5 Solvent Extraction

Solid Effluents

No solid effluents are released from the solvent extraction circuit.

Liquid Effluents

The solvent extraction and stripping tanks; and their associated mixers, pumps, piping, and small tanks, are located in an enclosed building. The concrete floor of this building is curbed and the volume below the top of the curb is large enough to accommodate at least the entire volume of the largest of the tanks.

The clarified solution storage and raffinate storage tank are located outside the solvent extraction building in areas surrounded by dikes. Spills are retained in the impoundments and are recovered for reuse or discharged to the tailings facility by a portable sump pump.

Approximately 75 gallons of kerosene are used each day in the solvent extraction circuit. Eventually, most of that kerosene is discharged from the plant to the tailings, where the kerosene remains adsorbed on tailings particles.

Gaseous Effluents

Approximately eight gallons of kerosene evaporate each day from the solvent extraction circuit. Air in the solvent extraction building is released into the atmosphere through three roof ventilators. These ventilators are located about 60 ft (18 m) above ground level, and each has a forced draft of about 12,000 cfm.

3.2.6 Precipitation

Solid Effluents

No solid effluents are released from the precipitation circuit.

Liquid Effluents

The precipitation and yellowcake thickener tanks, as well as all associated piping and appurtenances, are contained in the product building. Spills are collected and returned to the system.

Gaseous Effluents

The exhaust gases contain traces of radon-222.

3.2.7 Precipitation, Drying, and Packaging

Solid Effluents

After the precipitated yellowcake is washed and dewatered, it is dried in a multiple hearth furnace and then passed through a crusher. Exhaust from the furnace is vented to the atmosphere through a wet dust collector. Yellowcake dust (about 90 percent U_3O_8) is emitted with this exhaust at a rate of about 0.016 lb/hr (7.3 g/hr).

The finished product is transported to a packaging station and loaded into steel drums. Packaging is done in an enclosed room. Air from the room is passed through the same wet dust collector as the furnace discharge described above. Product dust is emitted with the exhaust gases at a rate of about 0.02 lb/hr (9.5 g/hr).

Liquid Effluents

No liquid effluent is released from the drying and packaging circuits.

Gaseous Effluents

The exhaust gas from the drying furnace contains about 5 ppm ammonia.

3.3 Controls of Plant Wastes and Effluents

The control systems used to minimize emissions from the plant are discussed in this section. Volatile fuels and reagents are stored in closed tanks to minimize the escape of vapors to the atmosphere. Many unit operations are carried out within buildings or closed vessels. The air and gases from the process vessels are passed through wet dust collectors or de-misters to remove dust, mists, and gaseous pollutants. Gaseous effluents and dust are discharged from stacks to promote atmospheric dilution and dispersion.

Buildings housing various plant operations have concrete floors. These floors slope to concrete lined sumps that collect any spillage. Spilled materials are pumped back into the appropriate plant circuit. The floors of the buildings are curbed or recessed to contain the volume of at least the largest process tank. Fuel oil, kerosene, and acid storage tanks are located in open areas, and are placed within impoundments capable of holding the volume of the enclosed tanks.

The nuclear density gauges have been removed from the site and new gauges will be installed at appropriate locations. The license to possess these sources is administered by the State of Utah.

Sewage disposal is conducted in accordance with the requirements of the Bureau of Water Pollution Control of the Utah State Division of Health. The permit was approved in 1979.

The plant has an analytical and metallurgical laboratory that routinely analyzes and tests the ore and process streams to optimize the extraction of uranium from ores with differing properties. The laboratory routinely analyzes the various process reagents and the finished product as quality control measures. The fume hoods of the laboratory collect air, chemical fumes, and mists and discharge them through a scrubber and stack to the atmosphere. The gaseous effluent does not contain sufficient quantities of potential radionuclides or chemicals to constitute a significant impact. Liquid effluent is collected in a laboratory dedicated sump which is periodically pumped to the tailings facility.

4. Operations

This section presents the corporate organization, site management activities, and employee qualifications required to control source materials both within the mill and in the environment around the mill. All activities related to assessing the environmental and health impacts from operations are conducted using Standard Operating Procedures.

4.1 Corporate Organization and Administrative Procedures

The Vice President of Milling has overall policy and management responsibilities for the Shootaring Canyon Uranium Mill. The Mill Superintendent is responsible for enforcing the policies and procedures and has the ultimate on-site authority. Written operating procedures have been established for routine production activities involving the handling and processing of radioactive materials and routine radiation safety practices.

The Corporate Radiation Safety Officer (CRSO) reports directly to the Vice President of Milling and is responsible for compliance with all environmental health and safety regulations, implementing all radiological and environmental monitoring procedures, and for compliance with the regulations and requirements administered by the State of Utah.

The basis for the radiation safety program is to maintain radiation exposures to levels that are as low as reasonably achievable (ALARA) for all employees, contractors, visitors, and members of the general public. The implementation of a successful ALARA program is the responsibility of management and all workers. Workers and management have the responsibility for developing work practices that minimize radiation exposure. ALARA is a primary consideration in worker training and developing work plans.

4.2 Personal Qualifications and Training

Minimum education and experience qualifications for the RSO, Environmental and Safety Technicians, and Radiation Safety Technicians are specified by the Utah Department of Environmental Quality, Division of Radiation Control.

The radiological protection training program for all workers includes providing basic radiation protection training for new employees and contractors, on-the-job training, and annual refresher training. The formal training includes the fundamentals of radiation, regulatory limits, methods for limiting radiation exposure, and personnel monitoring methods.

4.3 Security

The boundary limits of the processing facility are posted and enclosed by a fence except for sections where cliffs or other topographic features form a natural boundary. The process plant, mill ore storage area, ancillary facilities (such as laboratory, office building, warehouse and maintenance facilities, electrical power distribution, and reagent storage), and the entire tailings disposal area are located within the restricted area boundary of the facility. The restricted area is posted with "Caution Radioactive Materials" signs.

Access to all areas, except the general office building, employee parking and visitor parking, are controlled by fences and gates. Warning and information signs are posted near the main gate. Twenty-four hour security will be provided when the processing facility is in operation and/or if barreled yellowcake is stored on site. During extended periods of non-operation, access to the restricted area is through the main gate which is locked when personnel are not present. Visitors, including temporary workers, will be admitted only after management is assured that the person has appropriate radiation safety training and controls are in place to limit radiation exposure.

4.5 Radiation Safety

The Radiation Safety Program is implemented by the CRSO and a staff of technicians. The program consists of employee training, work-place monitoring, environmental and effluent monitoring, personnel monitoring and dose assessment, records management, and regulatory compliance. Supporting activities include job planning assistance, preparing radiation work permits, preparing and maintaining standard operating procedures, monitoring equipment calibration and maintenance, and conducting audits.

5. Environmental Characteristics of Mill Site

5.1 Demography

The population of Utah in 2004 was 2,389,039 (US Bureau of Census, 2004). This population represents an overall density of 29 persons per square mile (mi^2), [(or 8.9 persons per square kilometer (km^2)].

Utah is sparsely populated. More than 72 percent of Utah's population lives in four counties: Salt Lake, Utah, Davis, and Weber, which contain the cities Salt Lake City, Provo, Bountiful, and Ogden, respectively.

The population in the project area is also sparse. Garfield County is the fifth largest county in Utah, covering 5208 mi^2 (13,401 km^2). However, the population density is 1 person per mi^2 (0.3 persons per km^2). Approximately 89 percent of Garfield County land is owned by the U.S. Government in the form of national parks, forests, recreation areas, and resource lands. The U.S. Bureau of Land Management (BLM) has jurisdiction over surface and mineral rights on approximately 57 percent of the total area of Garfield County. These lands are used for recreation, mineral development, livestock grazing, and natural resource management. Ninety percent of the residents live in the western portion of the county near the north-south transportation corridor through Utah (Interstate 15 and U.S. Highway 89). There are also some ranches and farms scattered across Garfield County. The bordering counties of Wayne, San Juan, and Kane are also sparsely populated (See Table 5.1-1 for population data in the vicinity of the mill site).

Table 5.1-1: 2004 Area Population for Wayne, Garfield, San Juan, and Kane Counties and the State of Utah

	Land Area		2004 Population[b]		
County	**Square Kilometers**	**Square Miles**	**No.**	**People/km^2**	**People/mi^2**
Wayne	6,446	2,489	2494	0.4	1.0
Garfield	13,401	5,208	4427	0.3	0.8
San Juan	20,419	7,884	14,015	0.7	1.8
Kane	10,632	4,105	6178	0.6	1.5
State totals	213,260	82,340	2,389,039	11.2	29

Notes:
km^2 = square kilometers
mi^2 = square miles
[b]U. S. Bureau of Census, 2004, Utah Office of Planning and Budget

Residents living near the mill site are located in Ticaboo, the Off Shore Marina, the Shipyard, Bullfrog Basin Marina, Halls Crossing Marina, and Hanksville.

Ticaboo and the Off Shore Marina lie about 2.5 and 3 miles (4 and 4.8 km) south of the mill site, respectively. The Shipyard is located on Highway 276, approximately 6 miles (9.5 km) south of the site. Bullfrog Basin Marina lies on Lake Powell, about 14 miles (22 km) south of the mill site. Halls Crossing Marina lies approximately 3.5 miles (5 km) further south of Bullfrog Marina, on the opposite shore of Lake Powell. Hanskville is located about 46 air miles (74 air km) north of the site, in Wayne County. Green River and Moab, Utah are larger communities located approximately 93 and 86 air miles (150 and 138 air km) or 110 and 160 road miles away, respectively.

The population of Ticaboo was 60 in August 2004. The inhabitants are primarily Plateau Resources Limited employees and their families and most reside permanently in mobile homes. The population is expected to increase to approximately 200 when the mill operates. The community is constructed to accommodate 98 single-family homes, 144 mobile homes, and 41 recreational vehicles or camp trailers. The facilities available at Ticaboo consist of a 72 unit motel; restaurant and bar, grocery store (all open seasonally), and mobile-home park. During the school year, approximately 2 Ticaboo children attend school at Bullfrog Marina. The Shipyard and Off Shore Marina children also attend school at the Bullfrog Marina. It is expected that all employees will reside in Ticaboo; however, there may be a several who will commute daily from Hanksville and weekly from Green River, Utah and /or Grand Junction, Colorado.

The Off Shore Marina consists of approximately 24 employees and family members. The Shipyard is a privately owned and operated boat storage and gas station facility. Five people live and work at the Shipyard. Bullfrog Basin Marina consists of approximately 210 employees and family members. The marina is a recreational community, part of the Glen Canyon National Recreation Area. Transient residence at Bullfrog Basin Marina is limited by National Park Service regulations to two months at a time. Peak use of the Marina may approach 43,000 persons per month during summer. Halls Crossing Marina houses 94 permanent employees and family members. Hanksville has a current population of 250.

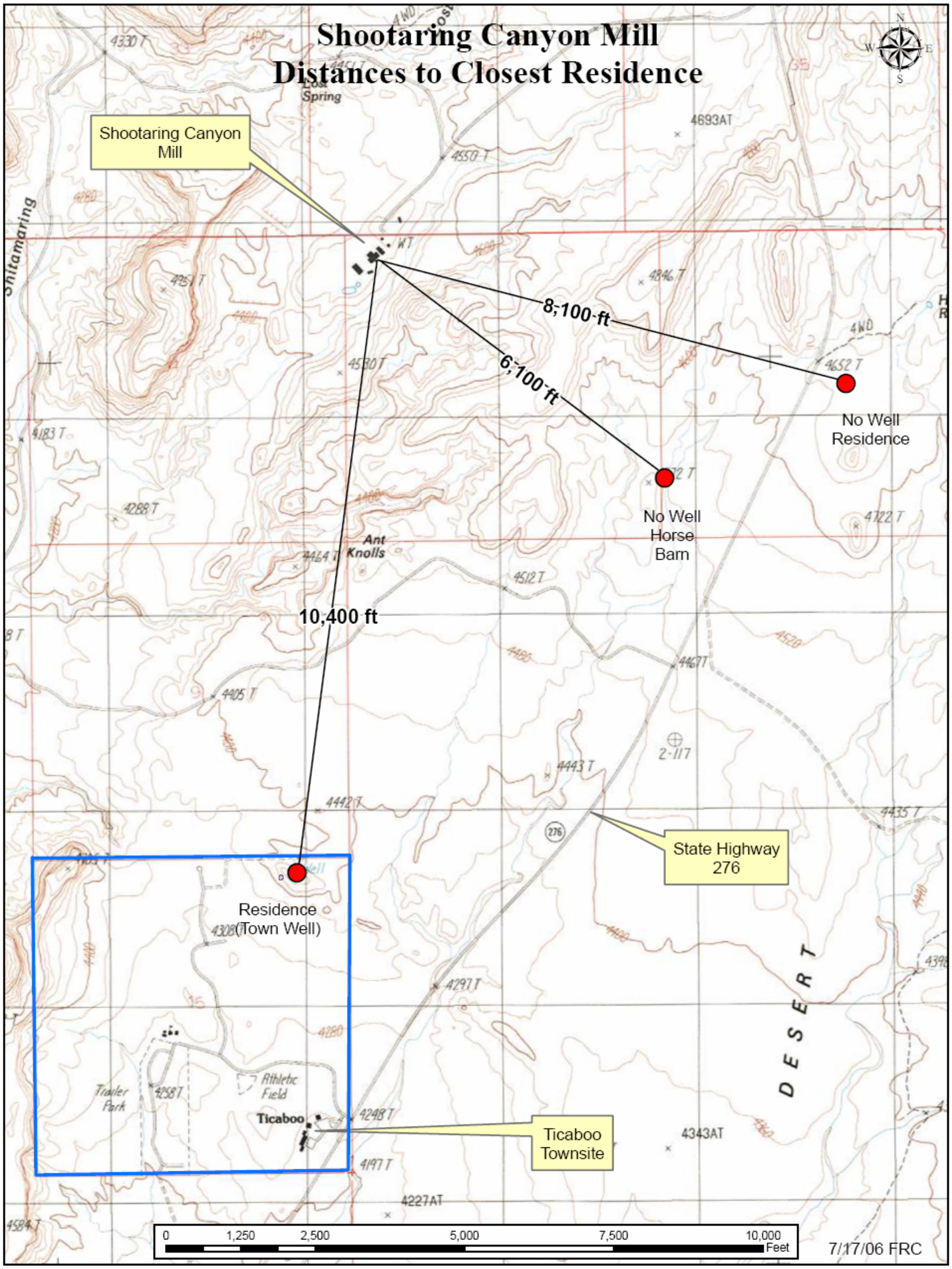
Gold Creek Ranch, consisting of private summer home sites, is located approximately 13 miles (20.5 km) northwest of the project. At this time, there are no permanent residents living in the development.

The “nearest resident” to the mill is a newly established residence approximately 2.5 km to the east of the site (Figure 5.1). The residence does not have a well associated with the property.

Few other permanent settlements exist in the general area surrounding the mill site. According to a field study conducted by Plateau Resources, the total number of permanent residents living within an 80 km radius of the mill site is 1544 (Plateau Resources, 1996 supplemented by August 2004 data).The permanent population within a 50 mile (80 km) radius of the facilities is 1,544 residents and distributed as shown in Table 5.1-2.

One national recreation area, three national parks, two national forests, one BLM primitive area, and one state park exist wholly or in part within a 50 mile (80 km) radius

Figure 5-2: Location of Nearest Resident to Shootaring Canyon Mill



Shootaring Canyon Mill
Distances to Closest Residence
Shootaring Canyon Mill
8,100 ft
6,100 ft
10,400 ft
No Well Residence
No Well Horse Barn
Residence (Town Well)
State Highway 276
Ticaboo Townsite
0
1,250
2,500
5,000
7,500
10,000
Feet
7/17/06 FRC

of the mill site. Traditional activities such as seasonal grazing, minerals prospecting, mining, and isolated ranching in these reserves have been supplemented with recreational activities during the last 10 to 20 years, as adequate roads were built. The recreational activities include hiking, backpacking, camping, biking, sight-seeing, and hunting. Access to the area by the general public is facilitated by parks and recreation services and concessionaires, who report that their staffs may double or triple during the summer months to accommodate the influx of tourists.

Visitations to these park areas during the spring through fall months result in a substantial transient population. For example, Glen Canyon National Recreation Area receives an average of three million visitors per year. In addition, the Dixie National Forest campgrounds within the population distribution survey area reported 24,000 visitors from May 15 through Sept. 30, 1995 with 33,000 for the year. Natural Bridges National Monument received an average visitation of 97,236 per year from 2002 to 2004. Although permanent residency is limited within all the park boundaries, overnight visitors are common, thus increasing the number of people who may be present in the area at any given time.

Table 5.1-2: Population Distribution within an 80 Kilometer Radius of the Shootaring Mill Site

	N	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**
km	**0˚**	**22.5˚**	**45˚**	**67.5˚**	**90˚**	**112.5˚**	**135˚**	**157.5˚**	**180˚**	**202.5˚**	**225˚**	**247.5˚**	**270˚**	**292.5˚**	**315˚**	**337.5˚**
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5	0	0	0	0	0	0	0	0	260	0	0	0	0	0	0	0
4.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.5	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	2	0	0	0	0	0	0	0	304	0	0	0	0	0	0	0
35	0	0	21	0	2	0	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
55	4	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0
65	0	0	0	0	8	1	0	0	60	0	0	0	0	180	2	3
75	250	2	0	0	0	0	0	0	360[a]	0	0	0	0	10	0	45
Tot.	**256**	**2**	**21**	**0**	**10**	**1**	**0**	**0**	**1002**	**0**	**0**	**0**	**0**	**190**	**14**	**48**

Notes:
[a]The total population of the portion of the Navajo Indian Reservation included in the January 1996 survey was reported by the Navajo Mountain Trading Post at 360.

5.2 Meteorology

The climate in the vicinity of the site is semi-arid (steppe), although it varies with elevation and terrain features. Skies are usually clear with abundant sunshine and annual precipitation is low. Because of the low humidity, the rate of evaporation is high. Daily ranges in temperature are relatively large, and winds are normally light to moderate.

The data included in this section is the most recent site specific information available. The meteorological station at the processing facility was not monitored during the interim shutdown period.

5.2.1 Wind and Atmospheric Stability

The relative frequency distribution for wind direction and wind speed by stability class is presented in Table 5.2-1 and is based on the one-year period from October 1979 through September 1980. Percentage data recovery is summarized by month in Table 5.2-2. The annual data recovery is about 76 percent, as shown in Table 5.2-3.

The frequency distributions of atmospheric stability; and dominant wind directions and speeds are presented in Tables 5.2-3 and 5.2-4, respectively. Calms are included in the lowest wind speed class. This is also true of the joint frequency distribution.

Winds of six knots or less comprise approximately 70 percent of the wind speed total frequency. The annual wind speed average is also six knots, with higher average speeds occurring in winter.

Compared to Supplement S2 of the Environmental Report for the Shootaring Canyon Uranium Project (Woodward-Clyde Consultants, 1978) herein the "1978 Environmental Report," there has been an apparent decrease in E stability with increases in B, C, and D stabilities.

The October 1979 through September 1980 wind direction distribution is similar to data collected at the processing facility from July 22 to September 30, 1977 (Woodward-Clyde, 1978). South-southwest is the predominant direction, with the S to SW and N to NE sectors containing approximately 57 percent of the wind direction occurrences.

A statistical summary of wind data is presented in Table 5.2-5.

Table 5.2-1: Relative Frequency Distribution for Wind Direction and Wind Speed by Stability Class

Direction	**North**					
	Wind Speed (mph)					
Stability Class	**1.5**	**5.5**	**10**	**15.5**	**21.5**	**28**
A	0	0	0	0	0	0
B	0.001789	0.002386	0.000895	0	0.000298	0
C	0.001807	0.000895	0.001193	0.000298	0	0
D	0.016139	0.013421	0.007754	0.000596	0.000298	0
E	0.018491	0.007754	0.002684	0.002982	0.000298	0
F	0.019982	0.012228	0.003877	0.000596	0	0
Subtotal	0.058208	0.036684	0.016403	0.004472	0.000894	0

Direction	**North-Northeast**					
	Wind Speed (mph)					
Stability Class	**1.5**	**5.5**	**10**	**15.5**	**21.5**	**28**
A	0	0	0	0	0	0
B	0.000596	0.001193	0.000895	0	0	0
C	0	0.000298	0.000298	0.000596	0	0
D	0.017035	0.008052	0.004772	0.002386	0	0.000596
E	0.023859	0.004772	0.002088	0.002982	0	0
F	0.015807	0.009246	0.001491	0.001491	0.000298	0.000298
Subtotal	0.057297	0.023561	0.009544	0.007455	0.000298	0.000894

Direction	**Northeast**					
	Wind Speed (mph)					
Stability Class	**1.5**	**5.5**	**10**	**15.5**	**21.5**	**28**
A	0	0	0	0	0	0
B	0	0	0.000298	0.000895	0	0
C	0	0	0.001193	0.000298	0	0
D	0.005081	0.000596	0.004175	0.004175	0.000596	0.000298
E	0.007754	0.001789	0.002386	0.006561	0.00507	0.000596
F	0.00507	0.002983	0.001491	0.001789	0.000894	0
Subtotal	0.017905	0.005368	0.009543	0.013718	0.00656	0.000894

Table 5.2-1: Relative Frequency Distribution for Wind Direction and Wind Speed by Stability Class (continued)

Direction	East-Northeast					
	Wind Speed (mph)					
Stability Class	1.5	5.5	10	15.5	21.5	28
A	0	0	0	0	0	0
B	0	0	0	0.000596	0	0
C	0	0	0	0.000895	0	0
D	0.008069	0.000895	0.000596	0.001789	0	0
E	0.005965	0.000298	0.001491	0.002684	0.001193	0
F	0.006561	0.000596	0.001193	0.000298	0	0
Subtotal	0.020595	0.001789	0.00328	0.006262	0.001193	0

Direction	East					
	Wind Speed (mph)					
Stability Class	1.5	5.5	10	15.5	21.5	28
A	0	0	0	0	0	0
B	0	0.000298	0	0	0	0
C	0	0	0.000596	0.000298	0	0
D	0.010759	0.001119	0.000895	0	0	0
E	0.011631	0	0.000895	0.000298	0	0
F	0.009842	0.009248	0.000298	0	0	0
Subtotal	0.032232	0.010665	0.002684	0.000596	0	0

Direction	East-Southeast					
	Wind Speed (mph)					
Stability Class	1.5	5.5	10	15.5	21.5	28
A	0	0	0	0	0	0
B	0	0.000596	0	0	0	0
C	0	0	0	0	0	0
D	0.005081	0.000895	2.98E-05	0	0	0
E	0.007158	0.00023	0.000298	0.000298	0.000596	0
F	0.001491	0.001193	0	0	0	0
Subtotal	0.01373	0.002914	0.000328	0.000298	0.000596	0

Table 5.2-1: Relative Frequency Distribution for Wind Direction and Wind Speed by Stability Class (continued)

Direction	Southeast					
	Wind Speed (mph)					
Stability Class	1.5	5.5	10	15.5	21.5	28
A	0	0	0	0	0	0
B	0	0.000596	0	0	0	0
C	0.000301	0.000298	0	0	0	0
D	0.004184	0.000596	0.000298	0	0	0
E	0.003281	0.001193	0.000895	0	0	0
F	0.004175	0.001789	0.000596	0.000298	0	0
Subtotal	0.011941	0.004472	0.001789	0.000298	0	0

Direction	South-Southeast					
	Wind Speed (mph)					
Stability Class	1.5	5.5	10	15.5	21.5	28
A	0	0	0.000298	0	0	0
B	0.000298	0.001491	0.000298	0	0	0
C	0.000602	0.000596	0.000596	0	0	0
D	0.01046	0.009544	0.003877	0.000596	0	0
E	0.00686	0.005965	0.002982	0	0	0
F	0.005666	0.003579	0.002982	0.000596	0	0
Subtotal	0.023886	0.021175	0.011033	0.001192	0	0

Direction	South					
	Wind Speed (mph)					
Stability Class	1.5	5.5	10	15.5	21.5	28
A	0.000298	0	0.000596	0	0	0
B	0.005368	0.011333	0.010438	0.000298	0	0
C	0.006024	0.008947	0.004772	0.000895	0	0
D	0.014645	0.023859	0.022368	0.002088	0	0
E	0.013719	0.008351	0.011631	0.002982	0.000895	0
F	0.008947	0.003574	0.00328	0.000895	0.00023	0
Subtotal	0.049001	0.056064	0.053085	0.007158	0.001125	0

Table 5.2-1: Relative Frequency Distribution for Wind Direction and Wind Speed by Stability Class (continued)

Direction	**South-Southwest**					
	Wind Speed (mph)					
Stability Class	1.5	5.5	10	15.5	21.5	28
A	0.000298	0.000298	0.000895	0	0	0
B	0.007456	0.015807	0.008647	0.002386	0	0
C	0.00753	0.008649	0.010737	0.005667	0	0
D	0.012254	0.009842	0.008351	0.00686	0.000895	0
E	0.007456	0.001789	0.003281	0.001491	0.000298	0.000596
F	0.007157	0.002386	0.000895	0.000596	0	0.000298
Subtotal	0.042151	0.038771	0.032806	0.017	0.001193	0.000894

Direction	**Southwest**					
	Wind Speed (mph)					
Stability Class	1.5	5.5	10	15.5	21.5	28
A	0	0.000596	0	0	0	0
B	0.007754	0.003877	0.002982	0.000596	0	0
C	0.004217	0.002386	0.00507	0.003877	0	0
D	0.005678	0.003877	0.004175	0.004474	0.000298	0
E	0.001789	0.000895	0.00023	0.000596	0.000298	0
F	0.002684	0.000596	0.000298	0	0	0
Subtotal	0.022122	0.012227	0.012755	0.009543	0.000596	0

Direction	**West-Southwest**					
			Wind Speed (mph)			
Stability Class	1.5	5.5	10	15.5	21.5	28
A	0.000596	0.000298	0	0	0	0
B	0.008052	0.005368	0.002386	0.000895	0	0
C	0.003313	0.001491	0.002386	0.001491	0	0
D	0.007173	0.001789	0.003877	0.002684	0.000298	0
E	0.004477	0.000895	0.001491	0.000596	0	0.000895
F	0.007456	0.000894	0.000298	0	0	0.000298
Subtotal	0.031067	0.010735	0.010438	0.005666	0.000298	0.001193

Table 5.2-1: Relative Frequency Distribution for Wind Direction and Wind Speed by Stability Class (continued)

Direction	West					
	Wind Speed (mph)					
Stability Class	1.5	5.5	10	15.5	21.5	28
A	0	0.000298	0	0	0	0
B	0.004474	0.002684	0.004772	0.000596	0	0
C	0.003614	0.001789	0.002386	0.000895	0	0
D	0.015242	0.003281	0.00686	0.003281	0	0.000298
E	0.009544	0.001783	0.001193	0.000596	0	0.000895
F	0.008948	0.002088	0	0	0	0
Subtotal	0.041822	0.011923	0.015211	0.005368	0	0.001193

Direction	West-Northwest					
	Wind Speed (mph)					
Stability Class	1.5	5.5	10	15.5	21.5	28
A	0	0	0	0	0	0
B	0.001193	0.000895	0.000895	0.000298	0	0
C	0.000904	0.000596	0	0.000298	0	0
D	0.003885	0.001491	0.000596	0.001193	0.000298	0.000298
E	0.003281	0.000298	0	0	0	0
F	0.00507	0.000596	0.000894	0	0	0
Subtotal	0.014333	0.003876	0.002385	0.001789	0.000298	0.000298

Direction	Northwest					
	Wind Speed (mph)					
Stability Class	1.5	5.5	10	15.5	21.5	28
A	0	0	0	0	0	0
B	0.000596	0	0.000293	0.000596	0	0
C	0.001205	0	0.001193	0	0	0
D	0.001793	0.000596	0.000298	0.001193	0.000298	0.000596
E	0	0.000298	0	0.000298	0	0
F	0.001491	0.000298	0	0	0.000596	0
Subtotal	0.005085	0.001192	0.001784	0.002087	0.000894	0.000596

Table 5.2-1: Relative Frequency Distribution for Wind Direction and Wind Speed by Stability Class (concluded)

Direction	North-Northwest					
	Wind Speed (mph)					
Stability Class	1.5	5.5	10	15.5	21.5	28
A	0	0	0	0	0	0
B	0.001789	0.001789	0.000298	0	0	0.000298
C	0.000904	0.000596	0.000596	0.000298	0.000298	0
D	0.004483	0.002982	0.002088	0.001449	0.000895	0.000895
E	0.006561	0.002088	0.001789	0.000298	0	0
F	0.006562	0.000596	0.000328	0	0.001789	0.00023
Subtotal	0.006562	0.000596	0.000328	0	0.001789	0.00023

Table 5.2-2: Wind Speed and Direction Data Recovery

Year	Month	Wind Speed and Direction Recovery (percent)
1979	October	89.7
	November	12.2
	December	60.3
1980	January	86.2
	February	94.8
	March	85.2
	April	95.6
	May	70.6
	June	100.0
	July	67.2
	August	57.9
	September	98.8
	Summary for October 1979 to September 1980	76.4

Table 5.2-3: Annual Relative Frequency Distribution of Atmospheric Stability at Shootaring Canyon

Pasquill Stability Class	Occurrence (percent)
A	2.2
B	10.1
C	12.3
D	45.6
E	17.4
F	12.5

Period of Record: Oct. '79 through Sept. '80

Table 5.2-4: Meteorological Parameter Summary for Shootaring Canyon, October 1979 through September 1980

Year	Month	Predominant Wind Direction	Wind Speed (Average Knots)
1979	October	NE, S	6.1
	November	SSW, SW	5.0
	December	NE, E	3.6
1980	January	S	5.1
	February	N	5.5
	March	N, E	5.2
	April	S	6.8
	May	S	6.9
	June	S	7.3
	July	S	6.1
	August	SW	6.6
	September	SW	6.4
	Annual	S	6.0

Table 5.2-5: Wind Statistical Summary January 1 to December 31, 1983

Compass	Average Heading	Wind Speed (percent)	Wind (percent)
	N	5.20	8.91
	NNE	6.89	11.25
	NE	4.71	3.79
	EE	5.07	2.70
	E	4.71	4.39
	ESE	4.67	2.20
	SE	5.34	3.97
	SSE	5.28	5.78
	S	6.22	11.44
	SSW	7.31	15.96
	SW	7.45	7.70
	WSW	7.76	5.23
	W	5.39	2.29
	WNW	5.79	3.11
	NW	7.15	4.99
	NNW	5.34	6.27
Class	**No. of Occurrences**	**Percent of Occurrences**	**Justification**
Calm	8	0.13 of 6328	Observations
Variable	0	0.0 of 6328	Observations
Missing	2424	27.67 of 8760	Possible observations

Notes:
Data Capture = 72.329 percent

5.2.2 Precipitation

The annual average precipitation is estimated to be about 7 inches at the processing facility based on regional data compiled for periods of more than 30 years (Table 5.2-6). Table 5.2-7 summarizes monthly precipitation recorded at the processing facility from1980 through 1982 and shows an average annual precipitation during this short period of approximately 7 inches. Most precipitation at the site occurs as rainfall; a maximum of about 10 to 25 percent of the annual total is expected to occur as snowfall on nearby mountain slopes. Precipitation is about 20 inches or more on the upper slopes of Mount Hillers, north of the site.

A rain gauge exists at the site and is read daily. The total recorded rainfall for 2004 was 4.74 inches. The total for the first eleven months of 2005 was 9.9 inches.

Table 5.2-6: Annual Precipitation at Selected Regional Weather Stations in Vicinity of the Processing Facility

Station	Elevation (feet msl)	Precipitation (inches)
Bluff[a]	4316	15.2
Bullfrog Basin[b]	3822	11.2
Boulder[c]	6642	30.2
Escalante[a]	5786	20.7
Hanksville[d]	4308	10.3

Notes: National Climatic Data Center
(http://www.ncdc.noaa.gov/oa/climate/online/coop-precip.html)
[a] Period of record: 67 years, 1931-1997.
[b] Period of record: 31 years, 1967-1997.
[c] Period of record: 44 years, 1954-1997.
[d] Period of record: 66 years, 1931-1996.

Table 5.2-7: Monthly Precipitation at the Processing Facility, 1980-1982

	Precipitation (inches)		
Month	**1980**	**1981**	**1982**
January	1.02	0	0.38
February	1.04	0	0.22
March	1.11	0.98	0.16
April	0.21	0.08	0
May	0.18	0.31	0.06
June	0	0.76	0
July	0.29	0.53	0.16
August	1.11	0.32	1.94
September	1.33	1.00	1.15
October	0.80	2.13	0
November	0.26	0.69	0.89
December	0.28	0.06	0.76
Totals	7.63	6.86	5.72

Two separate rainfall seasons exist in the region. The first occurs in late summer and early autumn, when occasional moisture-laden air masses from the Gulf of Mexico bring showers and thunderstorms. The second rainfall period occurs during the winter, when Pacific storms move into the region.

5.2.3 Severe Weather Events

Thunderstorms in July and August result in scattered precipitation over the site. The usually intermittent, scattered nature of thunderstorm precipitation is reflected in the data collected during these months. Comparisons with concurrent data from several weather stations in the region presented in Table 5.2-8, indicate that thunderstorms produce varying amounts of rainfall with no consistent relation to elevation.

Related precipitation is usually light, but a heavy local storm can produce more than an inch of rain in a day. The maximum precipitation reported to have fallen within 24 hours over a 30-year period at Blanding, Utah was 1.98 inches (U.S. Department of Commerce, undated). Hailstorms are unusual in this area.

Table 5.2-9 shows the maximum precipitation estimated for the site (point precipitation) for specific durations and recurrence intervals. Maximum short-term precipitation is usually associated with summer thunderstorms, although winter storms may occasionally deposit comparable amounts.

Strong winds can occur along with the thunderstorms in the spring and summer. The site is also susceptible to occasional dust storms, which vary in intensity, duration, and time of occurrence. The basic conditions for blowing dust are found in the general vicinity: wide areas of exposed, dry topsoil; and occasional strong, turbulent winds. Dust storms usually occur during the warmer months following frontal passages and are occasionally associated with thunderstorm activities.

Tornadoes have been observed in the general region, but they occur infrequently. As presented in the 1978 Environmental Report (Woodward-Clyde, 1978), the probability of a tornado striking a given point in the vicinity of the facility site is estimated at 0.000032. The recurrence interval of such an incident is estimated at 31,000 years.

Table 5.2-8: Total Monthly Precipitation Recorded for the Site and at Selection Regional Stations, 1980

		Regional Station with Elevation			
Month	**Processing Facility (4650 ft)**	**Bullfrog Basin Marina (3822 ft)**	**Bluff (4316 ft)**	**Boulder (6642 ft)**	**Hanksville (4308 ft)**
January	1.02	1.27	2.49	2.73	0.27
February	1.04	1.49	0.87	2.35	1.86
March	1.11	0.44	0.54	0.39	0.32
April	0.21	0.52	0.88	0.89	0.63
May	0.18	0	0	0	0
June	0	0.08	0.13	0.24	0.06
July	0.29	0.5	0.15	0.74	0.23
August	1.11	0.61	0.26	2.41	2.73
September	1.33	0.5	0.88	1.03	0.49
October	0.80	0.07	0.22	0.07	0.1
November	0.26	0.55	0.13	0	0.03
December	0.28	8.01	8.11	13.58	7.31
Totals	7.63	14.04	14.66	24.43	14.03

Notes:
Source: National Climatic Data Center
(http://www.ncdc.noaa.gov/oa/climate/online/coop-precip.html)

Table 5.2-9: Estimated Maximum Point Precipitation for Selected Durations and Recurrence Intervals

	Recurrence Interval (years)				
	2	**10**	**25**	**50**	**100**
Duration	**Precipitation (inches)**				
1 hour	0.7	1.2	1.5	1.7	1.9
12 hours	1.1	1.8	2.2	2.5	2.7
24 hours	1.2	2.0	2.4	2.7	3.2
2 days	1.3	2.3	2.7	3.0	3.5
7 days	1.8	2.7	3.3	3.6	4.2
10 days	2.0	3.0	3.5	4.2	4.5

Notes: Sources are Hershfield, 1961; Miller, 1964.

5.3 Hydrology

Groundwater is the only water of substantial yield in the vicinity of the processing facility. No perennial streams occur at the site.

Information regarding ground water and surface water hydrology; and geology at the site is described in previous reports (Woodward-Clyde Consultants, 1984, Plateau, 1998c, Hydro-Engineering, 1998).

6. Radiological and Other Environmental Impacts from Proposed Action

Radiological and other environmental impacts from the proposed action have been assessed from normal operations as well as from accidents at the mill site and from transport of ore and yellowcake to and from the mill site, respectively.

6.1 Off-Site Radiological Releases and Dose Assessment from Normal Operations

The radiation exposure was quantified using the MILDOS-AREA program, version 2.20 beta (ORNL, 1998). MILDOS-AREA is a computer code developed at Argonne National Laboratory that calculates the radiation doses received by individuals and the general population within an 80-km radius of an operating uranium recovery facility. The MILDOS-AREA code was designed as a primary licensing and evaluation tool to provide an accurate analysis of uranium facilities for critical licensing and regulatory decisions. It is used to perform compliance evaluations and routine radiological impact analyses for various uranium recovery operations. The code is also used by uranium recovery licensees to perform evaluations for a specific site. MILDOS-AREA adopts many assumptions in conjunction with input parameters detailed in the U.S. Nuclear Regulatory Commission Draft Regulatory Guide RH 802-4 and portions of the Uranium Dispersion and Dosimetry (UDAD) document (Argonne National Laboratory).

MILDOS-AREA (Argonne, 1998) can consider nine environmental pathways: external radiation, inhalation of particulates and radon; and ingestion of soil, plant foods, meat, milk, aquatic foods, and water. Models developed in MILDOS can consider both point sources (stacks, vents) and area sources (ore pads, tailing areas). Particulate releases considered are explicitly limited to uranium-238, thorium-230, radium-226, and lead-210. The model accounts for releases of associated decay progeny using an assumption of secular equilibrium. Secular equilibrium occurs when the parent radionuclide has a much longer half-life than its progeny, and a sufficiently long time has elapsed for in-growth of the progeny such that all members or portions of a decay chain have approximately the same activity. Gaseous releases are limited to consideration of radon-222 plus in-growth of decay progeny. The dose to exposed individuals is calculated for comparison with requirements in 40 CFR 190 and 10 CFR Part 20.

MILDOS-AREA computes doses from mill releases to nearby workers and the public located within 80 kilometers (km). The model accounts for contaminated sources such as water, soil, and food that arise from the mill operations.

A sector-average Gaussian plume-dispersion model is assumed in the calculation of airborne concentrations of radioactive materials from fixed-point sources. For area sources, either a virtual-point method or finite-element integration method is used. The latter method considers a composite of several point sources with distributed dispersion. For vertical-dispersion, either Briggs dispersion coefficients or Matrin-Tickvart coefficients are used. Briggs dispersion coefficients are appropriate for tall sources such as a uranium mill stack, while the Martin-Tickvart coefficients are more appropriate for near-ground level sources such as ore piles and tailings piles.

6.1.1 MILDOS-AREA Input Parameters

MILDOS-AREA allows the user to define and adjust several input parameters that contribute to the potential dose to on-site workers and the public. Shootaring's mill processes are the primary sources of radionuclide release. The physical mechanisms controlling dispersion of these releases are influenced by wind speed and direction, particulate sizes, distance, food and water parameters. These physical parameters and receptor-related parameters are summarized in Table 6.1-1 and discussed separately in the following sections.

Wind Characteristics

A 6x6x16 matrix consisting of stability class, wind speed in miles per hour (mph), and the direction of the wind defines the annual average for wind characteristics. Each matrix entry signifies a percentage of the entire matrix and therefore the summation of all entries in the matrix is equal to one. The data used in the model were obtained in 1979-1980 and first presented in the 1996 renewal application (Plateau, 1996b). According to the American Meteorological Society, only small changes of averaged annual meteorological data can be expected. Thus, the meteorological data are assumed to represent current conditions.

Population Data

The primary purpose of the MILDOS-AREA model is to estimate doses to individuals and the general population within an 80 km radius of an operating uranium mill. . Model results can be compared to associated regulatory limits for compliance purposes. Population data are input within a 12 x 16 matrix consisting of distance and direction up to 80 km from the mill site. According to Shootaring's site manager, the populations of the surrounding areas are as follows: One residence, containing three residents, approximately 2.5 km to the east of the site, Ticaboo lies four km south of the site and contains 47 permanent residents. Upon operation of the mill, the population of Ticaboo is expected to increase to approximately 200, supplemented with mill workers and their accompaniments. Bullfrog, 22 km south of the facility, has 210 residents. Approximately 5 km farther south from Bullfrog, located on the opposite shore of Lake Powell, is Halls Crossing

Table 6.1-1: MILDOS Model Parameters for Radiological Assessment

	Parameter	Value
Ore	Ore quality, U_3O_8	0.25 percent [a]
	Ore Production Rate	3.65 x 10^5 ton/yr [g]
Food Pathway Parameters	Fraction of year cattle graze locally	33 percent [a]
	Fraction of stored feed that is grown locally	less than 1 percent [a]
Area Food-Production rate	Vegetables	494 kg/yr-km^2 [e]
	Meat	106 kg/yr-km^2 [e]
	Milk	461 kg/yr-km^2 [e]
Wind and Population Data	Wind statistics	see Appendix A
	Population statistics	see Appendix A
Particle Size Distributions	Yellowcake dryer and packaging	3 µm [b]
	Ore activity (crushers and grinders)	1.5 µm [b]
	Ore pile and tailings 30 percent 70 percent	 7.7 µm [b] 54 µm [b]
Ore Handling and Storage	Maximum area of ore pad	14800 m^2 [a]
	Height of ore storage pile	3-8 m [a]
	Ore pad storage time	12 days [a]
	Nuclide release rates Uranium-238 Thorium-230 Radium-226 Lead-210 Radon-222	 7.75 x 10^{-3} Ci/yr [c] 7.75 x 10^{-3} Ci/yr [c] 7.75 x 10^{-3} Ci/yr [c] 7.75 x 10^{-3} Ci/yr [c] 100.7 Ci/yr

Table 6.1-1: MILDOS Model Parameters for Radiological Assessment(continued)

Crushers, Grinders, Rod Mills, Ore Blending, Solvent Extraction, Countercurrent Decantation, Ion Exchange and Leaching	Estimated dust lost to atmosphere via ore transportation devices (dumping of ore)	0.768 MT/yr [a]
	Estimated area of dust release from ore dumping	900 m^2 [f]
	Nuclide release rates Uranium-238 Thorium-230 Radium-226 Lead-210 Radon-222	 6.5 x 10^{-3} Ci/yr [c] 6.5 x 10^{-3} Ci/yr 6.5 x 10^{-3} Ci/yr 6.5 x 10^{-3} Ci/yr 25.17 Ci/yr [a]
Yellowcake Drying and Packaging	Yellowcake production rate	2131.88 Kg/day [g]
	Stack height	27.43m [a]
	Fraction of yellowcake released to atmosphere	0.05 percent [b]
	Activity fractions Thorium Radium Others	 0.275 percent [b] 0.25 0.5
Solid and Tailings Disposal Cell 1	Tailings area	88,200 m^2 [d]
	Covered tailings flux	20 pCi/m^2-s [b]
	Nuclide release rates Uranium-238 Thorium-230 Radium-226 Lead-210 Radon-222	 0 0 0 0 55.6 Ci/yr [a]

Table 6.1-1: MILDOS Model Parameters for Radiological Assessment(concluded)

Solid and Tailings Disposal Cell 2	Tailings area	156,600 m^2 [d]
	Uncovered-dry tailings flux	467 pCi/m^2-s [b]
	Nuclide release rates Uranium-238 Thorium-230 Radium-226 Lead-210 Radon-222	 2.175 x 10^{-2} Ci/yr [b] 3 x 10^{-1} Ci/yr 3 x 10^{-1} Ci/yr 3 x 10^{-1} Ci/yr 2.306 x 10^{3} Ci/yr [a]

Notes:
Ci/yr = Curies per year; kg/yr-km^2 = kilograms per year per square kilometer; m = meters; m^2 = square meters; MT/day = Metric tons per day; MT/yr = Metric tons per year;pCi/m^2-s = picoCuries per square meter per second; µm = micrometer

[a] Plateau, 1998b, Table 5.4-10
[b] NRC, 1980
[c] Woodward-Clyde, 1980.Table S2-F-1. Appendix S2-F
[d] Plateau, 2005
[e] Bureau of Census, http://www.census.gov/
[f] Based on estimated area of ore loading opening from topographical map.
[g] Plateau, 1996c

Marina with 94 residents. About 6 km south of Ticaboo is a small commercial area on the highway called Offshore, which contains 18 residents. Also within 80 km of the site are two small towns called Boulder and Hanksville at 69 km North West and 74 km North of the Shootaring mill respectively. A Utah population table indicates that the populations of Boulder and Hanksville are approximately 180 and 250 (Bureau of Census, 2005). The Navajo Indian Reservation with a total population of 360 is located south of Halls Crossing on the other side of Lake Powell. Also near the site are rural communities and secluded houses and farms, approximately 50 air miles northwest beyond Henry Mountain. These populations are based on a 1998 survey of the area and updated in 2005 (Bureau of Census, 2005). Recently a there has been a residence established approximately 2.5 km east of the site. This is the closest residence to the mill and offsite doses to this residence will be estimated.

Food Production

Grazing season occurs 33 percent of the year during which cattle graze on pasture land. Cattle eat stored feed during the off-grazing season with less than one percent of the stored feed grown locally. This information was obtained from the 1998 Renewal Application. The food production rate used in the model is Utah's average productivity in 1984 and represents the distributed density throughout the state. This information is based on data from the U.S. Bureau of Census.

Particle Sizes

The distances that particles travel in air are inversely related to their size. MILDOS-AREA allows particulate sizes to be defined for ore and tailings piles, crushers and grinders, and yellowcake dryers. The particle size distributions used for the Shootaring model were obtained from the Final Generic Environmental Impact Statement on Uranium Mining and are consistent with recommendations of the International Commission on Radiological Protection (MILDOS AREA Users Guide, 1998)

Source Parameters

The Shootaring uranium mill has four primary sources of radioactive emissions: an ore pile, ore crushers and grinders, yellowcake dryer, and tailings pile. Based on a topographical map of the mill facility, each source is defined and assigned input parameters to model the emissions **(**See MILDOS printout in Appendix A**)**. The ore pile area and height were taken from the 1998 renewal application and represent maximum values. Radiological release estimates of lead-210, radium-226, thorium-230, and uranium-238 are based on an average of 0.25 percent U_3O_8 content in the ore. Estimates of plant releases have been scaled by a factor of 1.67 to account for the planned increase in ore grade compared to that from the original Environmental Report (ER) for the Shootaring Mill (Woodward-Clyde, 1978c appendix S2-F). They are based on information provided by the architect-engineer for the project, using assumptions and methods described in the ER and in response to NRC questions on the ER dated August 29, 1978.

The radon release for the ore pile was calculated using the estimated ore production of 365 thousand tons per year and the following assumptions provided by the Final Generic Impact Statement on Uranium Mining: 20 percent of the radon is available for release from the mineral grains (yields an emanating fraction of 0.2), 90 percent of equilibrium will be reached within 12 days, and the particular activity for the ore is 280 pCi/g. This value was adjusted using ratios to account for the area and grade of the Shootaring ore pile.

Ore processing includes the following sources: crushers, grinders, rod mills, fine ore blending, solvent extraction, countercurrent decantation, ion exchange and leaching. Ore dust emissions are controlled by automatic water spray systems. Also, at the point of entry into the semi-autogenous (SAG) mill, a continuous flow of water is introduced along with the ore feed. Due to emission control equipment, the ore dump pocket emits negligible amounts of sulfuric acid mist and radon-222. The radon released to the atmosphere from all ore activity sources was taken from the 1998 renewal application, scaled to the proposed ore grade. Radiological release estimates of lead-210, radium-226, thorium-230, and uranium-238 were also adjusted to reflect the anticipated ore grade of 0.25 percent U_3O_8.

Yellowcake production was derived by scaling the production rate from the 1998 renewal application by the increase in ore grade. The operating parameters of the yellowcake dryer stack listed in Table 3.2-1 suggests that, an average of 0.03 percent of uranium produced in mills escapes as particulates into the atmosphere. The final Generic Environmental Impact Statement on Uranium Milling (NRC,1980) provides releases of radionuclides other than uranium isotopes based on reported values for in situ leach facilities. The activities of thorium-230 and radium-226 are 0.275 percent and 0.25 percent of uranium-238 activity where other activity fractions such as lead and polonium are 0.5 percent of the uranium-238 activity in the yellowcake.

The tailings pile is the primary source of radon and particulate emissions at the mill. Radiological release estimates of lead-210, radium-226, thorium-230, and uranium-238 are based on an average of 0.25 percent U_3O_8 content in the ore. The tailings will consist of two cells: 21.8 acres (Cell 1) and 38.7 acres (Cell 2). In terms of radon and particulate emissions, the most conservative scenario for the tailings pile occurs when Cell 1 is full and radon barrier has been placed, and Cell 2 is full and dry (Hydro Engineering, 2005). Particle emissions from the covered tailings pile will be insignificant and the maximum radon flux expected from the covered tailings pile is 20 picoCuries per square meter per second (pCi/m^2-s), the maximum allowed in 10 CFR 40, Appendix A. The flux from the uncovered cell is estimated at 466 pCi/m^2s for dry uncovered conditions (NRC, 1980). Table 6.1-1 presents a summary of the model input parameters.

6.1.2 Assumptions and Uncertainty Analysis

Uncertainty is inherent in the dose and risk assessment process (EPA, 1989). It can result in both over- and under- estimations of dose. The interpretation of the acceptable dose should consider the implications of an uncertainty analysis and any assumptions presented in the model. The uncertainties in the estimation of dose relate to the characteristics of the receptors and the movement of the radionuclides. The uncertainties and assumptions related to these factors are described in the following paragraphs.

Transport Analysis

The MILDOS-AREA model accounts for dry deposition of particulates, re-suspension, radioactive decay and progeny in-growth, and plume reflection. Deposition buildup and in-growth of radioactive progeny are considered where surface concentrations are estimated (ORNL, 1996). In MILDOS-AREA, one can vary the emission rates of the sources as a function of time. This is used to model sources such as tailings piles, from which radon and particulate emissions increase over time. In the Shootaring model, the most conservative scenario is posed: Cell 1 is full and covered with an interim cover to limit radon flux to 20 pCi/m^2s, and Cell 2 is full with exposed bare tailings.

Receptor and Off-Site Population Analysis

The primary exposure pathway for site workers and the public is inhalation of airborne emissions from the site. This pathway is defined by the air concentration at the receptor, the amount of time a person is present, and the breathing rate of the person. The air concentration of mill emissions is modeled based on source input paramenters.

Because the amount of time a person is present affects the dose, exposure frequency and duration for the receptors is considered. Residents within 80 km of the mill are assumed to be at home for the entire duration of the model year (365 days). On-site receptors are assumed to be at the mill 2000 hours per year. MILDOS default breathing rate values based on the "Standard Man" model were used.

6.1.3 MILDOS Model Results

The Shootaring MILDOS model uses the source input parameters as well as wind speeds and directions, population distribution, and food distribution parameters to calculate doses to workers and public near the mill. Residents within an 80-km radius of the mill, two on-site receptors and two offsite receptors are placed in the model for evaluation. During operation of the mill, all of the Shootaring Mill workers will be radiation workers and will, therefore, have occupational radiation dose limits. The scenario for the highest potential public dose,100 percent occupancy at the restricted area fence line, is represented by the Office Dose below. Two offsite receptors have also been modeled. One is the nearest residence to the site and is approximately 2.5 km to the east, southeast. The other is a residence 3.2 km south, southwest of the site just north of the town of Ticaboo.

According to the results of the MILDOS model, the office dose at the Shootaring site would receive a Total Effective Dose Equivalent (TEDE) of 61 mrem/year and a dose equivalent to the lung of 96 mrem/year, assuming that he/she is at the site boundary for 8760 hours per year. . This scenario is very unlikely since there are no residences near the site boundary, but does represent a work case dose to a member of the public

On-site, outdoor radiation workers will be subject to the highest dose when working near the tailings pile. A receptor standing next to the tailings pile will have a 55 mrem/y total effective dose equivalent, assuming 2000 hours on site a year. This is less than two percent of the 5000 mrem/yr allowable effective dose equivalent for a radiation worker (Utah administrative rule R313-15-301(1) (a)).

The adult resident 2.5 km to the east, southeast of the site would receive a TEDE of 4.9 mrem per year and a dose equivalent to the lung of 10 mrem per year resulting from site emissions. The adult resident 3.2 km south, southwest of the site would receive a TEDE of 11 mrem per year and a dose equivalent to the lung of 19.5 mrem per year. For both of these receptors, the estimated TEDEs and dose equivalents are below the limits of 100 and 25 mrem respectively. The TEDE for the south, southwest resident does not comply with the 10 mrem constraint rule (Utah Admin. Rule R313-15-101 (4)). This dose estimate is conservative since the resident likely will spend some time indoors and the mill likely will run 350 out of 365 days in the year. MILDOS-AREA model output assumes releases 365 days per year and does not adjust modeled outdoor concentrations for indoor scenarios.

Ticaboo residents account for the largest doses to the public since it is the closest town to the mill. The collective TEDE to Ticaboo residents is 0.65 person-rem which is 2.5

millirem per year per person (0.65/260 = 2.5). The colletive TEDE to the population within 80 km is 0.823 person-rem per year which corresponds to 0.5 mrem/yr per person (0.823/1544). Regional doses to populations beyond 80 km of the Shootaring mill site are negligible. Table 6.1-2 provides a summary of these results.

Table 6.1-2: MILDOS Model Results

Receptor/Location	Total Effective Dose Equivalent (mrem/y)	Dose Equivalent to Lung (mrem/y)
Office	61[a]	96
Ticaboo Resident	2.5 [b]	16
East Resident	4.9	10
Southwest Resident	11	19.5
Within 80km of site	2 [d]	3
Beyond 80km of site	Negligible[c]	Negligible

Notes:
mrem/yr = milirem per year

[a] Assumes individual is at mill site boundary for 365 days out of the year.
[b] Assumes resident is in Ticaboo 365 days out of the year.
[c] Values are low enough to be considered zero by MILDOS Modeling.
[d] Average effective dose per person based on total population within 80 km of site.

6.1.4 Non-radiological Impacts

Due to the inherent remoteness of the site, non-radiological offsite impacts such as increased noise and traffic in the area will be minimal. The town of Ticaboo, approximately 3 km south of the site, is owned by PRL and was established primarily to house families employed by the mill. The housing and infrastructure to support the increased workforce supporting operation of the mill is already in place.

The mill provides its own electrical power via onsite diesel power generators. No public power utilities service the mill.

6.1.5 Non-radiological Effluent

Non-radiological solid and liquid effluent from routine mill operations are contained within engineered structures within the mill complex and have limited to no potential for offsite impact.

Non-radiological gaseous effluents are limited mainly to kerosene evaporation in the solvent extraction process as described in Section 3.2.5 and ammonia emissions from the yellowcake drying furnace as described in Section 3.2.7. The potential offsite impacts of these emissions are evaluated below.

The kerosene loss due to evaporation was estimated to be 8 gallons (24 kg) per day through three roof vents operating collectively at 36,000 cfm (1,467,720 m^3 per day). Given this information, the daily average kerosene air concentration in the effluent would be 0.0164 mg/m^3 (= (24 kg/d*1000 mg/kg)/1,467,720 m^3/d). The 8 hour time weighted average (TWA) threshold limit value (TLV) for kerosene is 200 mg/m^3 (ACGIH 2006). The average effluent concentration at the point of release is much less than the 8 hour TWA TLV thus any potential offsite human impacts would be minimal.

Using a similar approach for ammonia, Section 3.2 7 states that the concentration of ammonia in yellowcake dryer stack emissions is 5 ppm. The 8 hour TWA TLV for ammonia is 25 ppm (ACGIH 2006). Again, the average effluent concentration at the stack is lower than the 8 hour TWA TLV. Potential offsite human impacts would be minimal.

6.2 Environmental Effects of Accidents

The radioactive materials handled at the mill have specific activities on the order of 10^{-9} Ci/g for the tailings, 10^{-9} Ci/g for the ore, and 10^{-6} Ci/g for the refined yellowcake product. Because of the low specific activities, releases of large quantities are required to produce significant human health and environmental impacts. Engineering controls generally limit the potential for large-scale releases even during accidents. Four categories of plant-related accidents involving radioactivity have been considered as well as releases of hazardous chemicals:

1. Trivial incidents.
2. Small releases to the environment.
3. Large release to the environment.
4. Transportation accidents.
5. Releases of hazardous chemicals

Trivial incidents include spills, ruptures in tanks or plant piping containing solutions or slurries, overfilling process tanks, and the rupture of a tailings pond retention system pipe in which the tailings slurry is released into the tailings facility. Small releases include failure of the air-cleaning system serving the concentrate drying and packaging area, or in the yellowcake drier. Large releases include a tornado dispersing materials from the mill buildings or tailings area.

In the 1998 license renewal application (Plateau, 1998b), a large release of tailings solution off site was considered. A recent design change calls for the separation of the liquid from the tailings slurry prior to placement of the tailings in the tailings cell. The liquids will be transferred to a lined storage/evaporation pond. The location of the pond is such that if a breach of the pond embankment occurred with a loss of liquid, the liquid would be contained in the tailings cell. Therefore, this potential accident has been eliminated from further consideration.

6.2.1 Trivial Incidents Involving Radioactivity

The following accidents at the mill caused by human error or equipment failure should not result in the release of radioactive material to the environment.

LEAKS OR RUPTURE IN TANKS OR PIPING
Uranium-bearing slurries and solutions are contained in several tanks comprising the leach, washing, clarification, and precipitation stages of the mill circuit. Human error during the filling or emptying of tanks or the failure of valves or piping in the circuit might be expected to occur several times annually during normal operations. Large spills from tank failures or uncorrected human error might involve the release of several hundred pounds of uranium in the liquid phase to the mill floor. However, the entire content of each tank would be contained within the mill sumps and the spill retention dike and therefore should not reach the environment.

RUPTURE OF PIPE IN THE TAILINGS DISPOSAL SYSTEM
The maximum throughput of the mill is approximately 1000 tons of ore per day. Operating three shifts a day approximately 44 T (40 MT) per hour of sands, silt and clay-sized particles are transported to the tailings area through the tailings disposal system piping. This material is transported as a slurry (approximately 45% solids), which contains mill chemicals and radioactive materials. Within the tailings area, the liquids are then separated from the solids and pumped to the nearby evaporation pond. Occasional ruptures in the tailings slurry pipeline are expected to occur. A rupture would allow liquids to flow into the secondary containment, an 18-inch diameter polyethylene half pipe supporting the slurry pipeline. The liquids would then flow by gravity to the tailings facility. Fresh water from the mill can then be used to flush any residual materials in the trough into the tailings facility. Should a design for separation of the tailings solution at the CCD circuit be feasible, the mitigation measures for controlling releases will be designed into the system.

6.2.2 Small Release Involving Radioactivity

The following accidents, caused by human error or equipment failure, are likely to release small quantities of radioactive materials to the environment. The releases, however, are expected to be small in comparison with the annual release from normal operations.

AIR-CLEANING SYSTEM FAILURE IN THE YELLOWCAKE DRYING AREA
The off-gases from the yellowcake drying operation, which contain entrained solid particles of yellowcake, pass through a wet scrubber which collects roughly 98% of the solid material, depending on particle size. Should the scrubber fail, excessive quantities of yellowcake could be released to the environment. The stack is routinely monitored for

uranium and the circuit is checked approximately every four hours of operation. Under conditions of scrubber failure, drier operations would be terminated until the scrubber is repaired. Although quantitative data on failures of wet dust collectors are unavailable, a catastrophic scrubber failure is highly unlikely. Progressive failure, in which case the plugging of vents causes back pressure, would be readily detectable during operational checks and result in inefficiencies, rather than complete failure.

Drying and packaging operations will be terminated when controls are inoperative. When the checks indicate the equipment is not operating within the range prescribed for peak efficiency, actions shall be taken to restore parameters to the prescribed range. When this cannot be done without shutdown and repairs, drying and packaging operations shall cease as soon as practicable. Operations will not be restarted after cessation due to off-normal performance until needed corrective actions have been identified and implemented. All such cessation's, corrective actions, and restarts shall be reported to the State of Utah, Division of Radiation Control in writing within 10 days of the subsequent restart.

GAS EXPLOSION IN THE YELLOWCAKE DRYING OPERATION

A diesel-fuel-fired furnace is used to dewater the yellowcake slurry after the filter wash operation. The furnace consists of several hearths enclosed within a large cylinder. The off-gas from the drier is vented through a wet scrubber. An explosion in the drier or the fuel piping, however, could blow off the duct work associated with the ventilation system and disperse yellowcake into the mill work space.

The consequences of explosion accidents are limited by the concentration of heavy material that can be maintained in the air, estimated to be approximately 100 mg/m^3. For a room with a volume on the order of 10^4 m^3, the quantity of yellowcake released to the room air is estimated to be approximately 1000g. Based on the conservative assumptions that (1) all of the material would be swept out into the environment when the room is ventilated and (2) that 100% of the insoluble particles are in the respirable size range, the office receptor would receive an TEDE of 0.3 mrem. The above calculation was made using MILDOS-AREA by adjusting the release to occur over a one-year period, the average wind speed and class directed toward the office worker receptor location, and occupancy of the receptor was 100 percent.

If such an event were to occur, downwind unrestricted areas would be surveyed for excess alpha activity. It is reasonable to expect that typical public land use, such as cattle grazing and recreation, of the downwind unrestricted areas would be temporarily limited until the areas are surveyed and reclaimed if needed. Contaminated soils could be removed and recycled through the mill circuit or disposed of in the tailings facility, thereby minimizing any long-term environmental impact.

6.2.3 Large Release Involving Radioactivity

There is only one conceivable accident that could release large quantities of radioactive materials to the environment resulting in significant environmental and health impacts. This hypothetical accident assumes that a tornado strikes the yellowcake processing area.

High winds, thunderstorms and dust devils are frequent in spring and summer and may occasionally cause slight damage in their paths. Although tornadoes are an infrequent occurrence and tend to be less destructive than those appearing further east, their maximum probable impact has been estimated. In a typical tornado, the wind speed approximates 240 mph, of which approximately 190 mph is rotational and 50 mph is translational. The mill structures are not designed to withstand a tornado of this intensity.

The nature of the milling operation is such that little could be done to secure the facility even with advance tornado warning. It is not possible to accurately predict the release during such an event. A conservative approach was adopted where it is assumed that two days' production of yellowcake is in the process piping (2480 kg) and will be released. In addition, it is assumed that 48 drums containing 16 MT (18 T) of yellowcake are onsite when the tornado strikes; and that all of the unpackaged and 15% of the containerized material is released. Thus, the tornado is assumed to cause about 4880 kg (10736 lb) of yellowcake (equivalent to the contents of fourteen 55-gallon drums) to become airborne.

MILDOS-AREA is designed to calculate the dose to receptors from a constant release from the site over a one year period. For dispersion analysis from a single release, the input parameters were adjusted to distribute the release from the tornado over a year, assuming a constant but conservative wind direction and speed. The average annual wind speed was directed into a 45 degree cone to the south toward Ticaboo. Using the above assumptions, the TEDE to a Ticaboo resident was calculated to be 38 mrem while the dose equivalent to the lung was estimated to be 317 mrem. The TEDE to the south, southwest resident was calculated to be 49 mrem while to dose equivalent to the lung was estimated to be 387 mrem.

Given this scenario and the estimated ground deposition of uranium in the model output, soil remediation of unrestricted areas south of the mill site would be required. It is reasonable to expect that typical public land use, such as cattle grazing and recreation, of the downwind unrestricted areas would be temporarily limited until the areas are reclaimed. Contaminated soils could be removed and recycled through the mill circuit or disposed of in the tailings facility, thereby minimizing any long-term environmental impact.

6.2.4 Transportation Accidents

Transportation of materials to and from the mill can be classified into three categories:

1. Shipments of refined yellowcake from the mill,
2. Shipments of ore from the mine to the mill, and
3. Shipments of process chemicals from suppliers to the mill. An accident in each of these categories has been considered.

SHIPMENTS OF YELLOWCAKE

The refined yellowcake product is placed in 55-gallon drums, classified by the Department of Transportation as Type A packaging (49 CFR Parts 171-189 and 10 CFR Part 71), holding an average of 750 lb. We have assumed that the yellowcake will be shipped 2400 km (1500 miles) by truck to the conversion plant in Metropolis, IL. The average truck shipment contains approximately 48 drums, or 36,000 pounds of yellowcake. Based upon the current mill capacity, 1.7 million pounds of yellowcake annually, approximately 46 such shipments will be required annually. Published accident statistics set the probability of a vehicle accident at approximately 1.4×10^{-6}/km (DOT, 2003).

The annual probability of a vehicle accident while transporting the yellowcake to the conversion plant is 0.15, or one accident in about 7 years. Using the method proposed in

(NRC, 1980), a wind speed of 5 m/s, and a release time of 24 hours, the environmental release fraction is 0.009. Assuming all uranium particles are in the respirable size range and a population density of 7.5 persons per square mile, the 50-year collective dose commitment to the lungs of the nearby general population was calculated to be 0.7 person rems.

The assumptions in the calculations are conservative since the spilled yellowcake would be cleaned up as rapidly as possible to prevent spread of the contamination.

SHIPMENTS OF ORE TO THE MILL
While all sources of uranium ore to be milled have not been identified, it is assumed that ore will be hauled in trucks an average of 161 km (100 miles), the sources ranging from local mines as well as from mines as far away as Moab, UT, which is approximately 290 km (180 miles). A conservative estimate (NRC, 1980) of the respirable fraction of ore dust in a truck is 0.01. If 25 ton trucks are used, 13,240 trucks per year will be required to supply the mill at full capacity of 365,000 tons per year. Using the accident rate from above and 100 miles per trip, three accidents are predicted per year. It should be noted that the NRC, 1980 predicts that 55 percent of these accidents will be minor accidents with no release.

It is estimated (NRC, 1980) that only 1 percent of the ore is in the respirable range. Applying the same 0.009 release fraction, the average respirable quantity to be released in an accident is only 2.04 kg (4.5 lb). Since the specific activity of the ore is three orders of magnitude less than that of yellowcake, it is obvious that the radiological exposure to this release is very small. Therefore it is easy to conclude that the radiological impact of ore transport is considered insignificant.

SHIPMENTS OF CHEMICALS TO THE MILL
The most serious trucking accident involving the transportation of chemical to the mill would most likely involve the shipment of anhydrous ammonia. The probability of a truck accident is 1.4×10^{-6}/km, but not all of those predicted accidents would release ammonia. If, however, large amounts of ammonia were released, human lives could be endangered.

6.2.5 Releases of Hazardous Chemicals

The potential environmental effects from accidents involving nonradiological material is expected to be small. Ducting and ventilation systems in the solvent extraction and precipitation areas are designed to vent and dilute the chemical vapors emitted and protect the workers from hazardous fumes. Failure of these ventilation systems may result in the short-term collection of these vapors in the building air. Since the vapors would ultimately be discharged to the atmosphere in either case, such a failure would have no incremental effect on the environment.

A number of chemical reagents used in the process are expected to be stored in relatively large quantities at the mill site. Specifically, storage tanks are provided for such materials as sulfuric acid, ammonia, and sodium chlorate. If an overflow or rupture were to occur, drainage of the liquid reagents would be contained in the mill sumps and the spill containment dikes.

The only chemical which may seriously impact the environment is ammonia. This event was assessed in Plateau's original application (Plateau, 1996c). A break in the ammonia storage tank's external piping would result in only a minor release. The line carrying ammonia to the storage tank from the tank truck could rupture, in which case the release rate is assumed to be limited to 0.2 lbs (100 g/s) of vapor. This would be released outside of the building. The truck delivery person would be trained to respond by avoiding the plume and advising nearby personnel to clear the area until the cloud disperses. The resulting concentration of ammonia at 2000 m was conservatively estimated to average approximately 35 mg/m^3 over the release period. Published information on ammonia (Texas, 2003) indicates that odors are readily detectable at concentrations between 20-50 ppm and that levels in the range of 150-200 ppm have a visible cloud with general discomfort and tearing for humans, normally with no lasting effect with short-term exposure. The most restrictive time-weighted average limit for workers exposure is given as 17 mg/m^3 by the American Conference of Government Industrial Hygienists. Since the exposure duration would be expected to be short compared to exposure in the work place, no significant off-site impact should result

7. Evaluation of Alternatives

The Selected Alternative is to amend the license to allow operation of the uranium mill to process 0.25 percent ore as presented in Sections 3 and 4 and to allow the addition of a vanadium extraction circuit. This does not preclude continuing in the standby mode until the resources are obtained and the modifications made to the existing mill that are necessary to begin processing the uranium ore.

The Second Alternative, while less desirable, is to process ore under the original license conditions (Plateau, 1996b) where the ore grade averaged 0.15 percent uranium. No vanadium extraction circuit would be added.

The No Action alternative is to continue under the current approved license. Should the request for an operating license be denied, Plateau Resources will proceed to decommission the mill and reclaim the tailings facility.

7.1 Unavoidable Adverse Environmental Impacts

Unavoidable adverse environmental impacts associated with operating the mill includes the release of small quantities of radionuclides, diesel exhaust from operating the electrical generator, and vehicle exhaust from workers going to and from work. In addition, current employees and additional mill workers hired to support the operations will be exposed to direct radiation as well as airborne radionuclides.

The incidence of occupational safety accidents and the severity of the accidents are expected to be similar to those at other operating mills. Other sources for accidents arise from vehicular travel to and from the site. Site workers will normally drive from nearby Ticaboo or from the Hanksville area. In addition, it is estimated that an average of 40 ore trucks per day will be received at the site creating additional traffic on Highways 24, 95, and 276.

Tailings facility design for the Selected Alternative has improved significantly compared to the Second Alternative (original design). The tailings will be dewatered and the water will be recycled or evaporated in a lined evaporation pond. The original design disposed of the tailings and tailings liquids in the lined disposal cell. While the cell was designed to contain the liquid, the potential for liquid releases to the environment has been significantly reduced by placing only relatively low moisture tailings in the disposal cell.

The Selected Alternative and the Second Alternative could potentially create a higher number of industrial accidents and total radiation exposure than the No Action Alternative since the number of employees will be greater and the exposure period much longer. The selected alternative could potentially create a slightly higher radiation exposure than operating the mill under the Second Alternative operating parameters.

7.2 Irreversible and Irretrievable Commitments of Resources

The Selected and Second Alternatives require significant energy and water consumption. Diesel generators are used to supply electrical power to the site. Diesel power levels and thus diesel fuel consumption would be significantly less for the No Action Alternative, especially over the long term. Also industrial chemicals are consumed in the milling process.

7.3 Relationship between Local and Short-Term Uses of the Environment and the Maintenance of Long-Term Productivity

Several construction projects will be required to prepare for the Selected Alternative including adding the vanadium circuit, restoring previously removed mill process components and laboratory equipment, and constructing the cell and solution storage/evaporation pond. Upon approval of the Selected Alternative, additional personnel will be hired to supplement the small staff currently at the site. Upon starting the mill, these staff will be trained to support the mill operations. This is expected to provide stable long-term employment opportunities for area residents in an area that has and is currently experiencing the highest unemployment rate in Utah.

7.4 Socioeconomic Impacts

Implementation of the Selected Alternative will require a total staff of approximately 70 at the site for the foreseeable future. In the near term, construction personnel will be imported and require temporary housing. Anticipated annual expenditure for personnel and other site operations is approximately $8 million in year 2005 dollars. This is expected to have a significant positive effect on the local area.

If the Selected Alternative or Second Alternative are not approved, the No Action Alternative is to proceed with the decommissioning. The site staff will be increased to approximately 20 for the duration of the decommissioning, creating a positive short-term economic impact on the local area.

7.5 Cost-Benefit Balance of Environmental Action and Alternatives

The cost-benefit balance of the Selected Alternative and Second Alternative is very similar with the exception that yellowcake production will be higher with higher grade ore and the recovery of vanadium from the tailings renders the tailings less hazardous and results in a useful product. Should an increase in grade ore not be allowed, additional low grade ore will have to be transported to the site to mix with the higher grade ore, creating greater transportation-related impacts and unfavorably changing the break-even economics of uranium processing. Under the No Action Alternative, there is a long-term local environmental benefit from closing the mill and reclaiming the tailings. This is, however, off-set by depriving the nuclear power industry of much-needed uranium for fuel and a permanent loss of high paying jobs for the area.

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Appendix A
MILDOS Model Output

Routine Operations

Explosion Scenario

Tornado Scenario