1993 ALARA Audit Report

of the

ATLAS MINERALS DIVISION

of

Atlas Corporation

Radiation Protection Program

at the

Moab Mill Site

May 1994

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Section II

Executive Summary

In compliance with Source Material License Number SUA-917, License Condition 29, an ALARA audit was conducted for calendar year 1993.

The findings of this audit are presented below:

1. As is depicted by this audit, occupational exposure to radiation and radioactive materials is satisfactorily controlled, and in some cases being lowered.

2. Surface water quality upstream and downstream from the mill, reflect no significant differences.

3. There were increasing trends in Rn^{222} on three environmental monitoring stations. Station 2 surpassed 148% average MPC. This station increased last year (1992) from 137%. It should be noted that the average MPC would be 127% when one takes into consideration the 21% average MPC of the background station S6. The gamma radiation from the TLD badges indicated last year (1992) that three stations had decreasing trends. This year (1993), no trends were observed at any of the monitoring stations. Gamma radiation levels continue to decrease.

4. Although the dose equivalent for all employees is very low, a TLD badge is worn at all times by each employee who is required to perform work in the mill area. This function also includes contractors. No trends were apparent in any of the dose equivalents. The control badge revealed a higher reading than any of the employees.

5. Routine breathing zone samples were taken each month for all office and supervisory employees. No increasing trends were apparent; two displayed a decreasing trend.

6. Non-routine breathing zone samples were taken each day. This activity included the contractor employees dismantling the mill. No trend was apparent in the breathing zone samples for 1993.

7. The bioassays (urine analysis) displayed no trends. One analysis revealed an action level, and the sample taken two days later was clear.

8. There seems to be a difference in vegetation samples, sampled at the nearest pasture and the background station. The pasture is lower in both the Ra^{226} and the Pb^{210} analysis.

9. The results from the soil samples displayed either no trends or decreasing trends on all samples.

10. Trends in the ground water wells revealed an apparent surpass of the standard limits on some of the constituents in the samples (see Table 14 series).

Radiological

U-Nat: a significant decrease in one well; the remaining three wells displayed no trend.

Ra^{226}: a weak decrease in one well; the remaining three wells displayed no trend.

Ra^{228}: no trend in all four wells.

Gross Alpha: a decreasing trend in two wells; the remaining two wells displayed no trend.

Non-Radiological

Na: no trend in all four wells.

Cl: one well with an increasing trend; the remaining three wells displayed no trend.

SO_4: one well with a decreasing trend; the remaining wells displayed no trend.

NO_3: one well with a decreasing trend; the remaining wells displayed no trend.

Cr: no trends.

Pb: increasing trends for all four wells.

Mo: one well with an increasing trend; the remaining wells displayed no trends.

Ni: no trends.

Ag: no trends.

V: no trends.

Se: decreasing trends for two wells; the remaining wells displayed no trends.

TDS: decreasing trend for one well and increasing trend for one well; the remaining wells displayed no trends.

pH: increasing trends for two wells; the remaining wells displayed no trends.

11. There was no increasing trend in the employees exposure for U-Nat.

12. The radon daughters displayed increasing trends, but all are below 10% MPE.

13. In general, the radiation control and environmental monitoring programs continue to function well. Efforts to improve will continue to be made where it is appropriate and reasonable to do so.

Section III

Procedures for Trend Analysis

The data was converted to a percentage of the applicable standard, guide limit, or maximum permissible concentration. Additionally, linear regression analysis is applied using algorithm built into the Hewlett-Packard 11C hand calculator.

The designation of significance is based on the value of the coefficient of determination, which is used to determine how well the straight line fits the data. To aid in the interpretation and use of the coefficient of determination, the following assumptions were made.

Value of Coefficient of Determination	Assumption
1.0 - 0.8	♦ Significant Linear Trend
0.7 - 0.8	♦ Moderate Linear Trend
0.5 - 0.7	♦ Weak Linear Trend
0.0 - 0.5	♦ No Linear Trend

Section IV

ALARA Report - Scope

In compliance with Source Material License Number SUA-917, License Condition 29, an ALARA (as low as reasonably achievable) audit has been conducted for the 1993 calendar year.

The audit was conducted using the guidelines presented in Regulatory Guide 8.31, "Information Relevant to Insuring that Occupational Radiation Exposures at Uranium Mills will be as Low as Reasonably Achievable", and complies with Source Material License Number SUA-917, License Condition 29, which states:

> "A copy of the report documenting the annual ALARA audit in accordance to Section 5.1.4 of the renewal application dated May 31, 1984, shall be submitted to the U.S. Nuclear Regulatory Commission, Uranium Recovery Field Office, for review within 30 days of completion of the audit report."

Section V

Review of Previous Audit

The following is a follow-up of the items found in the audit of last year (1992).

Item 1

As is shown by this audit, occupational exposure to radiation and radioactive materials is satisfactorily controlled, and in some cases being lowered.

Action

No action is warranted.

Item 2

There appears to be no significant difference in surface water quality upstream and downstream from the mill.

Action

No action is warranted.

Item 3

There were increasing trends in Rn^{222} on three environmental monitoring stations. Station 2 monitored 137% average MPC. This station increased from 102% last year (1991). It is expected to remain about the same, even though additional soil cover was placed on the pond beaches. This 137% average MPC does not take into consideration the 34% average MPC of background Station S6. The gamma radiation from the TLD badges indicates Stations 1, 2, and 3 have decreasing trends, and the rest of the monitoring stations displayed no trends. Rn^{222} and gamma radiation continue to display reductions.

Action

We have increasing trends in Stations S3, S4, and S6 for Rn^{222}, but again, Station 2 went up from 137% average MPC to 148% average MPC. If the background was subtracted, the average MPC would be 127%. Until the pond is completely covered, Rn^{222} is expected to increase.

We are in the process of covering the pond with additional soil as the pond recedes. This year (1993) the monitoring stations displayed no trends in gamma radiation.

Item 4

Although the dose equivalent for all employees is very low, a TLD badge is worn at all times by each employee, including contractors, who perform work in the mill area. There were decreasing trends or no trends, in all of the dose equivalents with the exception of the high, which displayed a weak increase.

Action

No action is warranted.

Item 5

Routine breathing zone samples are taken each month for all employees who work in the office or in a supervisory capacity. Sample results display no trend.

Action

No action is warranted.

Item 6

Non-routine breathing zone samples are routinely taken each day. The samplers were worn by the contractors dismantling the mill. There was an increasing trend for the high, and none for the average. There was a decreasing trend for the low. An increasing trend is expected until the mill is dismantled.

Action

No action is warranted.

Item 7

The bioassay (urine analysis) results displayed no trends. All of the high results are baseline analysis. The remainder fell below the action level.

Action

No action is warranted.

Item 8

Vegetation sample results from the nearest pasture and the background station show the pasture to be lower in both Ra^{226} and Pb^{210} concentrations.

Action

No action is warranted. The pasture is still lower in Ra^{226} and Pb^{210}.

Item 9

The results from the soil samples displayed no trends or decreasing trends.

Action

No action is warranted.

Item 10

Trends in the ground water well surpass the standard limits on some of the constituents in the samples (see Table 14 series).

Radiological

U-Nat: AMM-1 (Background Well) shows a weak increase, a significant decrease is indicated for ATP-2S, and the other two show no trend.

Ra^{226}: a weak decrease in one well, and the remaining wells display no trend.

Ra^{228}: a weak increase in one well, and the remaining wells display no trend.

Non-Radiological

Na: two wells with a decreasing trend, and the remaining wells display no trends.

Cl: one well (ATP-2S) with an increasing trend, and the remaining wells display no trend.

SO_4: a decreasing trend in one well, and the remaining three wells display no trend.

NO_3: no trend.

Cr: no trend.

Pb: an increasing trend for two wells, including AMM-1, and the remaining wells display no trend.

Mo: no trend.

Ni: no trend.

Ag: no trend.

V: no trend.

Se: a decreasing trend on one well, and the remaining three wells display no trend.

TDS: a decreasing trend in one well, one shows an increasing trend, and the remaining two wells display no trend.

pH: a decreasing trend in one well, an increasing trend in one well, and the remaining two wells display no trend.

Action

It is important to note that the apparent surpass of the standard limits on some of the constituents in the wells should have no detrimental impact to human health or the environment. Quarterly sampling has been done, and will continue to be done. Trends will be discussed further in the ground water portion of this audit.

Item 11

There was an increasing trend in the employee exposure for U-Nat. The reason for higher employee exposure is because of the mill dismantling. None were above 25% of the MPE.

Action

No action is warranted. They are all less than 10% of the MPE. There is an increasing trend, and during dismantling of the mill, increases are expected.

Item 12

The radon daughters displayed decreasing trends or no trends. All are below 10% MPE.

Action

No action is warranted.

Item 13

In general, the radiation control and environmental monitoring programs continue to be functioning well. Efforts to improve will continue to be made where it is appropriate and reasonable to do so.

Section VI

Audit Results

The results of the ALARA audit are presented below, and are divided into two groups: (1) Mill Radiological Protection and Monitoring, and (2) Environmental Monitoring.

1.0 Mill Radiological Protection and Monitoring

1.1 Employee Exposure to U-Nat

The exposures are determined on a monthly and daily frequency, and are calculated on a weekly basis. The routine samples are done monthly, and the non-routine samples are done daily. Determinations of radiological exposure appear to be correctly calculated and complete. The monthly averages of percent of the monthly ore guide limit range from 0.9 to 3.1%, and the monthly average for the year is 1.5%. The presence or absence of trends is based on linear regression analysis. The U-Nat exposures are indicated in Table 1.

1.2 Employee Exposure to Radon Daughters

The exposures are determined on a monthly basis for all mill and contractor personnel. The monthly averages of percent of the monthly limit (0.33 WLM), range from 0.6 to 4.2, and the average of the monthly averages is 1.7%. The presence or absence of trends is based on linear regression analysis. There is an increasing trend for the high, for the l w, and for the average. The radon daughters are indicated in Table 2.

1.3 Bioassays (Indirect) Urine Analysis

Urine analysis was started in September 1992 when the contractors began to dismantle the mill. Urine samples were taken monthly for both the contractors and mill workers. The monthly averages of percent of the limit range from 4.0 to 11.0%. There is no trend. The urine analysis is indicated in Table 3.

1.4 Bioassays (Direct) In-Vivo Lung Counting

In-Vivo lung counting has not been necessary.

1.5 Personnel Gamma-Beta Dose

All mill and contractor personnel wear a TLD badge for the whole year, or during the duration of the job. The badges are exchanged quarterly. The presence or absence of trends are based on linear regression analysis. There were no trends indicated for either the high, low, or the average (see Table 4).

1.6 Mill Gamma Readings

The mill gamma readings are taken on a quarterly frequency. Two areas show an increase, one area shows a decrease in trends, and four show none. The presence or absence of trends are based on linear regression analysis (see Tables 5 and 5A).

1.7 Surface Contaminants

Surface contamination surveys are done every week in all eating areas throughout the mill; this also includes offices and lunchrooms. The presence or absence of trends is based on linear regression analysis. There were no trends in either the high, low, or the average (see Table 6).

1.8 Surface Contamination Surveys for Release of Equipment for Unrestricted Use

All equipment and scrap that has been in the mill operation is checked for total and removable contamination. The presence or absence of trends is based on linear regression. The measurements show no trend (see Table 7).

1.9 Yellow Cake Stack Samples

Because the status of the mill is non-operational, there were no stacks sampled in 1993.

1.10 Ore Stack Samples

Because the status of the mill is non-operational, there were no stacks sampled in 1993.

1.11 U-Nat General Air Samples (Area Samples)

There were ten locations throughout the mill that were sampled. There were eight locations sampled monthly and two locations sampled quarterly. The presence or absence of trends is based on linear regression analysis. There were three locations that showed decreasing trends, and seven showed no trends (see Tables 8 and 8A).

1.12 Radon Daughter Air Samples

Radon daughter air samples are sampled in the same locations throughout the mill as the U-Nat air samples. The areas were sampled on a quarterly frequency. The presence or absence of trends is based on linear regression analysis. There were six areas that showed an increasing trend, one that showed a decreasing trend, and the remainder showed none (see Tables 9 and 9A).

1.13 Routine Breathing Zone Air Samples

There were as many as nine air samples taken throughout the month. The presence or absence of trends is based on linear regression analysis. There were two that showed a decreasing trend, two that showed an increasing trend, and the remainder showed none (see Table 10).

1.14 Non-Routine Air Samples

Non-routine air samples are worn by the contractors and mill personnel when there is a chance of getting a high exposure during the dismantling of the mill. These samplers are worn each day by workers dismantling the mill. The presence or absence of trends is based on linear regression analysis. There was no trends shown (see Table 11).

1.15 Visual Inspection Report

The Radiation Control Coordinator conducts a daily walk-through visual inspection of all areas in the mill to ensure that good radiation safety procedures, housekeeping, and clean-up practices are being carried out in the mill. Copies of the inspection report are distributed to the Vice President of Environmental and Governmental Affairs. Corrective action is specified on the report. The results of these inspections are summarized in the monthly report. The daily inspections continue to appear to be achieving the desired ALARA results. Also, all of the elements of the radiation protection program are summarized in the monthly report to the Vice President of Environmental and Governmental Affairs. Possible trends are noted for follow-up surveillance and corrective action if necessary.

1.16 Training

Training sessions were conducted for mill workers and contractor personnel. The topics covered were compared to the radiation safety training outline in Regulatory Guide 8.31, and found to be equivalent in content.

1.17 Radiation Safety Meetings

Radiation safety meetings are not routinely held at the Atlas mill, nor are radiation safety topics routinely included in the industrial safety meetings held at the mill. There was one special radiation safety meeting held in 1993. When a specific radiation topic needs to be brought to the attention of individual workers, the Radiation Control Coordinator conveys the information to their supervisors, who then instruct their men on the radiation safety topics. This method of communication through their supervisors provides instruction and discipline directly from the same person who evaluates the performance of each worker. Although this method of communication is a variation to the use of safety meetings as recommended in Regulatory Guide 8.31, the system works well for Atlas.

1.18 Over-Exposure

No over-exposures occurred in 1993.

1.19 Operating Procedures

The Radiation Safety Procedures Manual presents all the procedures for the radiological and environmental sampling and monitoring programs. Under Source Material License Number SUA-917, Condition 23 of the latest license, the procedures are to be reviewed and revised every year by the Vice President of Environmental and Governmental Affairs, and the Radiation Control Coordinator. The mill operation procedures for specific tasks conducted by mill workers were reviewed by the Radiation Control Coordinator on March 01, 1994. These operating procedures have been revised to fit the shutdown and

dismantling status operation of the mill personnel. The Vice President of Environmental and Governmental Affairs, and the Radiation Control Coordinator reviewed them relative to radiation safety.

1.20 Radiological Control Equipment

The air samplers are being calibrated weekly and monthly, depending on which ones they are. Many are being calibrated monthly and quarterly, and some are being calibrated before each use. The counters and scalers are being calibrated quarterly and semi-annually. The respiratory protection program is being conducted according to Regulatory Guide 8.15. The respirators are being maintained and inspected properly.

1.21 Recommendations to Reduce Exposure to ALARA

Atlas has an ALARA Committee consisting of the Vice President of Environmental and Governmental Affairs, and the Radiation Control Coordinator. Although the mill is down and being dismantled, the ALARA committee has met on at least one occasion and discussed ways to reduce exposure and maintain good ALARA philosophy.

In our radiation training class, good housekeeping is stressed. We continue to aim at reducing contamination in accordance with ALARA philosophy. Also, during the meetings, the Radiation Control Coordinator discussed where eating and smoking is permitted, such as offices and lunchrooms.

Additionally, the Radiation Safety Department is maintaining a check-off sheet for all items completed by the Department. It helps in spotting a specific test or survey to ensure it will be completed when required.

2.0 Environmental Monitoring

2.1 Environmental Continuous Air Samples

There are three continuous air samplers around the perimeter of the mill, one at Arches Headquarters, and also one down the river which is used as a background station. The filter papers are changed weekly, and saved for quarterly composites, which are then sent off to a commercial laboratory for analysis. The presence or absence of trends is based on linear regression analysis. Three of the air samplers showed an increasing trend in Rn^{222}, while two showed none. One of the samplers showed no increase in Th^{230}, while the rest of the samplers showed variable decreasing trends in Th^{230}. All of the sample stations showed variable decreasing trends in U-Nat, except S6, it showed none. All of the sample stations showed variable decreasing trends in Ra^{226} (see Table 12).

2.2 Surface Water

Surface water samples are collected from two locations: (1) ¼ mile above the mill and (2) just below the mill. The samples are collected on a quarterly frequency. The presence or absence of trends is based on linear regression analysis.

¼ Mile Above the Mill

There were variable increasing trends in (S) U-Nat, (S) Th^{230}, (S) Ra^{226}, (S) Pb^{210}, SO_4, and pH. There were variable decreasing trends in (D) U-Nat, (D) Th^{230}, (D) Ra^{226}, and (D) Pb^{210}. All other constituents showed no trend.

Downstream from the Mill

There were variable increasing trends in (S) U-Nat, (S) Th^{230}, Ra^{226}, (S) Pb^{210}, SO_4, TDS, pH, and Se. There were variable decreasing trends in (D) Th^{230}. All other constituents showed no trend (see Table 13).

2.3 Ground Water

There are a total of four monitoring wells: AMM-1, AMM-2, AMM-3, and ATP-2S. AMM-2, AMM-3 and ATP-2S are located between the tailings pond and the Colorado River. AMM-1 is located at the northeast boundary of the mill, up-gradient from the tailings pond, and serves as the background well.

AMM-1

There was a moderate increasing trend in Pb. There was a significant increasing trend in pH. The rest of the constituents showed no trend (see Table 14 and 14A).

AMM-2

There was a weak increasing trend in NO_3. There was a moderate increasing trend in Pb and Se. There was a significant decreasing trend in gross alpha. The rest of the constituents showed no trend (see Tables 14 and 14A).

AMM-3

There was a weak increasing trend in TDS and Pb. There was a weak decreasing trend in Se (see Tables 14 and 14A).

ATP-2S

There were significant increasing trends in Cl. There was a weak decreasing trend in gross alpha, and SO_4. There was a significant decreasing trend in TDS and U-Nat. There was a weak increasing trend in Mo, and a moderate increasing trend in pH (see Tables 14 and 14A).

2.4 Vegetation Samples

A vegetation sample was collected in the field closest to the mill, and a background vegetation sample was also collected at the background station down river. Both samples are of the same type of vegetation. A comparison of the two samples revealed that there were either no trends or a weak decreasing trend (see Table 15).

2.5 Soil Samples

A soil sample was collected at each of the environmental continuous air sampling stations and compared with the soil at the background station. The presence or absence of trends is based on linear regression analysis (see Table 16).

S1

There was a weak decreasing trend in Pb^{210}, and no trend was identified on Ra^{226}.

S2

There were no trends identified.

S3

There was a weak decreasing trend in Pb^{210}, and no trend was identified on Ra^{226}.

S4

There was a weak decreasing trend in Pb^{210}, and no trend was identified on Ra^{226}.

S6

There was a weak decreasing trend in Pb^{210}, and no trend was identified on Ra^{226}.

2.6 Environmental TLD Badge Results

Six TLD badges are located at the air sampling stations and the guard house.

#S1 Station

There was no trend identified.

#S2 Station

There was no trend identified.

#S3 Station

There was no trend identified.

#S4 Station

There was no trend identified.

#S6 Station

There was no trend identified.

Guard House

There was no trend identified. The presence or absence of trend is based on linear regression analysis (see Table 17).

TABLE 1
EMPLOYEE EXPOSURE RECORDS
U–NAT 1993

% Of Monthly Ore Guide Limit	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Coefficient of Determination	Trend
High	44.17	31.76	51.43	80.39	38.66	37.89	45.74	25.83	67.46	24.88	18.82	16.00	–.46	None
%	5.1	3.7	5.9	9.3	4.5	4.4	5.3	3.0	7.8	2.9	2.2	1.9		
Low	.21	.12	.50	.93	.38	2.68	.24	.05	.44	.42	.04	.96	.02	None
%	.02	.01	.06	.1	.04	.3	.03	.01	.05	.05	.005	.11		
Average	9.72	10.92	15.33	26.53	13.56	20.11	14.28	9.87	11.41	7.79	7.40	8.18	–.43	None
%	1.1	1.3	1.8	3.1	1.6	2.3	1.7	1.1	1.3	.9	.9	.9		

Ore Guide Limit – 867×10^{-11} μCi hr/ml/month

TABLE 2
EMPLOYEE EXPOSURE RECORDS
RADON DAUGHTERS 1993

WLM % of Monthly Limit	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Coefficient of Determination	Trend
High	.009	.004	.010	.009	.009	.009	.027	.036	.029	.028	.027	.019	.74	Moderate Increasing
%	2.7	1.2	3.0	2.7	2.7	2.7	8.2	10.9	8.8	8.5	8.2	5.8		
Low	0	0	0	.001	.0001	.0005	.00002	.0002	.00002	.0006	.0002	.004	.50	Weak Increasing
%	0	0	0	.3	.03	.2	.01	.06	.01	.2	.06	1.2		
Average	.003	.002	.003	.002	.002	.002	.005	.005	.005	.013	.011	.014	.84	Significant Increasing
%	.9	.6	.9	.6	.6	.6	1.5	1.5	1.5	3.9	3.3	4.2		

Mo. Limit .33 WLM

TABLE 3
URINALYSIS 1993

U-NAT ug/L	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Avg. % Limit	Yearly Coefficient of Determination	Trend
High	8.3	19.9	4.7	13	6.6	10.0	14	9.1	11.0	18.0	4.7	8.6	35.5	-.10	None
%	27.7	66.3	15.7	43	22	33.3	46.7	30.3	36.7	60.0	15.7	28.7			
Low	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	2.7	0	None
%	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7			
Average	1.6	2.58	1.2	2.9	2.1	1.9	1.9	1.6	2.4	4.0	1.9	3.3	7.6	.44	None
%	5.3	8.6	4.0	9.7	7.0	6.3	6.3	5.3	8.0	13.3	6.3	11.0			

Limit = 30 µg/L

TABLE 4
PERSONNEL GAMMA – BETA DOSE
1993

mrem/Quarter % of Limit	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Yearly Coefficient of Determination	Trend
GAMMA DOSE						
High	80	100	65	85	– .18	None
%	6.4	8.0	5.2	6.8		
Low	0	35	0	0	– .26	None
%	0	2.8	0	0		
Average	44	64	34	51	– .09	None
%	3.5	5.1	2.7	4.1		
BETA DOSE						
High	0	0	110	0	.25	None
%	0	0	8.8	0		
Low	0	0	0	0	0	None
%	0	0	0	0		
Average	0	0	6	0	0	None
%	0	0	.5	0		

Limit = 1250 mrem/Quarter

TABLE 5
MILL GAMMA TRENDS 1993

Location	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Coefficient of Determination Yrly	Running	% Limit 1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
Ball Mill Area Classifiers	2.1	2.2	--	--	--	-.37	88	92	--	--
SX Area – U_3O_8 Extractors	1.6	1.6	1.3	1.5	-.55	-.03	67	67	54	63
U_3O_8 Hearth Dryer	.36	.32	--	--	--	-.32	15	13	--	--
U_3O_8 Precipitation	.10	.10	--	--	--	-.48	4.2	4.2	--	--
Y.C. Doghouse	.07	.07	--	--	--	.52	30	30	--	--
Y.C. Packaging Area	.42	.42	--	--	--	.88	18	18	--	--
Y.C. Scrubber	1.3	1.3	--	--	--	-.86	54	54	--	--

Limit = 2.4 mr/Hr.

Table 5A

Mill Gamma Trends / Years 1983 to 1993

Area	Trend
Ball Mill Area Classifiers	None
SX Area - U_3O_8 Extractors	None
U_3O_8 Hearth Dryer	None
U_3O_8 Precipitation	None
Y.C. Doghouse	Weak Increase
Y.C. Packaging Area	Significant Increase
Y.C. Scrubber	Significant Decrease

TABLE 6
SURFACE CONTAMINATION SURVEY
REMOVABLE ALPHA 1993

dpm/100 cm² % of Limit	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Coefficient of Determination	Trend
High	38	91	63	109	63	118	84	85	95	64	42	30	−.25	None
%	3.8	9.1	6.3	10.9	6.3	11.8	8.4	8.5	9.5	6.4	4.2	3.0		
Low	0	0	0	0	0	0	0	0	0	0	0	0	0	None
%	0	0	0	0	0	0	0	0	0	0	0	0		
Average	11	16	12	20	18	19	14	13	16	16	12	9	−.26	None
%	1.1	1.6	1.2	2.0	1.8	1.9	1.4	1.3	1.6	1.6	1.2	.9		

Limit 1000 dpm – 100 cm²

TABLE 7
EQUIPMENT RELEASE FOR UNRESTRICTED USE
SURFACE CONTAMINATION SURVEYS
REMOVABLE ALPHA 1993

dpm/100 cm² % of Limit	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Coefficient of Determination	Trend
High	247	291	119	487	159	479	135	158	717	274	0	0	-.20	None
%	24.7	29.1	11.9	48.7	15.9	47.9	13.5	15.8	71.7	27.4	0	0		
Low	0	0	0	0	0	0	0	0	0	47	0	0	.31	None
%	0	0	0	0	0	0	0	0	0	4.7	0	0		
Average	37	45	32	59	54	68	47	48	120	147	0	0	.08	None
%	3.7	4.5	3.2	5.9	5.4	6.8	4.7	4.8	12.0	14.7	0	0		

Limit 1000 dpm/100 cm²

TABLE 8
GENERAL AREA AIR SAMPLE 1993
U-NAT (X 10^{-11} uCi/ml)

Location	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MPC	Avg. % Limit	Coefficient of Determination Yrly	Running
Tailings Pond	.07	.07	.01	.02	.04	.08	.09	.07	.02	.08	.01	.06	5.0	1.0	-.03	-.59
Pump House	.06	.07	.08	.02	.06	.10	.08	.05	.05	.11	.02	.06	5.0	1.3	-.06	-.40
Yard	.04	.07	.03	.09	.08	.09	.01	.06	.02	.04	.02	.10	5.0	1.1	-.08	-.64
Main Mill Building	.07	.05	.05	.02	.07	.04	.08	.02	.12	.03	.09	.11	5.0	1.2	.397	.397
Maint. Office	.02	.08	.02	.03	.08	.03	.04	.09	.04	.03	.02	.14	5.0	1.0	.32	-.45
Lab *	.04			.06			.03			.08			5.0	1.1	.52	-.49
Front Office *	.07			.06			.01			.08			5.0	1.1	-.08	-.61
Crusher	.04	.03	.05	.05									5.0	.9	.67	.04
Sample Tower	.05	.06	.02	.11									5.0	1.2	.48	.06
Ball Mill	.03	.06	.04	.06	.09								5.0	1.1	.82	.06

* QUARTERLY

Table 8A

General Area Air Sample Trends / Years 1983 - 1993

Area	Trend
Tailings Pond	Weak Decreasing
Pump House	None
Yard	Weak Decreasing
Main Mill Building	None
Maintenance Office	None
Lab	None
Front Office	Weak Decreasing
Crusher	None
Sample Tower	None
Ball Mill	None

TABLE 9
RADON DAUGHTERS
WORKING LEVELS 1993

Location	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Control Guide Limit	Avg. % Limit	Coefficient of Determination Yrly.	Running
Main Mill Building	.008	.002	.003	.021	.33 WL	2.6	.591	.591
Front Office	.008	.008	.025	.029	.33 WL	5.3	.93	.80
Lab	.015	.006	.028	.028	.33 WL	5.8	.73	.84
Maint. Office	.011	.007	.029	.024	.33 WL	5.4	.75	.50
Pump House	.004	.004	.006	.019	.33 WL	2.5	.84	.31
Tails Pond	.001	.001	.001	.007	.33 WL	.8	.77	.53
Yard	.004	.001	.001	.017	.33 WL	1.7	.66	.55
Crusher	0	.001	--	--	.33 WL	.2		-.60
Ball Mill	.0006	.005	--	--	.33 WL	.8		.10
Sample Tower	.0001	.001			.33 WL	.2		-.81

Table 9A

Radon Daughter Trends / Years 1983 - 1993

Area	Trends
Main Mill Building	Weak Increasing
Front Office	Significant Increasing
Lab	Significant Increasing
Maintenance Office	Weak Increasing
Pump House	None
Tailing Pond	Weak Increasing
Yard	Weak Increasing
Crusher	Weak Decreasing
Ball Mill	None
Sample Tower	Significant Decreasing

TABLE 10
BREATHING ZONE SAMPLES
1993

Location	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MPC $x10^{-11}$ uCi/ml	Avg. % MPC	Coefficient of Determination Yrly	Coefficient of Determination Running	Trend
Carl Dixon	.04	.05	.06	.05	.05	.03	.02	--	.02	.04	.07	.01	5.0	.8	-.36	.45	None
Dale Edwards	.01	.02	.02	.01	.03	.09	.05	.04	.04	.05	.01	.02	5.0	.7	.20	.53	Weak Increase
Joe Mitchell	.04	.04	.04	.05	.10	.14	.02	.02	.01	.07	.01	.01	5.0	.9	-.30	-.02	None
Joan LaGrassco	.05	.02	--	--	--	--	--	--	--	--	--	--	5.0	.7	--	-.98	Significant Increase
Bob Hopper	--	--	--	--	.07	.12	.02	.02	.02	--	--	--	5.0	1.0	-.71	-.18	None
Dan Sullivan	.02	.03	.02	--	--	--	--	--	--	--	--	--	5.0	.5	0	-.78	Moderate Decrease
Niki Christensen		.01	.03	.12	.01	.02	.07	.01	.02	.01	.02		5.0	.6	-.26	--	None
Tisha Christensen	--	--	--	--	--	--	--	.02	.02	.01			5.0	.3	.87	--	Significant Decrease
Joel Anderson	--	--	.03	.09	.03	.05	--	--	.02				5.0	.9	-.34	--	None

TABLE 11
NON–ROUTINE AIR SAMPLES
1993

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MPC $x10^{-11}$ uCi/ml	Avg. % MPC	Coefficient of Determination Y-by	Trend
High	.78	.94	.77	6.8	.90	.93	1.04	3.14	1.16	1.14	.45	.38				
%	15.6	18.8	15.4	136	18.0	18.6	20.8	62.8	23.2	22.8	9.0	7.6	5.0	31	–.19	None
Low	.02	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01				
%	.4	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	5.0	.2	–.48	None
Average	.13	.17	.17	.36	.13	.16	.21	.15	.23	.15	.11	.10				
%	2.6	3.4	3.4	7.2	2.6	3.2	4.2	3.0	4.6	3.0	2.2	2.0	5.0	3.5	–.28	None

TABLE 12–1
CONTINUOUS AIR SAMPLE #1
TREND ANALYSIS 1983–1993

	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Avg. % MPC	Coefficient of Determination	Trend
U–Nat $\times 10^{-12}$ uCi/ml	.0005	.0009	.001	.0006	.015	–.765	Moderate Decrease
Rn^{222} $\times 10^{-10}$ uCi/ml	17.0	14.0	24.0	42.0	81	.24	None
Ra^{226} $\times 10^{-12}$ uCi/ml	.0012	.00030	.00024	.00021	.016	–.55	Weak Decrease
TH^{230} $\times 10^{-14}$ uCi/ml	.066	.075	.29	.032	1.4	–.508	Weak Decrease

TABLE 12–2
CONTINUOUS AIR SAMPLE #2
TREND ANALYSIS 1983–1993

	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Avg. % MPC	Coefficient of Determination	Trend
U–Nat $\times 10^{-12}$ uCi/ml	.0021	.0030	.0074	.0019	.07	–.72	Moderate Decrease
Rn^{222} $\times 10^{-10}$ uCi/ml	27.0	28.0	48.0	74.0	148	.33	None
Ra^{226} $\times 10^{-12}$ uCi/ml	0	.00019	.00037	.00010	.005	–.58	Weak Decrease
TH^{230} $\times 10^{-14}$ uCi/ml	.0033	.13	.0071	.082	.44	–.55	Weak Decrease

TABLE 12-3
CONTINUOUS AIR SAMPLE #3
TREND ANALYSIS 1983--1993

	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Avg. % MPC	Coefficient of Determination	Trend
U-Nat $\times 10^{-12}$ uCi/ml	.00039	.0016	.0025	.00061	.026	-.77	Moderate Decrease
Rn^{222} $\times 10^{-10}$ uCi/ml	12.0	19.0	24.0	29.0	70	.84	Significant Increase
Ra^{226} $\times 10^{-12}$ uCi/ml	.00034	.00024	.00026	.00013	.008	-.76	Moderate Decrease
TH^{230} $\times 10^{-14}$ uCi/ml	.074	.19	.24	.031	1.7	-.78	Moderate Decrease

TABLE 12-4
CONTINUOUS AIR SAMPLE #4
TREND ANALYSIS 1983-1993

	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Avg. % MPC	Coefficient of Determination	Trend
U-Nat x 10^{-12} uCi/ml	.00029	.00041	.001	.00039	.011	-.71	Moderate Decrease
Rn^{222} x 10^{-10} uCi/ml	8.0	6.0	9.0	17.0	34	.92	Significant Increase
Ra^{226} x 10^{-12} uCi/ml	.00033	.00014	.00014	0	.005	-.73	Moderate Decrease
TH^{230} x 10^{-14} uCi/ml	.020	.021	.050	0	.3	-.65	Weak Decrease

TABLE 12–6
CONTINUOUS AIR SAMPLE #6
TREND ANALYSIS 1983–1993

	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Avg. % MPC	Coefficient of Determination	Trend
U–Nat $\times 10^{-12}$ uCi/ml	.0013	.00046	.00034	.00045	.013	–.23	None
Rn^{222} $\times 10^{-10}$ uCi/ml	7.0	8.0	9.0	1.0	21	.89	Significant Increase
Ra^{226} $\times 10^{-12}$ uCi/ml	.00034	.00015	.000055	.00005	.005	–.52	Weak Decrease
TH^{230} $\times 10^{-14}$ uCi/ml	.035	.0037	.011	.013	.20	.34	None

TABLE 13–1
SURFACE WATER MONITORING
UPSTREAM FROM MILL 1993

Location	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	% MPC	Coefficient of Determination Yrly.	Coefficient of Determination Running	Trend
(D) U - Nat	.00054	.00016	.00037	.00048	.013	- .024	- .50	Weak Decrease
(S) ($3X10^{-3}$ uCi/ml)	.00041				.014		.94	Significant Increase
(D) Th^{230}	.0002				.010		- .514	Weak Decrease
(S) ($2X10^{-1}$ uCi/ml)	.0024				.12		.89	Significant Increase
(D) Ra^{226}	.06				2.0		- .65	Weak Decrease
(S) ($3X10^{-8}$ uCi/ml)	.30				10.0		.89	Significant Increase
(D) Pb^{210}	.006				.60		- .72	Moderate Decrease
(S) ($1X10^{-7}$ uCi/ml)	.052				5.2		.77	Moderate Increase
(D) PO^{210}	0				0		- .119	None
(S) ($7X10^{-7}$ uCi/ml)	.045				.64		.25	None
SO_4 (PPM)	303						.84	Significant Increase
Cl (PPM)	100						.49	None
NO_3 (PPM)	.6						- .36	None
As (PPM)	.001						.428	None
Cu (PPM)	L.01						- .15	None
TDS (PPM)	756						.28	None
pH	7.96						- .34	None
Conductivity (uMHOS)	1250	600	1200	1300		.30	.466	None
Se (PPM)	.006						.58	Weak Increase

TABLE 13-2
SURFACE WATER MONITORING
DOWNSTREAM FROM MILL 1993

Location	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	% MPC	Coefficient of Determination Yrly.	Running	Trend
(D) U-Nat	.00065	.00021	.00037	.00056	.015	-.07	-.04	None
(S) (3X10^{-3} uCi/ml)	.00043				.014		.97	Significant Increase
(D) Th^{230}	.0002				.01		-.68	Weak Decrease
(S) (2X10^{-8} uCi/ml)	.0014				.07		.93	Significant Increase
(D) Ra^{226}	.03				1.0		.52	Weak Increase
(S) (3X10^{-8} uCi/ml)	.24				8.0		.94	Significant Increase
(D) Pb^{210}	.003				.3		.21	None
(S) (1X10^{-7} uCi/ml)	.071				7.1		.77	Moderate Increase
(D) PO^{210}	0				0		-.08	None
(S) (7X10^{-7} uCi/ml)	.045				.64		-.32	None
SO_4 (PPM)	301						.74	Moderate Increase
Cl (PPM)	102						.32	None
NO_3 (PPM)	.7						.10	None
As (PPM)	.001						.43	None
Cu (PPM)	< .01						.46	None
TDS (PPM)	742						.568	Weak Increase
pH	7.86						-.77	Moderate Increase
Conductivity (uMHOS)	1200	600	1100	1200		.22	.239	None
Se (PPM)	.006						.72	Moderate Increase

TABLE 14-1
GROUNDWATER MONITORING 1993
AMM-1

	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Coefficient of Determination Yrly.	Running	% of MPC 1st	2nd	3rd	4th
LIMITS:										
Gross Alpha 33 pci/L		0		0		-.45		0		0
U-Nat 4 pci/L		2.64		2.3		.29		66		58
Ra^{226} 5 pci/L		.5		.1		.40		10		2
Ra^{228} 5 pci/L		.7		.6		.38		14		12
Na PPM	2100	2220	2060	2160	.04	.15				
Cl PPM	3180	3520	3290	3010	-.45	.10				
SO_4 PPM	1080	1070	1100	1040	-.46	-.35				
NO_3 PPM	.5	.3	.1	.5	-.13	.15				
Cr PPM		<.01		<.01		0		12.5		12.5
Pb PPM		<.1		<.1		.75				
Mo PPM		<.01		<.01		-.20		20		20
Ni PPM		<.05		<.01		.23		83		17
Ag PPM		<.01		<.01		.17				
V PPM		<.05		<.01		.04		125		25
Se PPM		.011		.014		.03		110		140
TDS PPM	6710	6830	6710	6660	-.48	-.07				
pH Units	6.70	6.64	6.83	6.76	.59	-.89				

TABLE 14-2
GROUNDWATER MONITORING 1993
AMM-2

	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Coefficient of Determination Yrly.	Running	% of MPC 1st	2nd	3rd	4th
LIMITS:										
Gross Alpha 33 pci/L		1700		1700		-.83		5152		5152
U--Net 4 pci/L		2160		2654		.40		54000		66000
Ra^{226} 5 pci/L		.1		.2		-.42		2		4
Ra^{228} 5 pci/L		2.1		1.9		-.31		42		38
Na PPM	3690	4000	3640	4100	.49	-.43				
Cl PPM	2340	2850	2550	2300	-.22	.35				
SO_4 PPM	12800	10700	12100	11800	-.24	.03				
NO_3 PPM	54.3	263	236	179	.48	.51				
Cr PPM		<.01		<.01		0		12.5		12.5
Pb PPM		<.10		.1		.76				
Mo PPM		1.03		1.22		.17		2060		2440
Ni PPM		<.05		<.01		-.25		83		17
Ag PPM		<.01		<.01		-.41				
V PPM		<.05		<.01		-.21		125		25
Se PPM		.005		<.002		-.71		50		20
TDS PPM	19500	17100	19000	18600	-.10	-.19				
pH Units	7.10	7.10	7.08	7.15	.56	-.34				

TABLE 14-3
GROUNDWATER MONITORING 1993
AMM-3

	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Coefficient of Determination Yrly.	Running	% of MPC 1st	2nd	3rd	4th
LIMITS:										
Gross Alpha 33 pci/L		3000		2100		.10		9091		6364
U-Nat 4 pci/L		2329		1957		.04		58225		48925
Ra^{214} 5 pci/L		.7		0		.03		14		0
Ra^{228} 5 pci/L		.9		1.0		-.11		18		20
Na PPM	3100	3260	2920	3150	-.17	.35				
Cl PPM	2090	1890	1870	1800	-.92	-.02				
SO_4 PPM	6550	6670	6800	6440	-.17	.46				
NO_3 PPM	<.5	.3	<.5	<.5	.26	.12				
Cr PPM		<.01		<.01		0		12.5		12.5
Pb PPM		<.1		.2		.68				
Mo PPM		1.14		1.11		.18		2280		2220
Ni PPM		<.05		<.01		.07		83		17
Ag PPM		<.01		<.01		0				
V PPM		<.05		<.01		-.07		125		25
Se PPM		<.002		<.002		-.55		20		20
TDS PPM	13200	12400	12500	13200	.029	.62				
pH Units	7.05	7.09	7.05	7.16	.72	-.37				

TABLE 14-4
GROUNDWATER MONITORING 1993
ATP 2-S

	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Coefficient of Determination Yrly.	Rnng.	% of MPC 1st	2nd	3rd	4th
LIMITS:										
Gross Alpha 33 pci/L		2800		3220		-.646		8485		9758
U-Nat 4 pci/L		3412		4035		-.86		85300		100875
Ra^{226} 5 pci/L		.2		.7		-.56		4		14
Ra^{228} 5 pci/L		2.8		1.7		.37		56		34
Na PPM	3480	3880	3800	4160	.90	-.40				
Cl PPM	1970	1640	1490	1310	-.99	.98				
SO_4 PPM	12900	16000	17300	17000	.87	-.69				
NO_3 PPM	33.9	67.8	105	85.7	.82	-.38				
Cr PPM		<.01		<.01		0		12.5		12.5
Pb PPM		<.1		<.02		.52				
Mo PPM		1.18		1.35		.62		2360		2700
Ni PPM		<.05		<.01		-.44		83		17
Ag PPM		<.01		<.01		-.46				
V PPM		<.05		<.01		-.19		125		25
Se PPM		.019		.018		-.16		190		180
TDS PPM	18700	20100	24000	23100	.89	-.87				
pH Units	7.29	7.27	7.38	7.41	.89	.73				

TABLE 14A
GROUNDWATER MONITORING TREND ANALYSIS
1979–1993

	AMM–1	AMM–2	AMM–3	ATP–2S
Gross Alpha	None	Significant Decrease	None	Weak Decrease
U–Nat	None	None	None	Significant Decrease
Ra^{226}	None	None	None	Weak Decrease
Ra^{228}	None	None	None	None
Na	None	None	None	None
Cl	None	None	None	Significant Increase
SO_4	None	None	None	Weak Decrease
NO_3	None	Weak Increase	None	None
Cr	None	None	None	None
Pb	Moderate Increase	Moderate Increase	Weak Increase	Weak Increase
Mo	None	None	None	Weak Increase
Ni	None	None	None	None
Ag	None	None	None	None
V	None	None	None	None
Se	None	Moderate Decrease	Weak Decrease	None
TDS	None	None	Weak Increase	Significant Decrease
pH	Significant Increase	None	None	Moderate Increase

Table 15

Vegetation Samples

Concentration in $\mu Cl \times 10^{-4}$ /kg Wet	1993	Coefficient of Determination Running (81 - 93)	Trend
Ra^{226} Background	.64	-.32	None
Pb^{210} Background	1.5	-.44	None
Ra^{226} Near Mill	.18	-.63	Weak Decreasing
Pb^{210} Near Mill	.93	-.54	Weak Decreasing

The coefficient of determination is calculated on the assays from 1981 through 1993.

Table 16

Soil Samples

	1993	Coefficient of Determination Running (81 - 93)	Trend
# S1			
Ra^{226} (μCi x 10^{-6}/g)	0.8	-.49	None
Pb^{210} (μCi x 10^{-6}/g)	1.1	-.68	Weak Decreasing
# S2			
Ra^{226} (μCi x 10^{-6}/g)	7.6	-.10	None
Pb^{210} (μCi x 10^{-6}/g)	6.9	-.42	None
# S3			
Ra^{226} (μCi x 10^{-6}/g)	11.0	.22	None
Pb^{210} (μCi x 10^{-6}/g)	13.0	-.67	Weak Decreasing
# S4			
Ra^{226} (μCi x 10^{-6}/g)	0.7	.14	None
Pb^{210} (μCi x 10^{-6}/g)	1.7	-.57	Weak Decreasing
# S6			
Ra^{226} (μCi x 10^{-6}/g)	0.3	-.16	None
Pb^{210} (μCi x 10^{-6}/g)	1.4	-.55	Weak Decreasing

TABLE 17
DIRECT RADIATION MEASUREMENTS
ENVIRONMENTAL BADGES MR/QTR 1993

Location	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Coefficient of Determination 81–93 Yearly	Running	Yrly. Average	81–93 Trend
#1 Monitor	15	16	18	18	.95	–.27	17	None
#2 Monitor	38	37	44	46	.91	–.46	41	None
#3 Monitor	82	80	84	88	.83	–.23	84	None
#4 Monitor	22	24	26	26	.94	–.18	25	None
#6 Monitor	9	10	16	12	.63	–.14	12	None
Guard House	100	98	105	105	.80	–.26	102	None