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Northwest Territories Renewable Resources

7 March 1995

David H. Anthony, P. Eng.
Manager, Environmental Services
NWT Division
Royal Oak Mines Inc.
PO Bag 3000
YELLOWKNIFE, NT X1A 2M2

Dear Dave:

I have attached for your information a draft copy of a report on *Yellowknife Air Quality Monitoring, 1993 Data*. This report will be provided to the general public within the next few weeks.

High volume air samples collected during 1993 in downtown Yellowknife show that dust continues to be a problem, especially in the Spring. 10 of the 57 samples collected had dust (Total Suspended Particulate) levels above the Northwest Territories 24 hour air quality standard. The geometric mean in 1993 was slightly above the NWT annual standard.

Arsenic levels showed an increase over the previous few years but remained much lower than during the 1970's. 1993 arsenic levels have already been reported in an Interim Data Report. Department of Health officials reviewed this data and they concluded that the 1993 increase did not present an unacceptable risk to human health.

Lead levels in Yellowknife air continued to decline as they have in the rest of Canada since leaded gasoline was phased out.

Sulphur dioxide monitoring in downtown Yellowknife measured levels above the NWT one hour standard on 30 occasions during the ten months that measurements were made. The daily and annual standards were not exceeded. Sulphur dioxide in Yellowknife did rise to levels considered to have some impact on vegetation but were below levels at which mild and reversible impacts on human health are considered to begin.

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Acid rain monitoring at the Snare Rapids hydro site found only very low levels of acidifying chemicals, levels that typically are associated with unpolluted areas.

Please call me at 873-7654 if you wish to discuss this information.

Yours sincerely,

Emery Paquin
Director
Environmental Protection Division

Attachment

Northwest Territories

YELLOWKNIFE AIR QUALITY MONITORING

DRAFT 1993 DATA

The Department of Renewable Resources monitors air quality in the Yellowknife area. Dust levels have been monitored in Yellowknife since 1974. Acid rain has been monitored at the Snare Rapids hydro-electric site since 1986. Sulphur dioxide (SO_2) has been monitored in downtown Yellowknife since 1992.

WHAT WERE THE RESULTS FROM YELLOWKNIFE DUST SAMPLING?

Dust samples are taken in downtown Yellowknife on the roof of a two story building. Every six days a sample is collected over a 24 hour period using a high volume air sampler. A measured volume of air is drawn through a filter to collect the suspended particulate (dust). The filters are sent to Environment Canada's National Air Pollution Sampling (NAPS) laboratory in Ottawa for analysis. Dust is measured as the weight of Total Suspended Particulate (TSP) collected on the filter divided by the volume of air drawn. Lead, arsenic, nitrate and sulphate levels in the collected dust are also determined.

A total of 57 high-volume air samples were collected in downtown Yellowknife during 1993. The following table summarizes the results obtained over the year including the highest and lowest levels over 24 hours and the annual geometric mean for each parameter.

1993 Yellowknife Air Quality Data

Exposure	TSP	Lead	Arsenic	Nitrate	Sulphate
highest (24 hr.)	777	0.340	0.251	0.63	4.24
lowest (24 hr.)	13	0.000	0.00	0.17	1.00
Annual Geometric Mean	62	0.004	0.015	0.40	2.00

Note: all units in micrograms per cubic metre of air (μg/m³).

Each parameter is discussed in greater detail on the following pages.

Total Suspended Particulate

Total Suspended Particulate is a general term for dust which applies to a wide variety of solid or liquid particles which, because of their size and shape, tend to remain suspended in the air. A significant source of the TSP in Yellowknife is dust from roads, parking lots and other unpaved areas. A smaller percentage of the total comes from sources that include mining activities, combustion products from vehicles, heating and electricity generation and woodsmoke. Each source contributes particulate with a unique chemical make-up. Natural sources such as forest fires and pollen can also contribute to TSP levels.

An air quality guideline under the Northwest Territories' *Environmental Protection Act* sets standards for TSP levels in ambient air. Ambient air is the air found in the general environment that people breath and to which plants, animals and materials are exposed. The NWT 24 hour (daily) TSP standard is 120 micrograms per cubic metre ($\mu g/m^3$) and the annual geometric mean standard is 60 $\mu g/m^3$. These are consistent with standards or objectives in other parts of Canada.

Figure 1 shows that the highest levels occurred in April of 1993 but that the rest of the summer and fall had slightly less dust than the average between 1974 and 1992.

10 of the 57 samples collected in 1993 had TSP levels above the NWT 24 hour standard.

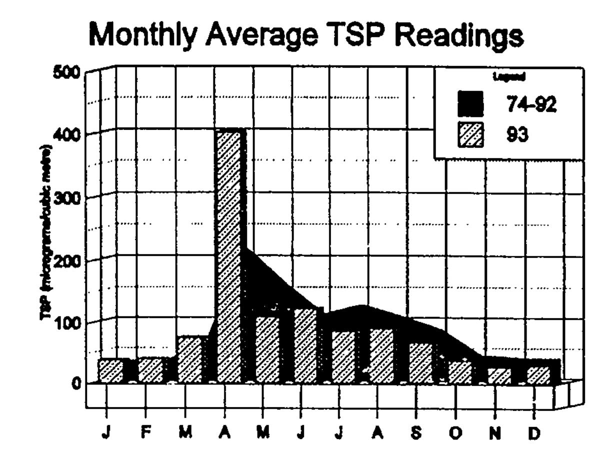

Figure 1

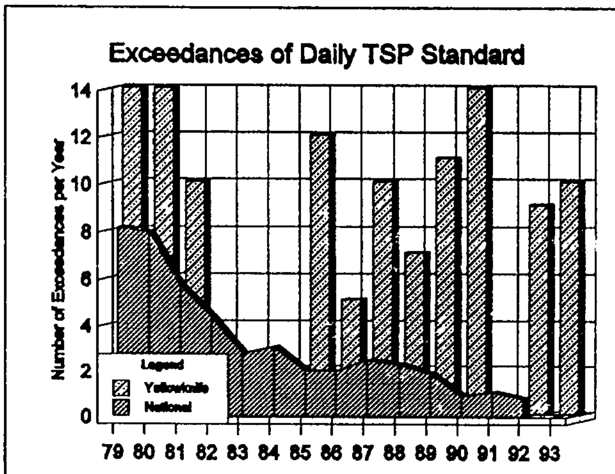

Figure 2 Note - the 1993 national average was not available when this report was prepared.

Figure 2 shows that while the number of exceedances of the NWT 24 hour standard has fluctuated over the years, there has been no steady improvement in TSP levels. The average number of exceedances in all other Canadian cities participating in the NAPS program have decreased.

Figure 3 shows that the 1993 annual geometric mean of 62 µg/m³ was within the range that has been experienced in previous years. This level is slightly above the annual standard of 60 µg/m³.

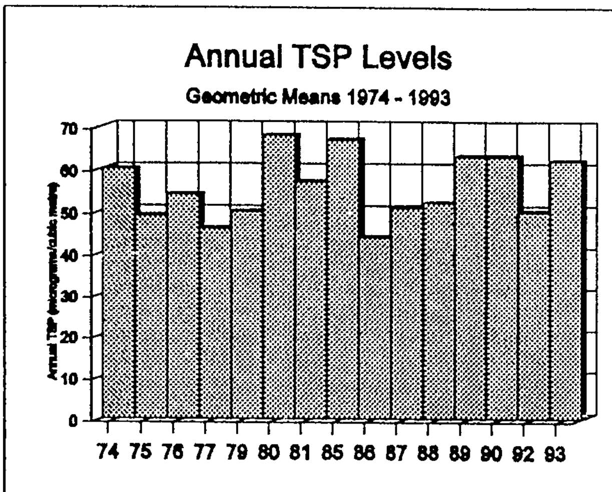

Figure 3

Dust (TSP) levels in Yellowknife cannot be entirely defined on the basis of measurements made at the single monitoring station. Some of the highest dust levels in Yellowknife occur near the downtown monitoring station but, based on complaints made to the Department of Renewable Resources, sources of suspended particulate are found throughout or affect large portions of the city.

Arsenic

Figure 4 shows that the 1993 annual geometric mean of 0.015 µg/m³ total arsenic was an increase over levels during 1989 to 1992. Levels remained lower than they were during the 1970's.

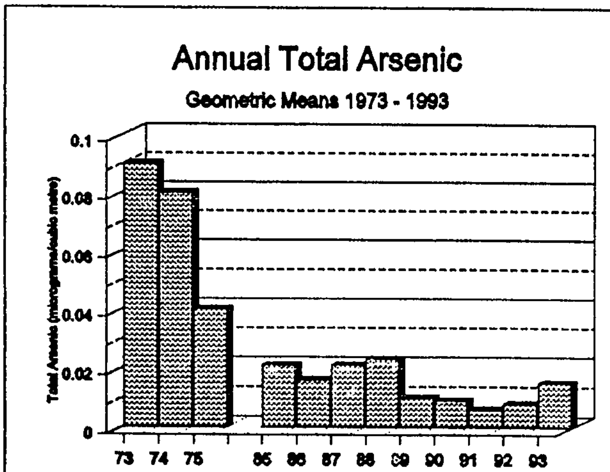

Figure 4

The highest 24 hour sample for total arsenic in 1993 was 0.251 µg/m³. The Ontario 24 hour standard for total arsenic is 0.3 µg/m³. Since 1985, total arsenic levels in Yellowknife over a 24 hour period have risen above the Ontario standard on two occasions. Those exceedances coincided with pollution control equipment malfunctions at the Royal Oak Giant Yellowknife Gold Mine, located about 5 kilometres north of Yellowknife.

In March of 1994 a survey was conducted in the Yellowknife area to determine total arsenic levels in snow cores. This survey confirmed previous surveys conducted in 1975 and 1986 that showed that the Giant Mine is the most significant source of arsenic in the Yellowknife area.

Lead

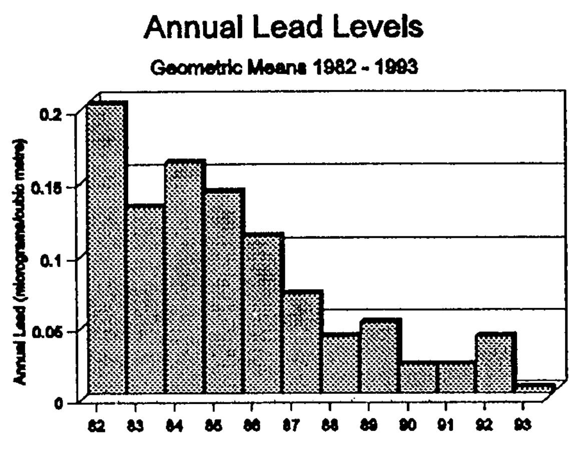

Figure 5

Lead was not detected in 15 of the 57 samples taken in 1993. The highest 24 hour sample measured 0.34 µg/m³, well below the Ontario standard of 5.0 µg/m³. The second highest 24 hour lead measurement was 0.07 µg/m³.

Figure 5 shows the decline in annual lead levels since 1982. Levels in Yellowknife air declined as lead in gasoline was phased out. Lead-painted wood is a potential source and should not be burned.

Sulphate and Nitrate

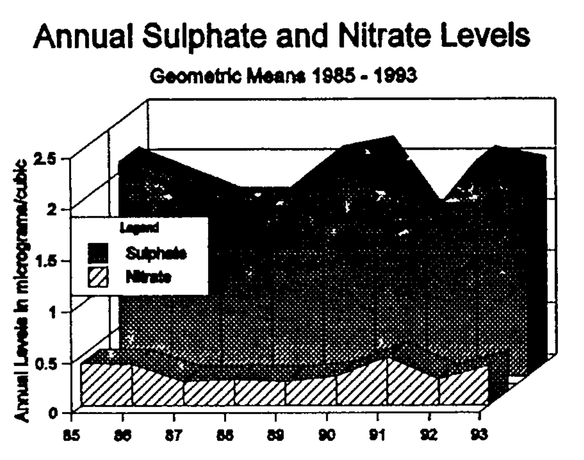

Figure 6

Figure 6 shows that there has been no noticeable trend in levels of these pollutants in Yellowknife. Levels detected in Yellowknife air are considered to be well within an acceptable range (there are no standards for these pollutants in Canadian jurisdictions). Levels are lower than in most Canadian cities.

Sulphate and nitrate particulates are emitted directly from combustion sources such as automobile engines or furnaces. Within about a day any sulphur dioxide or oxides of nitrogen emitted as gases will react with water droplets to also form sulphate and nitrate particulates.

WHAT WERE THE SULPHUR DIOXIDE LEVELS IN 1993?

Continuous monitoring for sulphur dioxide (SO_2) in downtown Yellowknife was started in late 1992.

An air quality guideline under the Northwest Territories' *Environmental Protection Act* sets a standard for maximum acceptable levels of SO_2 in ambient air. The standard is set at levels that would protect vegetation because, in general, plants are more sensitive to SO_2 exposure than people. The one hour standard for SO_2 is 450 micrograms per cubic metre (µg /m^3), the 24 hour (daily) standard is 150 µg/m^3 and the annual standard is 30 µg/m^3.

In 1993, SO_2 levels rose above the NWT one hour standard on 30 occasions during the ten months measurements were made. Only once was the one hour level measured above 900 µg/m^3, the level above which mild and reversible impacts on human health from exposure to SO_2 are considered to begin. The NWT 24 hour standard was not exceeded in 1993. The annual arithmetic mean was 13 µg/m^3 between March 1993 and February 1994, below the annual standard of 30 µg/m^3.

The following table shows the frequency distribution of levels detected in Yellowknife air. This table shows that for up to 80 percent of the time no SO_2 was detected at the monitoring station. 99 percent of the time levels were below 283 µg/m^3 or it could be said they were above 283 µg/m^3 1 percent of the time.

1993 - March to December Yellowknife One Hour Sulphur Dioxide Level Frequency Distribution

	Min	10	30	50	70	80	90	95	98	99	99.9	Max
µg/m^3	0	0	0	0	0	0	3	26	173	283	723	940
ppm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.07	0.11	0.28	0.36

Sulphur dioxide monitoring and other studies conducted by Renewable Resources since 1991 confirm that high SO_2 levels rarely occur at any particular location in the Yellowknife area if winds are not directly from the Royal Oak Giant Yellowknife Mine. High levels of SO_2 were found to be most frequent to the north along the Vee Lake Road. Vegetation damage from SO_2 has been observed as far as 5 kilometres from the mine along this road. The Royal Oak gold roaster is the largest source of SO_2 in the Yellowknife area.

During Arctic inversion conditions in cold months levels of SO_2 in Yellowknife air have been found to rise slightly to about 15 µg/m^3. This is because the inversion layer traps local emissions from heating and vehicles including SO_2 and the moisture content of exhaust that can contribute to ice fog formation. Giant Mine emissions are released from the stack above the inversion layer and do not affect Yellowknife air quality at these times.

ARE ACID RAIN LEVELS STILL LOW?

Precipitation monitoring to measure acid rain in the Yellowknife area started in 1986. Renewable Resources operates a Canadian Air and Precipitation Monitoring (CAPMoN) station at the Northwest Territories Power Corporation's Snare Rapids hydro site, 150 kilometres northwest of Yellowknife. Rain and snow samples are collected on a daily basis and sent regularly to Environment Canada's CAPMoN laboratory in Toronto for analysis.

Acidity in precipitation is measured in pH units, with lower values indicating greater acidity. Sulphate and nitrate that dissolve in precipitation are the primary cause of acid rain problems where emissions from industry and vehicles are high. Chloride, sodium, calcium and magnesium generally come from natural sources and act to neutralize acidity in precipitation. Data from 1993 are shown in the table below.

1993 Snare Rapids Acid Rain Data

	pH	Sulphate	Nitrate	Chloride	Sodium	Calcium	Magnesium
Maximum	6.51	11.62	4.60	0.85	0.29	0.70	0.15
Minimum	4.16	0.04	0.00	<0.01	<0.01	<0.01	<0.01
Geometric Mean	5.05	0.37	0.24	0.07	0.03	0.05	0.02
Deposition	-	0.90	0.95	0.15	0.05	0.10	0.02

Note: Units are in milligrams per litre(mg/l) except pH in pH units and deposition in kilograms per hectare (kg/ha).

Monitoring of pH and other compounds at the Snare Rapids hydro site in 1993 indicated negligible acid rain content. This is consistent with levels detected in past years and are considered to be typical background levels associated with unpolluted areas. The most acidic sample had a pH of 4.16 but came from a trace of precipitation so very little acidity entered the environment. In general, significant precipitation events had pHs close to 5.5, a level considered to be natural.

Annual sulphate deposition at Snare Rapids in 1993 was 0.90 kilograms per hectare per year (kg/ha/yr). This is well below 7 kg/ha/yr, the level considered to protect sensitive ecosystems in the Northwest Territories. In the parts of eastern Canada where acid rain is a serious environmental problem, sulphate deposition is in excess of 20 kg/ha/yr. Nitrate deposition at Snare Rapids is similarly low compared to eastern Canada.

For further information contact:

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