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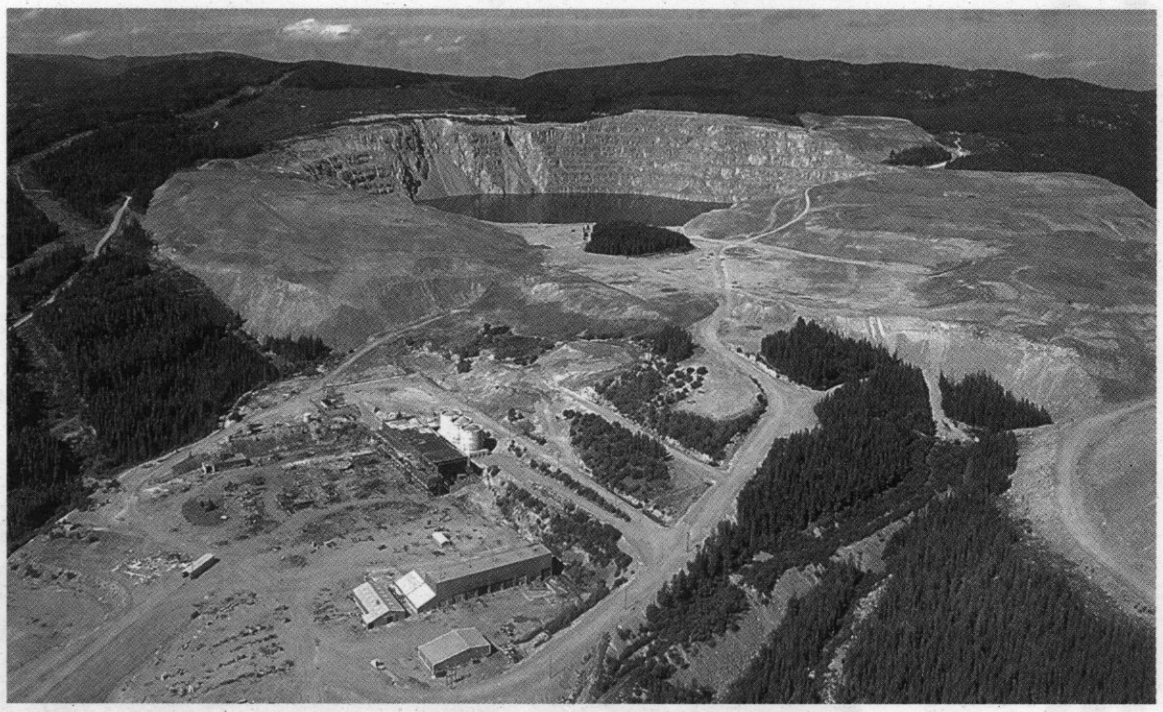
Brenda Mines infosheet

Site visit July 26/00 TGS

Brenda Mines operated from 1970 until 1990 with decommissioning activities beginning in 1988. An $11 million dollar water treatment facility was constructed in 1998 to treat water stored in the open pit.

HISTORY AND CLOSURE



MINE OPERATION

The Brenda copper-molybdenum mine site is situated in the southern interior of British Columbia, approximately 22 kilometres from the municipality of Peachland. The Brenda orebody was first discovered in the 1930s by the Sandberg family of Kelowna, while searching for gold in the area. A decision to develop a mine was not made until the 1960s when Noranda Inc. assumed management control for Brenda Mines. The mine was brought into production at 24,000 tons per day in 1970.

Capacity was gradually increased to 33,000 tons (30,000 tonnes). Due to a depleted ore reserve, Brenda Mines was officially closed in June 1990. Noranda Inc. assumed 100% ownership of Brenda in 1996.

Operating Facts

■ Opened	1970
■ Closed	1990
■ Employment levels	2,200 (1970 – 1990)
■ Benefits Paid (Salary)	$215 million
■ Construction cost	$62 million
■ Taxes	$79 million

Open Pit Operations

■ Ore processed	182 million tonnes (approx.)

Metal Produced

■ Copper	278,000 tonnes
■ Molybdenum	66,000 tonnes
■ Gold	2 tonnes
■ Silver	125 tonnes

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MINE CLOSURE

Site reclamation activities for Brenda Mines began in 1988. This included aerial seeding and fertilization, and irrigation of newly planted areas. Options were also evaluated for disposal of water collecting in the open pit. This required studies of drainage patterns, seismic stability of the dams, aquatic species, plants, forage crops and trees.

Two committees provided guidance during the evaluation: a Technical Committee of government representatives and a Public Surveillance Committee with local residents. A detailed closure plan was in place by 1993 and an amended Ministry of Environment permit to discharge water was issued first in 1997 and then with further requirements in 1998 (see The Permit InfoSheet for details). Between 1990 and 1997, $38 million were spent on site closure and reclamation activities.

Closure Facts

Closure & reclamation expenditures

(1990 –1997)	$38 million

Water Treatment Plant

■ Construction costs	$11 million
■ Annual operating costs (estimated)	$1.5 million

Tailings Dam

■ Length	2 kilometers
■ Height	140 meters

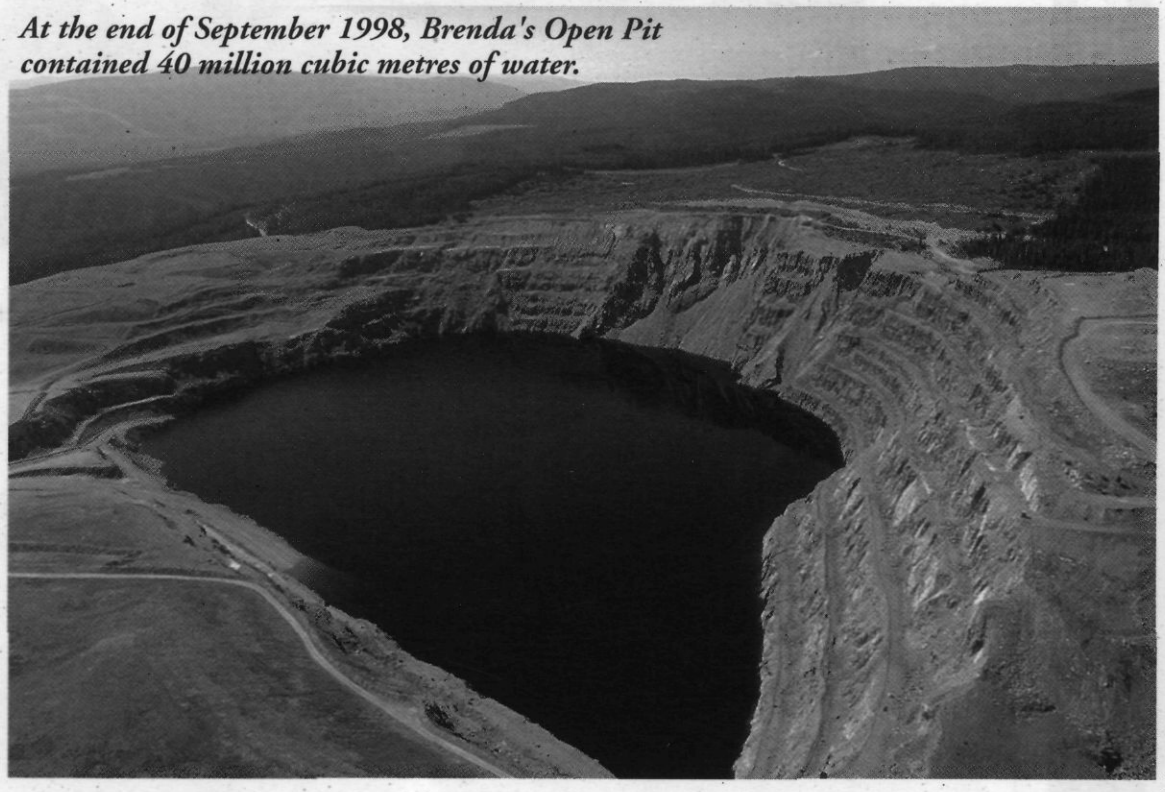
Tailings Pond

■ Water surface	87 hectares
■ Depth	3 to 4 metres

Open Pit

■ Diameter	914 meters
■ Perimeter	5 kilometers
■ Depth	335 meters at west end 240 meters at east end
■ Volume of Water	40 million cubic metres

At the end of September 1998, Brenda's Open Pit contained 40 million cubic metres of water.



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Brenda Mines Division, Noranda Inc. (November 1998)

Brenda Mines infosheet

THE PERMIT

Permit PE-00263 was issued and amended twice by the BC Ministry of Environment, Lands and Parks under the provisions of the Waste Management Act.

BACKGROUND

The Brenda copper-molybdenum mine closed in 1990 as both mineral reserves and prices declined. Since then all precipitation (rain and snowmelt) that has come into contact with exposed rock areas on the site has been collected and stored in the open pit and tailings pond.

The purpose of the Permit is to authorize the treatment, by way of a sophisticated treatment plant, of the stored precipitation in the pit and pond, so as to substantially reduce the elevated concentrations of molybdenum. The treatment plant reduces the concentration of molybdenum from approximately 3.5 mg/L to less than 0.25 mg/L.

The following is a summary of the Permit. Copies of the complete Permit are available by calling the Brenda InfoLine.

THE PERMIT

A Permit was issued on July 15, 1997 authorizing discharge of treated water into MacDonald Creek which flows into Trepanier Creek and then into Okanagan Lake. The Permit was amended on July 29, 1998 following an appeal. The appeal process included six days of oral hearings supported by written summary arguments. Concern focused on the impact of the proposed discharge of treated mine water on Trepanier Creek and the subsequent human health impacts related to the use of Trepanier Creek as a drinking water supply. New requirements are listed at the end.

Authorized Discharges (from the Treatment Plant)

Discharge of treated water will occur between October and June. The maximum authorized rate of discharge is 5,000,000 cubic metres per calendar year, and the average annual rate of discharge shall not exceed 3,100,000 cubic metres per year. These numbers are based on the maximum and typical amounts of rain and snow runoff on the site.

Discharge is not to exceed the following concentrations at *point of discharge from the plant* [expressed in millegrams per Litre (mg/L)]:

dissolved copper	0.03 mg/L
total iron	0.30 mg/L
dissolved manganese	0.10 mg/L
dissolved molybdenum	0.25 mg/L
dissolved zinc	0.20 mg/L
total dissolved solids	950 mg/L
total nitrogen & nitrates	3.0 mg/L
pH	6.5 – 8.5 units
total phosphate	0.10 mg/L
dissolved sodium	100 mg/L
dissolved sulphates	500
total suspended solids	15 mg/L

Water Quality Objectives

Over and above these point of discharge requirements, the Permit sets *receiving water concentrations* that must be met in Trepanier Creek as measured at the Peachland Irrigation District Intake:

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Five-year average concentration
less than or equal to 0.05 mg/L

Maximum annual average of monthly concentrations
less than or equal to 0.10 mg/L

In any single sample,

from June 1 to September 30
less than or equal to 0.03 mg/L

from October 1 to start of freshet
less than or equal to 0.20 mg/L

during freshet
less than or equal to 0.10 mg/L

Other General Requirements

The Permit sets out conditions related to the following operational matters:

- provision of alternate water supplies
- maintenance of works and emergency procedures
- provisional discharges
- unauthorized discharges and spill reporting
- process modifications
- seepage collection and return works
- surface diversion works
- pollution prevention initiatives
- prevention of habitat loss during spring freshet
- sludge management program

Monitoring Requirements

The Permit includes detailed sampling and monitoring requirements for the water leaving the plant (discharge), and surrounding groundwater and surface waters (creeks, weirs, ponds and lakes). Water sampling will be carried out by Noranda following the procedures set out in the British Columbia Field Sampling Manual. The table (see opposite page) shows the various parameters to be monitored in the discharge water and at nine sites down-stream from the discharge. Water quality parameters are also being monitored at nine non-discharge related sites, three groundwater sites and the open pit. The map (see back-page) illustrates the location of surface water monitoring sites.

Frequency of Monitoring

Discharge of treated water will be monitored daily at the outlet to MacDonald Creek. Monitoring at the Peachland Irrigation District Intake on Trepanier Creek will begin as daily and then shift to weekly depending on results. During periods of discharge, the flow (quantity) of treated water and the flow of Trepanier Creek will also be measured daily. Other sites that are related to the discharge water will be monitored at varying frequencies ranging from weekly to quarterly (see map). Sites not related to the discharge will be monitored quarterly and the groundwater will be monitored at three sites every six months.

Reporting

Records of all the monitoring results will be maintained, with quarterly and annual reports prepared. Performance reviews will be carried out every five years by the Ministry of Environment, Lands and Parks; the Ministry of Energy and Mines; and the Public Surveillance Committee.

Provisions added in 1998 state that the five-year review includes a review of water treatment technology and the impact of molybdenum on environmental and human health. Changes also require that monitoring results be made available to the public.

THE PERMIT

Parameters to be Monitored at Discharge and Downstream

Parameters to be Monitored	Discharge	Surface Waters (Receiving Waters)
dissolved molybdenum	✔	✔
dissolved copper	✔	✔
dissolved nitrate plus nitrate nitrogen	✔	✔
dissolved sodium	✔	✔
dissolved sulphate	✔	✔
dissolved chloride	✔	✔
pH	✔	✔
conductivity	✔	✔
dissolved solids	✔	✔
suspended solids	✔	
turbidity	✔	✔
hardness	✔	✔
total iron	✔	
dissolved manganese	✔	✔

ADDITIONAL REQUIREMENTS

The following new requirements were added to the Permit as a result of the 1998 appeal.

Financial Security

The amended Permit requires that Noranda provide financial security to the Ministry of Environment, Lands and Parks for the sum of $3 million on or before the date discharge begins.

Public Participation

The changes require Noranda to promote pubic participation to address concerns related to the discharge. This is to include ongoing involvement of a public committee and additional efforts toward improving public understanding of the technical issues related to the Permit.

Receiving Environment Study

A new section requires that Noranda conduct a five-year receiving environment study to evaluate the actual impact of the discharge. Terms of reference are to be developed with public input and submitted for approval to the Regional Waste Manager by January 30, 1999. The study scope is to include fish and aquatic organisms in Trepanier Creek, the uptake of molybdenum by plants and biota along MacDonald and Trepanier Creeks, sediment and plants in Okanagan Lake, and crops irrigated with water from Trepanier Creek.

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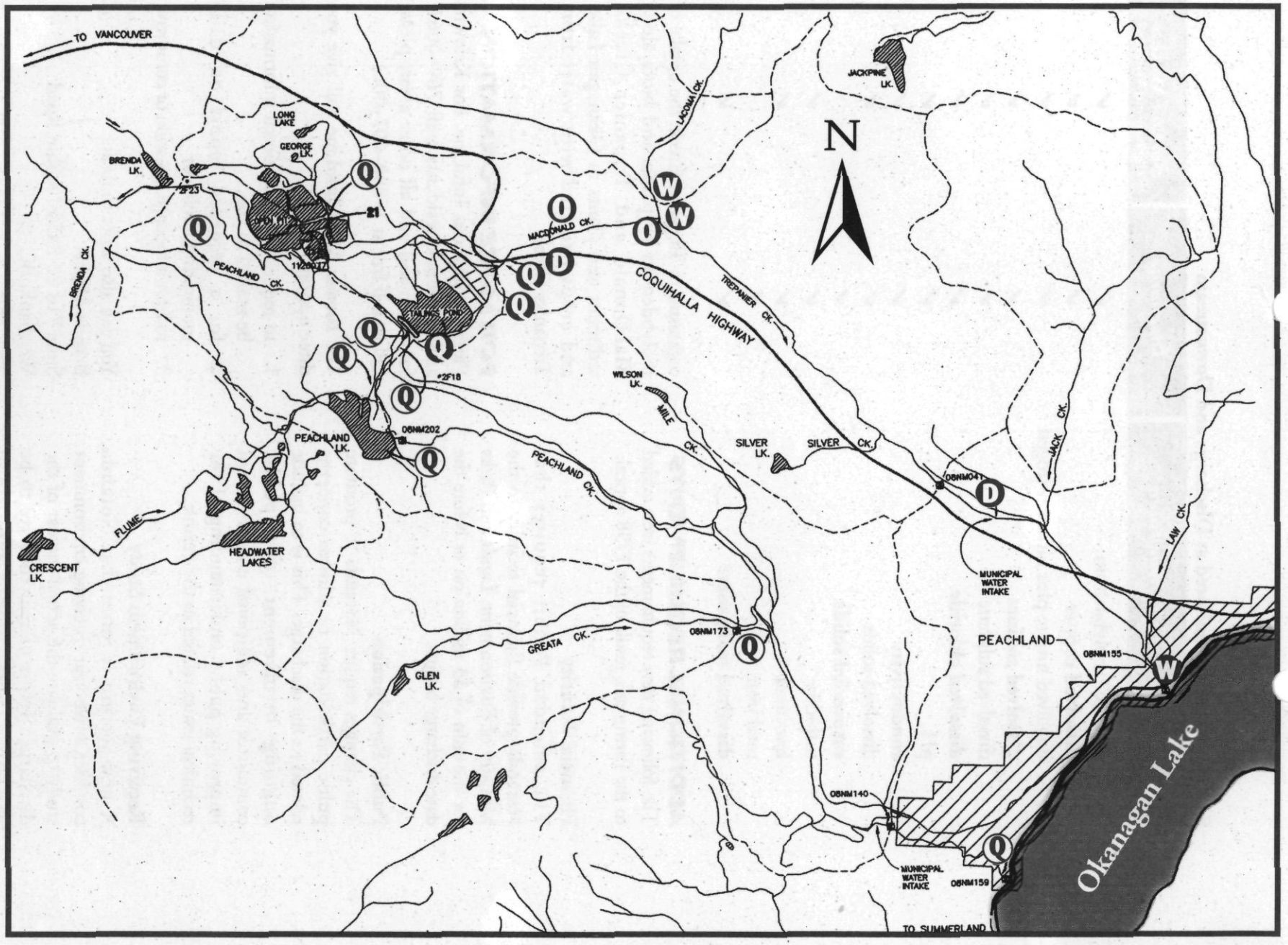
BRENDA MINES SURFACE WATER MONITORING SITES



Legend

- ● Discharge related site
- ○ Non-discharge related site
- **D** Daily monitoring
- **W** Weekly monitoring
- **Q** Quarterly monitoring
- **O** Optional

Brenda Mines infosheet

HEALTH MATTERS

"Water released from the treatment facility is safe for human consumption".

MOLYBDENUM AND HUMAN HEALTH

Molybdenum is a natural mineral in the environment. Since the Brenda mine closed in 1990, all precipitation (rainfall and snowmelt) that flowed onto the mine site has been collected and stored. This surface water cannot be released to the environment untreated due to its elevated molybdenum content.

Noranda has designed a water treatment system to reduce the molybdenum concentrations in the stored water and has obtained a permit to discharge the treated waters to Trepanier Creek.

The following information addresses a variety of questions regarding molybdenum and human health.

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MOLYBDENUM IN OUR DIET

Molybdenum is an essential element for the maintenance of good human nutrition. Molybdenum is required for many different enzymes that are essential for all tissues and organs in the body. An example of the importance of molybdenum for good nutrition is the required supplementation of formulas for premature infants with molybdenum to ensure their optimal growth and development (Bougle et al., 1991; Casey and Hambidge, 1985).

Molybdenum is a normal mineral found in such foods as milk and milk products, dried legumes, organ meats (liver and kidney), cereal grains and baked goods. Most of our daily requirements for molybdenum are met by the consumption of cereal grains such as wheat, oats, barley and rye.

A number of regulatory agencies (e.g., NRC, Health Canada) have estimated typical daily consumption rates and healthy or safe consumption rates for molybdenum. The key representative values are listed in Table 1.0.

Studies of intake from normal foods have demonstrated that there are significant differences in daily molybdenum intake between sexes and among different age groups. When the intakes are compared on a body weight basis (per kilogram body mass), differences between sexes tend to disappear. Differences in molybdenum intake are also observed at different ages. Among young individuals, the consumption of molybdenum is greater than adults, even on a body weight basis.

However, while intakes of molybdenum do differ, there is no evidence of differences in sensitivity to molybdenum between sexes or age groups.

TABLE 1.0
Summary Table of Estimated Daily Intakes and Safe and Adequate Daily Intake Levels for Molybdenum

Substance	Health Canada (1996) Estimated Daily Intake (mg/day)	NRC (1989) Essential Safe and Adequate Daily Intake (mg/day)
Molybdenum	0.05 to 0.35	0.075 to 0.250

MOLYBDENUM IN THE HUMAN BODY

Everyone has "homeostatic" control systems to maintain a constant balance of essential nutrients within the body. Thus, the body is able to ensure that the required amount of a given substance for health and maintenance of normal body functions is retained in the body, and excess amounts are excreted to avoid build-up in body concentrations that could lead to toxic effects. For molybdenum, this "homeostatic" balance is achieved by clearance of excess molybdenum through the kidney and excretion from the body in urine. As molybdenum intakes increase beyond those required for normal nutrition, the rate of excretion from the body in urine also increases. This homeostatic mechanism operates to maintain the concentrations of molybdenum at the required levels in the body. If the intake of molybdenum is extremely elevated compared to the bodies' requirements, the clearance of the excess by the kidneys is overwhelmed, and molybdenum concentrations in the body increase to the point where toxicity can develop.

Since the kidney performs an important function in maintaining molybdenum homeostasis, changes in kidney function are important in the assessment of molybdenum safety. Understanding how molybdenum is excreted by the kidney into urine is the key to understanding the importance of various aspects of kidney function relative to molybdenum safety. A number of investigations have shown that molybdenum is excreted by the kidney by a process known as passive diffusion or passive filtration. Passive filtration processes occur via simple diffusion, and do not require any energy (i.e., molybdenum is simply excreted, rather than being "pumped" out of the body).

Passive filtration systems, by which molybdenum is excreted through the kidney, are relatively robust (are not readily affected by diseases and other disturbances) compared to active transport systems. Also, the passive filtration capacity of the kidney does not change appreciably with age, especially when expressed in terms of unit body weight (Holiday et al., 1994; Heibron et al., 1991).

Since molybdenum is excreted through the kidney by passive filtration, no changes in kidney excretion rates of molybdenum, per unit of body weight, would occur with age. As such, molybdenum levels established as safe for adults would also be protective of infants and the elderly.

TABLE 2.0
Long-Term Molybdenum Concentrations in Trepanier Creek in Relation to Various Drinking Water Objectives

Substance	Long-Term Average Concentration in Trepanier Creek (mg/L)	Drinking Water Objective (mg/L)	Description of Objective	Reference
Molybdenum	0.05	0.25	No adverse effects in humans	BC Environment
		0.07 [a]	No adverse effects in humans	WHO, 1993

a Based upon the Chappell et al. (1979) No Observed Adverse Effect Level of 0.2 mg/L with a 3-fold safety factor imposed.

MOLYBDENUM PERMITTED FOR TREPANIER CREEK

A number of researchers and regulatory agencies have established recommended drinking water quality objectives or limits for molybdenum. Key values are listed in Table 2.0, together with the long-term, average permitted molybdenum concentration in drinking water from Trepanier Creek, for comparative purposes.

The concentration in Trepanier Creek is well under the B.C. drinking water guideline for molybdenum. It is also under the World Health Organization (WHO) guideline for longterm intakes.

HEALTH MATTERS

The WHO drinking water guideline for molybdenum is based on a conservative value at which no adverse effects on human health have been seen. Other data involving greater daily intake concentrations of molybdenum also have demonstrated a lack of health impacts. Therefore it can be concluded that these concentrations in drinking water are far below those values for which human health effects would occur.

Furthermore, the drinking water guidelines established by BC Environment and by the WHO organization were developed prior to important molybdenum distribution/excretion data was collected in the 1990's.

Experts have indicated that, based on these distribution/excretion data, the safety factors applied in these guidelines were overly conservative (Chappell, 1998; Willis, 1998).

The issue of molybdenum concentrations in Trepanier Creek water was recently reviewed during an appeal of the Brenda Mines Permit issued by BC Environment. The appeal decision confirmed the above analysis.

ABOUT THIS INFOSHEET

This Health Matters information sheet on molybdenum and human health was prepared by Cantox Environmental Inc., a science-based consulting firm specializing in providing expert advice to a wide range of clients on toxicology issues related to human health, the environment and regulatory affairs.

Cantox Environmental scientific staff have degrees in biology, toxicology, aquatic toxicology, environmental toxicology and environmental studies, and have considerable expertise in toxicological, exposure and risk assessment techniques for humans and ecological receptors from both terrestrial and aquatic environments.

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