The Boreal Below:

Mining Issues and Activities in Canada's Boreal Forest Region

A Report by MiningWatch Canada

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Appendices

1.0 Purpose / Context of Report

The report provides an overview and general analysis of mining activities and impacts, but falls short of being fully comprehensive, particularly in its cataloguing of mining activity (other than operating mines), chiefly because the time and resources allocated to the task permitted only an initial overview and inventorying. The report provides a solid and reliable overview and refers the reader to additional resources and information sources.

The report was developed by MiningWatch Canada with a consortium of researchers and authors, including Northwatch mining campaigners Brennain Lloyd and Catherine Daniel, who assembled the inventory, researched and wrote all sections except those otherwise noted in this introduction, and edited the report into a single document; Colin Chambers and Hugh Benevides, who researched and wrote the section on political and regulatory trends; Henri Jacob, who provided research for the section on Quebec; Roch Tasse, who provided translation of portions of the Quebec report; Beverly Shiels of the Laurentian University Field Station in Elliot Lake who provided GIS and mapping services; and Joan Kuyek of MiningWatch Canada who provided overall support and editorial comment, as did members of MiningWatch Canada's board. Review of regional sections were generously provided by the Environmental Mining Council of British Columbia, Yukon Conservation Society, the Environmental Law Centre in Edmonton, Saskatchewan Environmental Society, Manitoba Resource Conservation, Northwatch and the Innu Nation.

The mining sector is one of the major industrial players and sources of long lasting and wide-ranging environmental and social impacts within and beyond the boreal forest region, both now and into the foreseeable future. Mining and mineral exploration leave virtually no part of the vast boreal forest untouched. With few exceptions, the entire forest landscape is subject to mineral exploration, and every major watershed is host to a mining operation. Abandoned mines are scattered across the region, the majority of them unattended and a great number of them not yet even evaluated for their impacts on the environment. And mines bring with them a full slate of industrial infrastructure – roads, power generators, transmission lines, and camps or communities and related development – paving the way for other resource extraction players, who inevitably follow.

2.0 Mining the Boreal

2.1 An Introduction to the Boreal as a Mining Region

Canada's boreal is an immense northern forest "draped like a green scarf across the shoulders of North America".[1] It comprises 77% of Canada's forest land, stretching in a multi-hued green band from the Yukon Territory to southeast Newfoundland.

The boreal is, in the romantic imagination of North Americans, the last and everlasting wilderness. While the wilderness qualities of the boreal may, tragically, prove to be less than everlasting, the legacy of the mining activities which rob the great northern forest of its wildness will be permanent.

So what is so "boreal" about mining in Canada? Three factors stand out:

- Eighty percent of the mining in Canada occurs in the boreal forest region.
- The long term impacts of mining and the slow recovery rate of the boreal ecosystem couple to make mining of great concern, particularly considering its prevalence.
- As a result of more readily accessible ore reserves having already been depleted, more mines are being developed in more remote locations. This phenomenon ensures that the mining industry will retain its deserved reputation as a frontier-buster, bringing the roads, power developments and infrastructure with them into the last remaining remote or semi-remote areas,

Canada's boreal forest builds soil, filters water, captures carbon and produces oxygen. While difficult to monetize the value of such life-giving functions, these life-support services have been quantified as nearly $70 billion worth of life-support services for Canadians annually.[2]

Mining, forestry and hydroelectric development are the most significant industrial activities in the boreal. These activities provide infrastructure in remote areas and interact with each other to "open up" a region. The last 40 years have seen rapid, poorly controlled, and poorly planned development in the boreal, as resources have become depleted in other regions and transportation has improved.[3] The cumulative effects of this development appear to have not been effectively considered at any point in this development "rush", nor has the its ecological context. The development is taking place in Canada's least conserved landscape;[4] one which both the country's leading scientists and Senate

> "The window of opportunity for preserving all of the values of the boreal forest is closing rapidly"
>
> "Competing Realities: The Boreal Forest at Risk" Senate Subcommittee on the Boreal Forest, June 1999 News Release

subcommittees have identified as being at risk of being lost in the next half-century, unless industrial development is drastically curtailed.[5]

There exists an unholy marriage between the unique impacts of mining and the unique qualities of the boreal forest region. The acid laden mine effluent and acid laced air discharges of the mining industry overlay the thin and naturally acidic soils of the boreal to stress these forest ecosystems perhaps beyond recovery. The slow growing and slow healing taiga is brutalized by earth-stripping activities of the diamond and mineral exploration industry, where crews move tens of thousands of the thin boreal soils each day in the search for pretty gems.

To evaluate the impacts of mining activity in Canada's boreal forest region, they need to be viewed in the context of the natural characteristics and function of the boreal forest.

2.2 The Ecology of the Boreal Forest Region

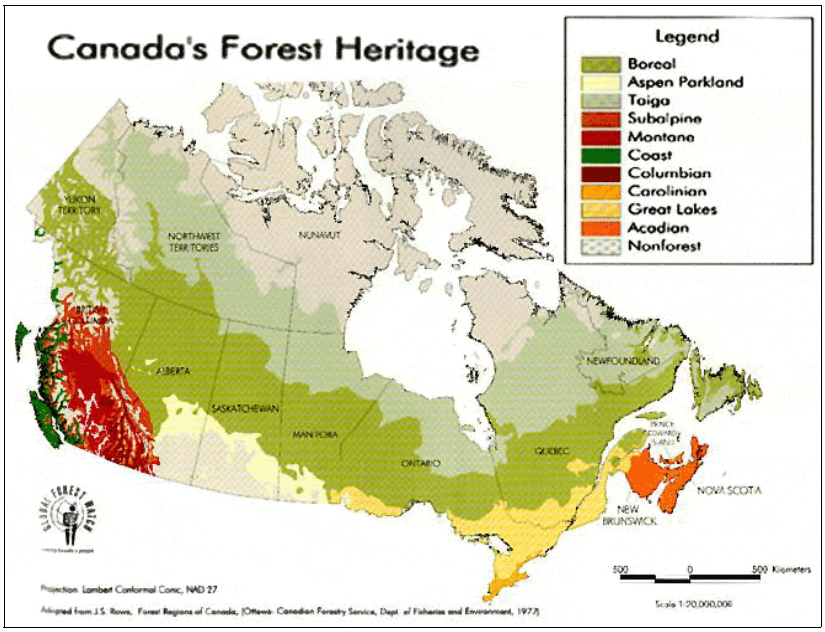
The northern boreal ecoregion accounts for about one-third of the earth's total forest area and is identified as one of the world's three great forest ecosystems.[6] Softwater boreal lakes around the world may contain 80% or more of the world's unfrozen freshwater.[7] Canada's boreal ecozones cover an enormous part of the country: 31.6% of its total area or 2.9 million square kilometers.[8]

Boreal ecosystems contain relatively low numbers of species (approximately 100,000 in Canada[9]) and their simple community structures make them vulnerable.[10] Limited numbers of plant and animal species result in a lower information content (i.e. DNA) in an ecosystem. Efficiency is reduced if the information content of a system is reduced.[11] Therefore, removing a few species from a boreal ecosystem that contains only hundreds of species may be more likely to degrade vital community and ecosystem functions than the removal of the same number of species from a tropical ecosystem that contains hundreds of thousands of taxa.[12] The disappearance of only a few species has been shown to impair the proper functioning of food chains and biogeochemical functions in boreal lakes.[13] Additionally, lower biotic productivity of boreal ecosystems increases their recovery time following disturbance.

Winters in the boreal forest are long and severe while summers are short and often warm.[14] White and black spruce, as well as tamarack dominate the boreal forest.[15] In east and central portions, balsam fir and jack pine occur, and in the west and northwest: alpine fir and lodgepole pine. Prominent broadleaved trees

are white birch, trembling aspen and balsam poplar.[16] Soils in the boreal are mainly thin and acidic, including podzols, brunisols, luvisols and cryosols.[17] Over 200 bird species breed in the boreal and wildlife includes caribou, lynx, black bear, moose, coyote, timber wolf and recovering populations of wood bison.[18]

Typically, there is no senescent phase in boreal forest development and forest systems appear to accumulate biomass and nutrients continuously until interrupted by fire or other disturbance.[19] Boreal forest plant communities are well adapted to fire, which occurs at average intervals of 80-100 years in midcontinental boreal systems.[20] Fires are larger and occur with greater frequency in the boreal shield than in any other forested region of the country.[21]

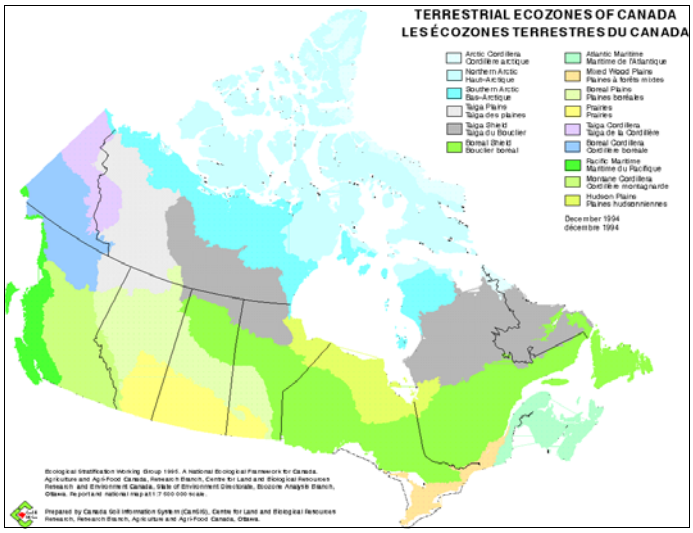


2.3 Definition and Delineation of the Boreal Forest and the Boreal Ecozones

The boreal forest region has been defined many ways. This poses some challenge to efforts to quantify activities or impacts in Canada's boreal region, since such quantification must first identify which delineation has been used.
This report relies upon Stanley Rowe's 1972 delineation of Canada's forest regions in general, and, in particular, adopts the boreal forest region defined by Rowe as "Boreal - Predominantly Forest".[22] This delineation does not include the taiga and the transitional area between the prairies and the boreal forest.

The delineation used by Environment Canada for their "State of the Environment" reporting is somewhat different, as it defines three boreal ecozones in Canada: the boreal shield, the boreal plains and the boreal cordillera.[23] Since the State of the Environment Report (SOR) information about the boreal is generally provided by these boreal ecozones – some of which is included in a later section of this report – these ecozones are described here and referred to occasionally throughout this text, although it is important to note that these three ecozones extend beyond the Rowe delineation.

The boreal shield ecozone takes in all of the island of Newfoundland (which is partially taiga) and a sizable chunk of the Great Lakes-St. Lawrence forest in Ontario. The boreal cordillera ecozone includes tracts of tundra in northwestern British Columbia. The three boreal ecozones exclude the boreal forest along the Mackenzie River Corridor in the Northwest Territories. Otherwise, these ecozones overlap in large part with the boreal as delineated in Rowe's mapping of the "Boreal - Predominantly Forest" classification upon which this report generally relies. Several very controversial mining projects, including Voisey's Bay, are located outside the Rowe delineated boreal forest, but are within the boreal ecozones.



2.4 A Socioeconomic Snapshot

Fewer than 20 million people live in all of the earth's boreal regions.[24] As of 1991, Canada's boreal ecozones contained approximately 3.5 million people or 13% of the country's population, with approximately 57% of those living in the region's urban areas.[25]

In 1991, the three boreal ecozones produced $64 billion in GDP or 10% of Canada's total, with a labour force of 1.7 million people. The largest employment sector throughout the ecozones was services, accounting for 31% of the labour force, while the mining-related sectors employed 103,237 people, or approximately 6.1% of the boreal labour force.[26] Fifteen percent of Canada's resource related employment occurs in the boreal shield ecozone.[27] The ecozone contributes $28 billion annually to the economy from resource extraction, mainly from hydroelectric generation ($16.5 billion), mining ($6 billion) and forestry ($5.8 billion from pulp and paper), while its total GDP is $49 billion.[28]

Natural Resources Canada produces annual reports trumpeting the important contributions of the mining industry to Canadian economic life, and outlining trends and shifts in employment, production and profit. Interestingly, in most instances the Mineral Yearbook provides a single number for the "mineral industry", which it characterizes as including primary mineral production, ie. mining, as well as smelting and refining, semi-fabricating industries which are metal-based, and metal fabricating industries. In 1999, employment in the mineral

industry was 386,000 and accounted for 2.7% of the national employment level of 14.5 million. Direct employment in mining was 52,300, including quarrying aggregates such as sand and gravel. This is less than half of one percent of national employment.[29]

The contribution of all four stages (mining, smelting and refining, semi-fabricating, and metals fabricating) is reported to be 3.7% of GDP, for a total of $27.7 billion. Primary mineral production contributes $7.5 billion, or a stunning 1%.[30]

Despite the continued importance of resource extraction, the trend in the primary and secondary labour sectors has been down, whereas that in the service sector has been up.[31] The growing tertiary sector reflects trends towards growth in the tourism and service sectors, and technological changes in the resource extraction business that reduce employment.

> Northern Canada serves as a colonial hinterland, the resource base on which the south fattens .. There is absentee ownership, both Canadian and foreign, and no political decision-making power to cope with this issue. Northern areas are used as reservoirs of exploitation of both the natural resources and the people. Over the years, some people have advocated cutting large provinces down to size, with new northern provinces being created.
>
> Mildred Barrett Fiorito, Essays on Mid-Canada, Maclean-Hunter Ltd., 1970

Many communities in the boreal region are heavily dependent on a single industry, with mining reported to provide the economic mainstay for an estimated 80 communities in the boreal shield ecozone, supplying 75% of Canada's iron, nickel, copper, gold and silver.[32] But while mines provide employment and purchase goods and services in communities where they are located, the operations are strongly tied to commodity prices in a cyclical market. Mining is heavily dependent on outside capital and external markets, with corporate decision-makers being both physically and socially removed from the local community. Economic benefits related to mining are usually short-term, given that minerals are non-renewable resources and as such inevitably become exhausted. Even before an ore-body is depleted, the mine may shut down due to low global metal prices, or the shareholders' attention and investment being drawn elsewhere. The result is suspended operations and laid-off workers.[33]

Populations in mining communities fluctuate dramatically. For example, Flin Flon, Manitoba lost 26% of its population between 1981 and 1991, Schefferville, Quebec lost 85%, and Uranium City, Saskatchewan lost almost it's entire population (from 2500 to less than 100).[34] In 1898, the Klondike Gold Rush saw 25,000 people crowding into Dawson City and the surrounding territory, but by the early 1900's most had left.[35] As a general observation, mining operations do not necessarily provide long-term economic stability for either individual workers or the community at large.[36] Although mines create jobs, there are also issues

regarding who will get the jobs (local vs. outside workers), how long the jobs will last, and whether or not the people of the community view work at a mine as a positive option.[37]

Mining and quarrying are Canada's most dangerous occupations and rates of workplace injury and death are increasing in the mining industry, while they are decreasing in other occupations.[38] Mining and forestry companies expand and mechanize, eliminating jobs while maintaining or increasing resource extraction. This increases pressure on the workers that remain. At the same time, governments across the country are cutting back on occupational health and safety enforcement. Alberta has laid off more than half of its health and safety inspectors, and downsizing in Ontario now means that inspectors visit remote mine sites on an in frequent basis.[39]

In addition to mine safety, workers must contend with a host of issues related to their health, where the chronic effects of their workplace become evident. Hardrock miners are more likely to get lung cancers than the rest of the population. The probability of developing cancer increases the longer a person works at a mine, if a person has worked in more than one mine, and if the person smokes. Carcinogens encountered in mine sites include radiation, arsenic, nickel, sulphuric acid mist and asbestos. Diesel combustion poses a major hazard in working underground and components of diesel exhaust can cause heart and respiratory problems and cancer. Mental health is also an issue at mines. Fly-in mines create an environment where the worker cannot get away from the work site, resulting in increased stress. The 7 days in-7 days out routine can also cause a major disturbance in family life.[40]

Mining communities share a number of troubling social characteristics, including higher levels of violence against women, alcoholism, and family breakdown,[41] as well as a number of industry-related health problems, including a higher incidence of cancer, asthma and other respiratory diseases in mine workers, their family members, and other local residents.[42]

Major power imbalances can exist between communities and mining companies. When communities try to organize around mining projects, they often cannot get the information and analysis they need. In order to effectively participate in any decisions around their community and neighbour mines, communities need comprehensive understanding of all of the impacts of mining. Yet this information, when it is available, is usually in a form and language that makes it inaccessible to most community members, and there is limited recognition of the right of local communities to in-depth analysis.[43]

In mining communities, services and infrastructure (powerlines, sewage and housing) are often developed to accommodate the larger population that grows up around a mine. At closure, when transient workers leave the community, those left have to shoulder a greatly increased tax burden as a result of the community carrying the costs of oversized and aging infrastructure.[44] Health and environmental impacts from the mine may reduce a community's investment appeal to other sectors. These factors, singly or in combination, often leave mining communities economically vulnerable, and perhaps even willing to consider economic development or activities that carry with them an additional environmental burden.

One such case is the community of Kirkland Lake, in northeastern Ontario. Built on a booming gold market, the town found itself in economic difficulties in the late '80's, as the number of gold mines dwindled and the nearby iron ore mine – a major employer in the area – shut down prematurely, due to low metal prices and high transportation costs. In stepped the first of a series of waste entrepreneurs. For the next decade the community was subject to one proposal after another from the proponents of massive landfills to service the urban communities 800 kilmetres to the south, from questionable tire "recycling" operations, and from a series of proponents for PCB incinerators and extractors. All these projects carried with them high levels of risk and little local control. A decade of such incursions have left the community seriously divided and no further ahead in terms of diversifying the faltering local economy. However, the Town Council persists in not only its entertainment of such offers, but its promotion of them, all for the single purpose of keeping the Town financially afloat in a time of provincial downloading and a drastically diminished tax base.[45] Not a single one of the mines left behind has been remediated, and not a single mine operator has had a community transition plan in place before closing. The last operator to go out, Kinross Mines, provided a full 10 minutes notice to its daytime shift workers of its intention to shut down operations immediately, and left the remainder of its work force and town officials to learn the news from that morning's local radio broadcast.[46]

Perhaps in response to the many problems endemic to communities that in the past have grown up around mining operations, most companies no longer allow them to develop. Mines that are opening up in remote areas now generally depend on bring the workforce in on a fly-in basis, usually working 7 days on / 7 days off, or 14 days in, 7 days out.

2.5 Major Anthropogenic Impacts

Large scale resource development activities – commercial logging, mining and hydroelectric generation – pose the single greatest human threat to biodiversity in

the North American boreal forest ecosystem.[47] The last 40 years have seen rapid, poorly controlled, and poorly planned development in the boreal, as resources have become depleted in other regions and transportation has improved.[48] Only 2.66% of the ecosystem is strictly protected from all forms of large scale industrial activities and 30% of the boreal forest is now within a kilometer of a road or access route.[49]

Human alterations to the atmosphere are causing climatic warming, acid precipitation and increasing UV radiation resulting from stratospheric ozone depletion. The boreal region is among the most sensitive to all three influences, which together have a synergistic effect on ecosystem degradation.[50]

It is predicted that climatic warming will degrade the boreal forest faster than any other ecosystem in Canada.[51] Since 1970, records reveal an upward trend in forest fire activity.[52] Insect and disease outbreaks have also increased in area and duration in the past 30 years due to fire control, harvesting, forest fragmentation, pollution, invasion of non-native species and climate variability.[53]

Most soils in the boreal are highly sensitive to acid precipitation, being relatively thin and also highly acidic and low in nutrients and oxygen. Acid precipitation has already had a significant effect on these soils where base ions have been partially leached away.[54] Since base ions in soils neutralize acid deposition, where they are low in soils, acid precipitation is having more effect than it did previously.[55] Particularly in the Canadian Shield region, soils are acidic enough to stunt forest growth by up to 10%.[56]

Direct causes of impacts to boreal waters include overexploitation of fisheries, alteration of flow patterns, introductions of non-native species, and discharge of eutrophying nutrients and persistent contaminants.[57] Improper management also causes degradation of boreal waters, and clear-cut logging, climatic warming, acid precipitation and stratospheric ozone depletion are among the more important of these indirect stressors.[58]

3.0 The Mining Sequence

3.1 An Overview of the Mining Sequence

Dubbed by both industry and regulators as the mining "sequence", a chain of events is set off when the first stake is driven in the ground to claim a piece of wilderness as a mineral prospect. The sequence supposedly continues through mine development and operation and metal refining, until industry casts their last backward glance at an exhausted mine and the operator moves on to other ventures. The mining sequence is not, however, a set of neatly compartmentalized activities. Nor can the path be relied upon to move from point "A", when the mining company first acquires a property for mineral exploration, through to point "E", when the mine is fully decommissioned and the company could responsibly request an "exit ticket" and leave the site behind. In fact, in the 150 year history of mining in Canada, there are few if any examples of a major mining operation which has been fully and successfully closed out.

A mine moves through a series of stages in its development, operation and closure: the initial prospecting and staking of the mineral claim; the exploration and evaluation of the claim for its mineral potential; the development and operation of the mine; the milling and refining of the ore into the sought-after metals; and the closing out of the mine and, in most cases, the perpetual care of that site. However, there are many variations, and some very faint lines between these mining stages.

For example, some initial evaluation of mineral potential may take place at the time the claim is staked, and the exploration activities can extend to the actual production of ore. At the closing end of the mining sequence, mine operators frequently blur the line between a suspended mine, ie. one which still has commercially viable ore reserves but which has temporarily suspended operations, and a closed mine. Some closed-out or abandoned mine sites are redeveloped, taking them back to the starting point in the mine sequence. There is also a great deal of variation among mines in terms of the milling, refining and further processing of the ores. Most mines will have an on-site mill, but few have on-site smelters, and frequently there is cooperation among producers, with one smelter servicing more than one mine. For example, Inco's operation in Thompson has phased out some of its products at the Manitoba Division, and is now shipping copper in concentrates from Thompson to Inco's Ontario Division in Sudbury.

The following sections provide a description of each stage, with a brief description of the activities generally assigned to that stage and the related impacts. More discussion of major areas of impact, such as acid mine drainage or

air emissions, occurs in later sections, and discussion of the regulatory regime pertaining to each stage can be found in in Section 6, which discusses Canada as a mining jurisdiction, and in Section 7's regional overviews.

3.2 Prospecting

Frequently, prospecting and exploration are clustered or discussed together, as if they are one stage in the mining sequence. There are however, disadvantages to doing so, despite the potential overlap of activities associated with each of these stages. There can be distinctly different impacts in the different stages and different rules apply, and, not insignificantly, industry makes an effort to portray both of these stages as benign, so it is important that the public be clear about the impacts. Neither prospecting or mineral exploration are activities which are conducted without environmental harm.

Prospecting is about finding and staking out a mineral "prospect", i.e. an area which is likely to have a potential mineral deposit, with ore of such quality and quantity as to make the mining of that ore a profitable venture. Generally, prospecting begins with some review of information already known about an area, such as geological reports, past exploration reports, maps, or other information which might provide some "clue" as to the minerology.

It is through prospecting – the first stage of the mining sequence – that mineral claims are staked. In most cases physical staking of a property takes place on the ground, known as "claim staking". Individuals and companies gain the exclusive right to search for minerals on an exploration property, and to develop any discoveries, by staking a claim. Several provinces now allow "map staking" in some or all regions. Map staking allows a company or individual to place mineral claim on an area – and so establish a form of tenure over that area – simply by identifying the area on a map and paying a small fee.[59]

Enter: Free entry and access to land
Prospecting is the stage where the key issue of land access, or "free entry" enters into the discussion of mining and mine-related impacts

The mineral industry in Canada enjoys almost unrestricted land access. Exploration across the boreal forest takes place under a "free entry" tenure system, except in Alberta, where a discretionary mineral tenure system is in place.[60] In most jurisdictions, surface and sub-surface rights are severed from each other, with subsurface rights available for claiming even when the surface rights are privately held, and occupied as residences, farms or recreational properites. Under a "free entry" regime, prospectors are permitted to explore and claim sub-surface rights to minerals without consulting other resource users. The

system was developed in Europe in the 1500s, largely to serve the financial needs of warring noble clans, where kings had an interest in keeping the coffers full in order to pay the military tab.[61] But the system persists to this day, giving priority to mineral development over other land uses and other social, environmental or cultural values.

Staking a claim on the ground generally involves cutting site lines through the bush, blazing trees to mark the claim boundaries, and driving a claim post – properly identified, usually with a prospecting tag – into each corner of the claim.

Prospecting can also include ground-work, such as stripping or trenching to remove the overburden (soils and subsoils, with associated vegetation) and so expose the mineral bearing rocks below, and can involve initial drilling to obtain samples from depth. Frequently, geochemical and/or geophysical surveys are done in advance of staking the claim, and maps and geological reports will have been reviewed, in order to identify areas of mineral interest.

The impacts include adverse effects on wildlife and wildlife movement, increased access and access corridors, garbage, fuel spills, forest clearing, disruption of the forest floor and breaking of forest cover, use and spill of drilling fluids, etc. The impacts are spread over a vast area because prospecting surveys large tracts of land to identify potential mineral deposits.[62] The sheer volume of the activity lays to rest any notion that prospecting is a benign presence. The area of new mineral claims staked or recorded in Canada in 1999 was 5,189,069, hectares (ha) with expenditures totalling an estimated $395 million.[63] Canada has consistently ranked among the top three destinations for mineral exploration investment for the last 25 years.[64] Not only is no environmental assessment required prior to initial exploration, but in most jurisdictions prospecting is done with no advance permitting required.

3.3 Exploration

Following staking, further mineral exploration is undertaken, including surface stripping, geochemical sampling, diamond drilling, and bulk sampling. Most or all of these are done in sequence.

Often, the first activity is trenching or more broadly-targeted removal of the soil and vegetation down to bedrock. Even if the trenching is done carefully, using a backhoe to remove the topsoil and then the deeper materials and then refilling the trench using the same materials, replacing them in reverse order, there is serious environmental disruption. One reclamation challenge is that the excavated material expands as much as 20 percent or more, which means the materials can not all be returned to the same trench.[65] Needless to say, all of the vegetative

cover has been lost, and the soil structure will have been changed.

Next comes diamond drilling. Drills with diamond bits bore deep into earth, often going thousands of metres through solid rock, in order to produce sample rock cores which are then assayed or assessed for the presence of valuable minerals. If initial drill samples look promising, a series of drills will be done, often in a grid like fashion, and the results will be analysed as part of mapping out the ore body.

Enter: Acid Mine Drainage
Mineral exploration is the stage in the mining sequence when acid mine drainage and metal leaching will frequently emerge as a key environmental issue.

Before actual mine development, bulk samples are taken to more accurately establish the grade of the ore. Bulk sampling can be done from surface, or through sinking of an exploratory underground shaft. Bulk sampling usually involves the removal of large volumes of ore. In Ontario an exploration project can include the removal of up to 10,000 tonnes per day of overburden, waste rock or ores to be bulk sampled. In some exploration projects, a pilot plant or "mini mill" will be used to determine what milling procedures will be needed if the mine is to go into production.

Feasibility studies will be done to examine questions of profitability. The mine infrastructure begins to develop, including shaft sinking, pit excavation, road building and construction of surface facilities. The minesite will be designed, including: mine production and processing facilities, waste management areas for waste rock, tailings and solid waste and sewage, and administration buildings. Depending on location, mine design and development are also likely to include the design and construction of roads, power-lines, and exploration and mining camps. Further, all of these activities – and associated impacts – are quite likely to occur not just when a decision is made to proceed with the mine, but in the course of gathering the information a company will require in order to make that decision. All of this activity takes place prior to any environmental review of the mine proposal.

Impacts from mineral exploration are numerous. Overburden is stripped. Many kilometres of geophysical grids are cut through vegetation and surface soils. Large volumes of water are consumed. Roads and trails increase overall access to the area, making other development projects more attractive and increasing hunting pressures. Leaks of fuels, oils and drilling fluids lead to contamination of soils and waters. Garbage is left behind in exploration camps. Mine waste, e.g. waste rock and ore, is left behind and may be acid generating/metal leaching. Noise, such as that from drill rigs, ATV's and 4x4s, and low-flying aircraft carrying sensing equipment, further disturb wildlife and people who live in the boreal.[66]

Mine development can also proceed past the "just taking a look" stage, and still claim to be mineral exploration. The Aquarius Mine in Timmins, Ontario is an open pit gold mine with a projected life span of five years. Numerous issues surround the mine development proposal, including a scheme to fill a cold-water stream in a nearby boreal valley with the mine tailings. However, nothing illustrates the elastic boundaries of "advanced exploration" better than the installation of the mine's experimental freeze wall. The mine design includes surrounding the open pit with a freeze-wall, which is purported to replicate permafrost, and therefore create a barrier to control groundwater movement during open pit operations. The company, Echo Bay Mines, installed the freeze wall – a series of pipes every eighteen inches that will be filled with brine brought to sub-zero temperatures – and two giant freezer plants, all before a single provincial permit had been issued or the federal environmental assessment concluded.[67] Company reports indicate an intention to actually begin freezing the sub-surface wall before provincial permits are issued, in order to demonstrate the method's feasibility and thereby attract needed investment and development dollars.[68]

3.5 Mine Development and Operation

The operation of a mine includes not just the mine itself (where the ore is removed from the ground) but also the creation of waste rock and mine tailings, and all of the infrastructure related to the mine's operation.

Enter: Water Impacts
It is at this stage of the mining sequence that water impacts become most significant, both in terms of the release of mine effluent, but also in terms of water "taking", for the purpose of pumping the mine shafts or pit to keep it dry enough to allow operation, or as a process water.

The ore can be extracted in a number of ways: an open pit or series of pits, strip mining, underground operations, or through heap leaching. Those extraction systems which create the most surface disturbance and create the most waste rock – strip mining and open pit mining – are the most economical to operate. However, underground operations also heavily impact the environment, particularly in terms of water consumption – underground mines have to be constantly pumped to keep them dry enough to allow operation – and water contamination. All mines create waste rock, and a great many, by extension, create acid mine generation when the sulphide bearing waste rock is exposed to air and water. This phenomena is discussed in more detail in Section 4.2.1.

Waste rock is created at rate of one million tonnes per day in Canada. To mine one tonne of gold, between one and three million tonnes of waste rock are generated, depending on the grade of the ore. At the Golden Bear Mine in

northern British Columbia, mining enough gold to create a 6 gram wedding ring will create 6 tonnes of waste rock.[69]

Surface mining operations can create serious dust problems, and open pit and strip mine projects – many of which operate 24 hours a day – also create high levels of noise and light pollution. Blasting in mines, both open pit and underground, can affect the local water table, local well conditions, as well as the structural integrity of local buildings. Stories abound in mining towns of pictures shaken from walls, and tea cups sent dancing off their shelf when the local mine blasted.

3.6 Milling and Smelting

In the processing stage, ore is crushed and ground, and the valued metals are separated from waste using gravity, magnetic, or flotation techniques. This results in two streams: concentrate that is further refined either on or off-site; and the mine tailings, the management of which poses one of the greatest challenges to the mining industry. The water quality impacts which begin at the exploration and mining stage intensify at the mine mill, for two reasons: the milling process creates mine tailings; and in the processing of the ore – first in the mill, and in later stages in the refinery and/or smelter – a number of chemical agents are added to the toxic soup which is mine effluent.

Common pollutants from metal mines and milling processes include arsenic, cyanide, copper, cadmium, lead, nickel and zinc; chemicals used in high volumes at mine sites, primarily as reagents in the milling process, include ammonia, calcium chloride, chlorine, hydrochloric acid, copper sulphate, sodium cyanide and sulphuric acid. Many of these heavy metals and chemicals have been declared toxic under the Canadian Environmental Protection Act.

These same pollutants transfer out into the natural world, through air and through water. Heavy metals pass through plants into the food chain, affecting reproduction, and wildlife and ecosystem health.[70] Industry's efforts to treat mine and mill waste water frequently means adding more chemicals or foreign substances to the water, usually at the "end of pipe" or close to the property's edge. Regulatory limits on pollution only apply as the contaminants leave the mine property. Addition of lime is the most common treatment for acidity. Ferric sulphate is frequently added to precipitate heavy metals. At Placer Dome's Dome Mine in Timmins, the mine effluent had been persistently lethal to the two test organisms, Rainbow Trout and Daphnia magna, and the company suspected that copper was the cause, although the copper levels were below those permitted in the regulation. The company's response was to add yet another chemical to the

mix: Ethylenediamine Tetraacetic Acid. EDTA is a chelating agent, which makes the harmful pollutant – in this case, thought to be the copper – biologically unavailable for a certain period of time. Simply put, Placer Dome adds EDTA to its lethal effluent, the EDTA makes the toxic elements in the effluent biologically unavailable to the test organism for long enough to pass the lab tests. However, the problem is clearly not solved, simply displaced, and left to reappear further downstream.[71]

Further metallurgical processing, such as smelting, and refining is carried out either on-site, or off-site, with concentrates shipped to another facility for further refinement.

Enter: Air Impacts
Refining and smelting metals creates a number of serious air quality impacts, including the release of sulphur dioxide and fugitive and stack releases of heavy metals, which can contaminate waterbodies and soil and impair human and ecosystem health.

While dust and diesel fumes are air quality problems encountered during mining operations, it is in the refining stage that air quality impacts become extreme. Air quality issues are usually a matter of provincial jurisdiction and the regulatory regimes are far from rigorous, resulting in substantial releases of sulphur dioxide and other harmful substances, including arsenic, nickel, cadmium and lead.[72] The Giant Mine in Yellowknife releases 10-11 tonnes of arsenic per day, and there is no limit in place to restrict the release. Manitoba has a regulation to control the release of SO2 which was written specifically for the mine complexes in Flin Flon and Thompson (Hudson Bay Mining and Smelting and INCO, respectively); the limit is set at 34 ppm, and when the companies exceed that limit, they must notify the public. Ontario's regulatory standard is 25 ppm, but the smelters in Falconbridge and Sudbury operate under a special control order which allows a release of 50 ppm. A proposal to revise the control order was released in September, but is drafted to allow Inco and Falconbridge until 2015 to reduce to 25 ppm.

While minerals and metals-based semi-fabricating industries and metals fabricating industries are frequently included when industry or government make claims regarding mining's contribution to employment or the Gross Domestic Product, they are not included in this report, and are generally considered by those outside of government and industry to be part of the manufacturing sector, rather than the mining sector.

3.7 Closure and Decommissioning

At this stage in the mining sequence, the economical ore body has been exhausted and the mine has to be closed, and the mine site is to be returned to its"original"

state or to a productive alternative. Structures are removed, openings to surface capped, regrading and revegetation work done. Most often the area is reclaimed by constructing ponds and wetlands or tailings areas and establishing vegetation over the mine site and any mine tailings areas not under water.

It is important to note that there has never been a major mine in Canada that has been fully closed out, and fully returned to a productive alternative, far less to it's "original state". There are many issues around mine closure: the standard of care that is provided, public oversight in the mine closure plan and its implementation, and long term nature of the impacts and need for long term monitoring and perpetual care.

Mine reclamation is not something that can be achieved overnight; indeed, it may take a decade or more for problems to emerge. For example, at Algoma Ore Division's closed out George McLeod Mine in Wawa the underground workings are slowly filling with water. When the underground workings reach the "full" point and start discharging to surface water – estimated to begin at the 10 year point – the mine water will require treatment, possibly in perpetuity, in order to meet surface water quality standards.

Enter: the "Exit Ticket"
A key issue in mine closure is industry's pursuit of an "exit ticket", which, if granted, would transfer liability from the company back to the public, for a one-time fee.

Mine closure and reclamation is an expensive and lengthy process, with uncertain results. Long term monitoring is needed, to ensure that the remediation efforts are successful, and to identify any new or emerging environmental concerns. In response to industry's concerns about the costs and uncertainties associated with cleaning up after themselves, Ontario introduced the concept of "exit tickets" in their 1996 round of changes to the Mining Act. Under this new scenario, after a company completes the remedial work set out in their own closure plan, the operator may apply to the Province for an "exit ticket", through which all liabilities and ownership of the property – and its associated hazards – would be transferred back to the crown. Homestake Canada and Barrick Gold, joint owners of the Renabie Mine, are currently seeking an exit ticket for the closed gold mine, which is in the centre of the land claim area of the Missinabie-Cree First Nation, near Chapleau. Homestake and Barrick propose to make a one-time payout of $102,290[73], and, in exchange, to be exempted from any further site liability even if it arises as a direct result of the companies' (in)actions.

Surface water flowing from the Renabie property contains elevated levels of zinc, cobalt, iron and copper. Acid mine drainage and metal leaching potential from the mine's 5 million tonnes of tailings has not been fully assessed. In Company

reports, reclamation work was described as having being completed in 1995, with the only outstanding issue the sustainability of vegetation on the tailings area. Then, in 1998, two small sinkholes were noted at the former mill site, followed in 1999 by the partial collapse of one of the crown pillars, leaving a gaping hole through to the underground workings. Just the cost of fencing around the collapsed crown pillar and sinkholes could, on its own, consume the alloted $102,290, leaving the public purse to bear the cost of any further remediation and the long term monitoring of the site.

3.8 Perpetual Care

After closure, most major mines require perpetual care to monitor such concerns as structural stability of the dams and structures which impound millions of tonnes of tailings. Many mines also require water treatment long after closure, some virtually into perpetuity. Long term monitoring is also required to identify new and emerging environmental issues, such as latent acid generating potential or changes in surface water quality. The stability of underground workings and pit walls is another concern.

For example, tailings dams have failed in the past due to weaknesses in construction, or from overtopping, sometimes because the spillway is inadequate or as a result of beaver activity in the area. Beavers will dam spillways, causing the tailings pond to overflow, or the pressure to build on the dam, resulting in its collapse and the release of massive volumes of tailings.

Adequate financial assurances and the legal means to require companies to maintain financial responsibility for mines post-operation care are essential to ensuring that monitoring and maintenance are provided in the longer term. Planning for perpetual care plays with a number of unknowns.

Enter: Abandoned Mines
Government's failure to require mining companies to care for closed mines into perpetuity will result in more abandoned mines in the future.

There are an estimated 7,000 abandoned mines across the boreal region (10,139 identified to date across Canada), and – in the absence of sound regulations which are consistently implemented in a manner which leaves the responsibility for mine closure and perpetual care with the mining companies – more will follow. It's a simple formula: if mines are created and then closed out inadequately – or not at all – and if the mining companies do not maintain long term responsibilities for the long term hazards, the mines of today will become the mistakes of tomorrow, with the taxpayers and the environment footing the bill.

4.0 Earth, Water, Fire, Air

4.1 Earth: Land, Surface and Soil

4.1.1 Access to the Land Base

The issue from which all others ultimately flow is that of the mining industry's free-for-all access to the land base. A hangover from feudal England and the early colonization of North America, the current system of access to land and land title is a fundamental source of uncertainty for all stakeholders, and is increasingly a source of conflict, primarily between the mining sector and conservation interests and/or indigenous land rights.

In Canada, mineral rights usually rest with the Crown. The current system for staking mineral title in effect in most of Canada (Alberta being the exception, where mineral permits are on allocation basis) gives priority rights to mineral exploration and development. This allows mineral claims to be established on the great majority of public land, and also on private land where the mineral or sub-surface rights are not specifically granted to the surface holder, ie. the property owner. Mineral claims can be staked without any consultation or any consideration of other values or potential land uses. Once established, a mineral claim then normally grants the holder the right to mineral exploration, with all of the companion impacts of surface disturbance, etc. [74]

Over 15 million hectares of new mineral claims were staked in 1995 alone.[75] In 1998 there were a reported 604 companies active on mineral exploration projects, and an unidentified number of prospectors, with an investment of $4.6 billion in prospecting and exploration.[76]

> The most significant areas of conflict over land access are with biodiversity protection areas and Aboriginal land claims. The appropriate assessment of mineral (and ecological) potential for land use planning purposes, the legal status of mineral tenure rights, and the weighting of "highest and best use" in land use planning are largely unresolved and problematic issues in many regions of Canada, often resulting in highly politicized decision-making process.
>
> "Public Interest Perspectives on Canadian Environmental Mining Issues: A Discussion Paper", EMCBC, July 1997

The issues around unfettered land access for the mineral sector are fourfold. Establishment of mineral tenure forfeits or makes more difficult other land use designations. The staking of mineral claims often proceeds where Aboriginal land rights are unsurrendered, but Aboriginal control over the land base is not fully established. Mineral exploration activities proceed without consideration of past practices of the operator or their ability or commitment to sound environmental performance. Establishing mineral tenure opens the door to exploration activities and all related impacts, including those impacts related to the infrastructure required to support a mineral exploration project. These impacts include exploration and haulage roads, rail lines, powerlines and power generating facilities and water use.

The mining industry is committed to pushing the very few boundaries that are currently in place to restrict mineral access to the land base. Both Saskatchewan and Manitoba have allowed mineral development within provincial parks.[77] Ontario's Living Legacy – the Harris government's answer to the need for land use planning – allows mineral exploration in almost half of the newly created protected areas.[78] Implementation of the OLL protected areas decision will include the opportunity for the mineral industry to negotiate an "exchange". If a mineral find within a protected area demonstrates a strong mineral showing, it will be removed from the protected area and another area of equal size – and, so the plan goes, of equivalent natural values – will be added to the protected area. Theoretically, the area could be returned to a protected areas designation after the mining operations are completed.

While mineral tenure is only quasi-ownership, it does establish rights and privileges for the tenure holder that are well beyond those of other stakeholders, and is the foundation for procuring other rights and approvals, such as permits for mine development. In Saskatchewan, a holder of mineral tenure is entitled to compensation if the disposition of resources are cancelled as the result of an environmental assessment.[79]

An important Supreme Court of decision in 1997 clarified that Aboriginal title includes sub-surface rights, and that it is a right to the land itself, rather than just a right to fish, hunt, or gather. The Delgamuukw case also asserted that governments must consult with First Nations, and may have to compensate them if their rights are affected. The decision could have far reaching consequences for mineral tenure as it has been recognized to date.[80]

4.1.2 Surface Disturbance

All stages of the mining sequence can result in the disturbance of the land surface and the terrestrial ecosystems which it supports, as well as the aquatic ecosystems into which they drain. As discussed in earlier sections of this report, disturbing – frequently stripping – the surface is integral to mineral exploration. Estimates range from year to year, but 5[81] to 15[82] million hectares are staked each year in new mineral claims, with an expectation that a large percentage of those will move into exploration, with all of the attendant surface impacts. In the mining stages, surface disturbances come not only from the mines themselves – particularly strip mines and open pits – but also from the large areas needed for the disposal or dumping of mine tailings and waste rock. An estimated 40 million

> Many of the most pervasive threats to biological diversity – habitat destruction and fragmentation, edge effects, exotic species invasions, pollution and overhunting – are aggravated by roads.
>
> Reed Noss, *The Ecological Effects of Roads*

hectares have been used for mining purposes. This figure excludes much of the related infrastructure, such as road systems, power-lines and power generation projects.

Roads rank as the supreme disturbance at a landscape level. An estimated 30% of the boreal forest is now within 1 kilometre of a road or access route.[83] Studies have shown that roads are mortality sinks for animals, significantly affect animal distribution, and fragment animal and plant populations. For some species roads are impassable barriers. Roads fragment the population, and each isolated pocket is subject to all of the problems associated with rarity, including genetic deterioration.[84]

In addition to the direct impact of habitat loss, roads also facilitate the invasion of exotic species, some of which might out-compete indigenous plants, resulting in significant changes to the ecosystem. Roads also create an "edge effect", considered one of the most harmful consequences of habitat fragmentation. Forest edge is a zone of influence which causes changes in micro-climate, increased blowdowns, and changes both competition dynamics among plants and predator-prey relationships among birds and animals.[85]

4.1.3 Contaminated Soil

The impacts of smelting and refining metals move quickly from stack to soil, and over time contaminants accumulate in the soil, making it a storehouse of hazards: arsenic, copper, lead, zinc, nickel among them. There are ten smelters operating in the boreal region of Canada – run by Noranda, Inco, Hudson Bay Mining and Smelting, Falconbridge, Rio Tinto and Alcan – and others such as INCO and Falconbridge's operations in the Sudbury basin – which continue to have an impact on the boreal forest through their significant contributions to acid rain. Algoma Steele's sintering plant in Wawa has ceased operations in the southern reach of the boreal, but its impacts will be in the soil and waters of the Lake Superior basin far into the future.

Algoma's Wawa operation serve as a case in point. In addition to the mining operation, Algoma Ore Division operated a sintering plant, which combined the ore with "reverts", iron-bearing wastes from steelmaking. The processing consisted of passing the two materials on a conveyor over flames to form the raw material for Algoma's Sault Ste. Marie, Ontario blast furnaces. Massive amounts of sulfur and arsenic were spewed into the air. The province of Ontario recognized that there was a problem, but provided an unusually low-tech solution. Unique to the Wawa operation, the control order specified a "zone of control". Basically, Algoma Ore Division was only required to control SO2 when the wind

was blowing towards the town. The company wasn't allowed to burn sinter when the wind blew the wrong way. The net result is a forty kilometre "kill zone" downwind of the old sintering plant. The boreal forest has been completely destroyed, and extremely high levels of arsenic are found in the soils in and around the town of Wawa. In conjunction with the plant closure in 1998, the Ministry of the Environment undertook studies to assess the extent of arsenic contamination of the town and surrounding areas, and made the results public in September 1999.

Initial studies estimated a cancer risk for the residents to be 1 in 10,000, or 100 times higher than the risk level used by the Province to set regulations.[86] Soil arenic levels exceed the MOE soil cleanup guideline of 20 micrograms per gram (µg/g) over a large area of the fume kill zone.[87] Soil arsenic concentrations consistently exceeded the guidelines in the western half of town, approaching 1,000 µg/g in the surface soil near the AOD gate. All school playgrounds and public parks, however, were found to have soil arsenic levels below the 20 µg/g clean-up guideline. Initial assessments of health risks posed by arsenic contamination identified cancer risks as high as 1 in 10,000.[88] A study of arsenic uptake into firewood identified elevated levels of arsenic in local edible mushrooms, and warned against their consumption.[89]

The Township of Michipicoten is pursuing a $55 million class-action lawsuit against Algoma Steel Inc., holding the company responsible for the arsenic in the soil.[90] The lawsuit is still wending its way through the courts and, to date, no remedial or clean up options have been identified by the Ministry of the Environment or Algoma Steel. Final responsibility for developing and applying criteria for mitigation rests entirely with the Ontario Ministry of the Environment.[91] Algoma Steel's financial difficulties dominated local and regional media throughout the fall of 2001, as the company wheeled and dealed its way out away from the brink of bankruptcy. Unsecured creditors and Algoma's workforce bore the brunt of the financial rescue package, with $65 million negotiated out of the workforce's collective agreement.[92]

Similarly disturbing results have emerged in the few studies that have been done of soil contamination in the shadow of other stacks – the Horne Foundry in Rouyn-Noranda[93], or the operations found south of the boreal, in Sudbury, Falconbridge and Port Colborne.

4.2 Water: Mining's Industrial Sink

4.2.1 Acid Mine Drainage

A major feature of mining is that it produces an extremely high volume of waste: waste in the form of rock, or rock that has been crushed into fines at the mill and rejected, called tailings. A typical Canadian metal mine rejects 42% of mined material as waste rock, 52% as tailings, 4% as slag with the remaining 2% comprising the "values" for which the ore was mined. The mining industry in Canada generates an average of 650 million tonnes of this waste per year or over 95% of all the solid waste generated in Canada each year.[94]

Most Canadian base metal, precious metal and uranium mines work with rock that contains metal sulphide mineralization.[95] Crushing rock and grinding ore into tailings exposes huge quantities of waste rock materials to air and water. When metal sulphides in waste materials are exposed to both oxygen and water, there is potential for a reaction process that generates sulphuric acid. The acid dissolves metals in leachate as it passes through the waste materials. This phenomena is known as Acid Mine Drainage, or AMD. The severity of the reaction depends on the concentration of metal sulphides and other mineralization in the rock. Predicting the potential of Acid Mine Drainage /Metal Leaching (AMD/ML) from mine waste is a complex exercise that involves estimating both the presence of acid generating sulphides and any buffering materials in the rock that could counter the acid generating effect.

> "...The influx of untreated acid mine drainage into streams can severely degrade both habitat and water quality often producing an environment devoid of most aquatic life and unfit for desired uses. The severity and extent of damage depends upon a variety of factors including the frequency, volume, and chemistry of the drainage, and the size and buffering capacity of the receiving stream"
>
> (Kimmel, 1983).

When acid mine drainage lowers the pH of the water, it makes it more acidic and more corrosive. Impacts range in severity, with toxicity dependent on discharge volume, acidity, and concentration of dissolved metals. The pH is the most critical component, since the lower the pH, the more severe the potential effects of mine drainage on aquatic life. If the pH is low enough, the water body will be unable to support many forms of aquatic life. The overall effect of mine drainage is also dependent on the flow (dilution rate), and the buffering capacity of the receiving stream.[96]

Acid mine drainage with elevated metals can have a devastating effect when discharging into headwater streams or lightly buffered water bodies. Like many other pollutants, acid mine drainage can cause a reduction in the diversity and total numbers, or abundance, of macroinvertebrates and changes in community structure. Most organisms have a well defined range of pH tolerance, but when the pH falls below that range, the effect can be lethal. The primary causes of fish death in acid waters is loss of sodium ions from the blood and loss of oxygen in the tissues. Acid water also increases the permeability of fish gills to water, adversely affecting gill function.[97]

Acidic waters typically have fewer species, due to both effects on the food chain and the direct effects of low pH levels on aquatic life. Recent studies have shown that direct effects of low pH on aquatic life are more critical than indirect effects on their food sources.[98]

Leaching metals can increase the toxicity of mine drainage and also act as metabolic poisons. Iron, aluminum, and manganese are the most common heavy metals which compound the adverse effects of mine drainage. The metals are generally less toxic at neutral pH. Trace metals such as zinc, cadmium, and copper, which may also be present in mine drainage, are toxic at extremely low concentrations and may act synergistically to suppress algae growth and affect fish and benthos. Some fish, such as brook trout, are tolerant of low pH, but the addition of metals decreases that tolerance. In addition to dissolved metals, precipitated iron or aluminum hydroxide may form in streams receiving mine discharges with elevated metals concentrations. Ferric and aluminum hydroxides decrease oxygen availability as they form. The precipitate may coat fish gills and body surfaces, smother eggs, and cover the stream bottom, filling in crevices in rocks, and making the substrate unstable and unfit for habitation by benthic organisms.[99]

Acid mine drainage / metal leaching is the mining industry's greatest environmental liability. As of 1994, federal estimates of clean-up costs for acid mine drainage at existing mines are between $2 billion and $5 billion.[100] An estimated 20% of the 13 billion tonnes of mine waste existing in Canada as of 1994 is acid producing or potentially acid producing.[101]

AMD/ML may not start for decades or more and it can persist for hundreds to thousands of years. There are Roman mine sites in the United Kingdom that continue to generate acid drainage 2,000 years after mining has ceased.[102] There is great uncertainty around predicting rates of acid generation and the time it will take to exhaustion. Many mines do not undertake a proper assessment of AMD/ML potential at site. Technologies for dealing with AMD/ML exist, but at present there is no solution that allows a walk away. A mine that is generating or has the potential to generate AMD/ML must be monitored and treated in perpetuity.

Treating discharges at acid generating and metal leaching mine sites is usually accomplished by countering the acidity of the effluent and by precipitating the dissolved metals. It is costly to treat discharge, and to properly manage the toxic sludge that is precipitated from the effluent in the course of treatment. At the Geco and Wilroy mines, owned by Noranda Minerals Inc. near Manitouwadge, Ontario, an estimated 90 cubic feet per minute of water discharge will require

long term treatment, at substantial cost, into perpetuity.
There are means of preventing AMD/ML, primarily by isolating the potentially acid generating material from oxygen and/or water, for example, by either flooding mine waste to create a water cover or by constructing a dry cover. Where water covers are undertaken, regular inspections must be done as part of long term monitoring, and to ensure the stability of dams that contain the tailings. Perpetual care will likely be required to maintain the containing structures. Many tailings dams have failed due to weaknesses in construction or from overtopping, sometimes because the spillway is inadequate, sometimes when beavers dam in the area, and sometimes when perma-frost melts.

Mines frequently plan to flood their impounded mine tailings at closure, thereby blocking the exposure of the tailings to air and preventing onset of AMD/ML. In engineering a water cover to flood these tailings impoundments, it is necessary to model a range of weather conditions (e.g. periods of drought) and to account for the effect of weather on maintenance of the water cover. However, in engineering water covers for the Shebandowan, Hemlo and Winston Lake mines in the boreal region of the Lake Superior Basin, the predicted effects of climate change were not accounted for when modelling weather conditions. Forecasts of climate change in the mid 1990's predict a reduction in precipitation in the Great Lakes Basin of up to 25%.[103] Such a major reduction in precipitation may seriously interfere with maintaining water covers over tailings.

4.2.2 Mine and Mill Effluent

Studies have shown that surface water becomes contaminated in 70% of the cases studies, and groundwater becomes contaminated in 65% of the case studies.[104] While water can become polluted from a variety of other means – acid mine drainage from waste rock and tailings and fuel spills – effluent from the mine and mill are the greatest source of contamination.

Pollution from mines and mills are controlled by both the federal and the provincial / territorial governments. The federal government's role is secured through the federal Fisheries Act, which prohibits any person from depositing "a deleterious substance into any type of water frequented by fish", except as permitted by a regulation under the Act.[105] The regulation under the Fisheries Act which sets out the exceptions is

International Comparison on Metal Mining Liquid Effluent Monthly Average Limits***

Country	Nickel	Copper	Lead	Total Cyanide
Canada	0.5	0.3	0.2	1
Sweden	0.1	0.1	0.1	n.a.
Finland*	0.3-1.0	0.05 - 3.0	n.a.	0.5
Vietnam	0.1	0.1	0.05	
Papua New Guinea	n.a.	0.03	0.005 / 0.004**	0.005 / 0.01**

* range of limits in effect at 6 mines in Finland
** Values of discharges into freshwater system and marine environment respectively
*** All values shown in mg/L

Comparative Summary provided by the Canadian Environmental Defence Fund, 2001

the Metal Mining Effluent Regulation. It has recently been revised, after almost a decade spent in a review which promised to "modernize" the regulation.

The regulation under the Fisheries Act – the Metal Mining Effluent Regulation or MMER – which sets limits on how much of each of these toxic metals can be released by a mine operator sets out only a partial list of the contaminants of concern. The allowable levels are not based on an assessment of toxicity or of the potential for harm to the environment, but rather on a determination of what water treatment can be achieved through the "best available technology economically achievable".[106] In the course of the regulatory review to the develop the revised regulation, an international comparison of BATEA technologies was conducted by consultants hired by the federal government, and their review identified technology based standards in several other countries that were far more protective than the Canadian standards. However, the BATEA standard that was adopted as the basis for the federal regulation redefined "best" to mean the average performance of the top 50 percentile of operating Canadian mines.[107]

The recently proposed changes will make compliance requirements somewhat more stringent than when they were first put in place in 1977, through the introduction of a requirement that effluent be non-acutely lethal to rainbow trout, the lowering of the allowable level of total suspended solids from 25 to 15 ppm and the addition of an upper limit for pH levels of 9.5. The addition of a requirement that mine effluent pass a test for acute lethality is significant improvement was made to the regulation. This means that at least 50% of the rainbow trout used to test a sample of the mine effluent must survive for more than 96 hours. A similar test for Daphnia magna, a waterflea, was added for the purposes of monitoring, but there is no requirement that the effluent be non-acutely lethal to the waterflea. The changes will also mean the end of an exemption that gold mines had been operating under since the regulation first came into force.

Reports summarizing industry performance during the first two decades of the federal regulation being in place indicate that on average 25% of the mines were out of compliance with the Metal Mining Liquid Effluent Regulations, but between 1977 and 1998, there was not a single charge laid or prosecution brought under the Regulation.[108] The federal government's 1998 report on water pollution control in the mineral sector – the report is only published every 4 years – indicate that, consistent with performance over the last quarter of a century – 25% of the metal mines subject to the regulations were out of compliance. Almost half of the mines subject to the guidelines (gold mines are exempt from the regulations, but subject to a "guideline") were out of compliance.[109] In 1999, Environment Canada conducted 14 site inspections and verified 43 reports of mines, as required under the MMLER. Only one mine was prosecuted under Section 36 of the Fisheries Act, although 3 closed mines were prosecuted under Section 33.[110]

In addition to the water quality problems related to acid mine drainage and metal leaching, which were discussed in the previous section of this report, a major cause of water quality impairment is the group of chemicals used in the processing of ores. Key culprits include cyanide, ammonia, chlorine, hydrochloric acid, and sulphuric acid.[111]

Cyanide is used to extract gold from ore, either through heap leaching of low-grade gold deposits, or as one of a series of conventional methods, which generally include gravity, cyanidation and carbon-in-leach processing. In either case, the function of the cyanide is to dissolve the gold. Simply put, the ore is ground, exposed to a cyanide solution, the cyanide dissolves the gold into the solution, and the gold is then removed from the solution, through a second chemical process, such as through adsorbing it to carbon through a carbon-in-pulp process, or through the Merrill-Crowe process, which removes precious metals from a cyanide solution by zinc precipitation.[112]

Heap leaching is increasingly used to extract low-grade gold deposits, and is a common practice of Canadian mining companies in their operations outside Canada. In Canada's boreal, only the Brewery Creek operation currently uses heap leaching, and it has ceased mining and expects to have processed all stockpiles by the end of 2002.[113] The Golden Bear Mine in northeastern British Columbia had a heap leach operation, until its closure in 2001. A third heap leach located 25 kilometres north of Amos, Quebec was operated by Sphinx Inc. in the early '90's, but the operation was suspended due to low gold recovery.[114]

Cyanide can be extremely toxic to some organisms, and can have an adverse effect on fish, plants, wildlife and humans. Cyanide is readily absorbed by the skin, inhaled or swallowed; cyanide suffocates humans by blocking the transfer of oxygen across cell walls. Very small amounts of cyanide, 10 µg/L, can permanently affect a trout's ability to swim, while 100 µg/L can be lethal. Chronic exposure may affect reproduction.[115] Typical levels of cyanide in mill discharges – prior to treatment – range between 25 and 250 mg/L, with the cyanide being present as free cyanide or cyanide complexes.[116]

While cyanide breaks down quickly, particularly when exposed to sunlight, it breaks down into a variety of new compounds, including some which can be harmful. Free cyanide – cyanide before it has broken down – is highly poisonous to humans, fish and wildlife. The chemical breakdown of many cyanide and cyanide-related compounds often create high concentrations of ammonia and nitrate.[117]Thiocyanates are compounds that are formed when sulfur, carbon and nitrogen are combined. Exposure to cyanide will also expose you to thiocyanate because cyanide is changed to thiocyanate in your body.[118]

Toxic concentrations of ammonia in humans may cause loss of equilibrium, convulsions, coma, and death. Ammonia concentrations can affect hatching and growth rates of fish; changes in tissues of gills, liver, and kidneys may occur during structural development.[119] At relatively low concentrations, ammonia in un-ionized form can interfere with fish reproduction and hamper normal growth and development. At higher levels it can kill fish.[120]

The mining industry's contribution of ammonia to local streams and lakes is through its use as process reagents, from the breakdown of cyanide wastes into ammonia, and from unspent ammonium nitrate explosives used for blasting in the mine. The free or un-ionized form of ammonia is toxic to fish, especially at high pH's and low temperatures.[121]

Surface Water Releases of Ammonia	
Hudson Bay Mining & Smelting Ltd., Flin Flon, MB	13780
Sleeping Giant Mine, Cambior Ltd., Amos, QC	25728
Falconbridge Ltd-Kidd Metallurgical Div, Timmins, ON	26385
Rabbit Lake Mine, Cameco Corporation Ltd., Saskatoon, SK	14580
These 4 mines are examples of levels of ammonia released into surface water. Measures are in kilograms. Source: National Pollutants Release Inventory.	

Other problem chemicals include chlorine, hydrochloric acid, and sulphuric acid. Chlorine chemistry starts with ordinary salt - sodium chloride - but because chlorine is so reactive, it combines quickly with organic matter to form a variety of very toxic byproducts and wastes called organochlorines – the chemical link to pollutants such as PCBs and dioxins.[122] Organochlorines are persistent in the environment, and are cancer causing, either directly or by increasing the cancer causing effects of other chemicals.

Hydrochloric acid is used to lower pH, and can produce acute effects to freshwater aquatic organisms below pH 5. Chronic exposure of fish to hydrochloric acid resulted in abnormal behavior and deformed fish at pH 4.5 and 5.2, but not at pH 5.9. Reproduction is impaired at at pH values less than 5.9.[123] Sulphuric acid interferes with fish's ability to take in oxygen, salt and nutrients needed to stay alive, and will lower pH, which in turn throws off the balance of salts in the fish tissue, adversely affecting reproduction. These impacts are in addition to those already discussed in relation to acid mine drainage and metal leaching.[124]

4.2.3 Sediments

Sediment impacts on fish and fish habitat in a variety of ways, depending on the

nature and severity of the sedimentation. Fish, fish habitat and food sources can all be effected.

Suspended solids are the sediment that is suspended in water. The degree of sedimentation is described in terms of "total suspended solids". While sedimentation happens naturally as a result of erosion and other natural processes, mining activities can dramatically increase the amount of suspended solids. Blasting, the removal of vegetation, the use of heavy equipment, and road and bridge construction can all cause erosion.[125]

Fish are affected directly and indirectly. If the level of suspended solids is high enough, it can kill fish directly. At lower levels, it can cause rot in fins and retard fish growth. At higher levels, it can reduce the survival rate of young fish, cause fish to hatch prematurely, or can smother fish eggs, preventing their hatching.[126]

Fish habitat can be destroyed, including spawning grounds and food sources. Suspended solids make the water turbid, which can also negatively affect the fish's ability to find food and avoid predators.[127]Turbidity also reduces the amount of light that penetrates the water, which in turn can lower the temperature and reduce plant growth. Both of these have obvious effects on fish habitat and food sources.

Sedimentation or increased turbidity is caused by many mining activities but placer mining is particularly problematic. Placer is a deposit of gravel which contains particles of gold deposits. Placer mining removes very large volumes of sediment from stream beds and stream banks.[128] Bulldozers and backhoes have replaced the pick and shovel, and a single operation can strip tens of thousands of cubic metres per season.

Only a small minority of mineral production in the boreal is placer mining but the impact is tremendous, particularly with respect to fish and fish habitat. This gold mining method is used in British Columbia and the Yukon. The Yukon Placer Authorization under Section 35 of the Fisheries Act allows placer mines in the Yukon to discharge sediment levels that are higher than

Threat: Placer Mining

Placer mining, a mining technique used to remove metals (i.e., gold) embedded in stream and/or river bottom sediments, has proven to be detrimental to freshwater biodiversity. Placer mining operations utilize suction dredges to remove sediment, completely destroying the stream and/or river bottoms down to their underlying bedrock layer. Once sediments are removed, they are filtered to separate the more dense rock and cobble material for metal extraction, from the finer, less dense sediment, which is returned to the stream and/or river as waste.

Placer mining completely destroys important river and stream bottom habitats that are heavily relied upon by organisms as spawning and breeding grounds. In addition, the removal and return of fine sediment particles often reintroduces contaminants such as heavy metals that were once trapped, back into the environment. Returning sediments increase the turbidity of the water, block out the sunlight necessary to support various aquatic plants, and inhibit the respiration of various gill breathing organisms.

U.S. Environmental Protection Agency Fact Sheet

anywhere else in North America or New Zealand. Sediments often carry elevated levels of metals such as arsenic, antimony, chromium, cadmium, aluminum and lead.[129]

The impact of placer mining on a watershed is huge, because the process of placer mining occurs directly in the streams and rivers. While the romantic image of a placer mine is that of an old man stooped over a stream, gold pan in hand, the modern reality is harsh and mechanized.

4.2.4 Water Consumption

Mining operations are a major industrial user of water. Water is pumped from open pits and underground mines to "dewater" them, in order to allow mining operations to proceed. Water is used to wash the ore, and in milling and refining processes. Water is also used to slurry tailings from the mill to the tailings management areas, and is frequently used as a water cover for acid generating mining tailings. While the mining industry describes these uses as "temporary", the fundamental fact remains that clean water goes in, and contaminated water comes out.

MAJOR WITHDRAWAL USES OF WATER		
Total economy	**1981**	**36717**
	1991	**45,019**
Agriculture	**1981**	**3,125**
	1991	**3,991**
Mining and Primary metal	**1981**	**2,698**
	1991	**2,099**
Personal and government	**1981**	**3,760**
	1991	**3,802**
Measured In Million Cubic Metres		

In a survey of water taking permits for one district in northeastern Ontario, 77% of the permits issued within one year were for mining purposes. Not all of the permits included totals or limits for the amount of water use permitted, but, of those that did, average water taking volumes was 6.4 million litres per day.[130] Some permits are much higher, such as one issued to North American Palladium Ltd for their Lac Des Iles Mine, northwest of Thunder Bay for a water taking at a rate of 30 million litres per day, for a period of five years.[131]
At a national level, the mining and metal sector consumes over 2 billion cubic metres of water annually.

4.3 Fire: Energy Consumer

Around the world, the mining industry is a major consumer of electricity. In the US, the mining sector is responsible for an estimated 5% of total US electricity consumption. In South Africa, the mining industry accounted for approximately 25% of electricity consumption. In Canada, estimates are 9.5%, including 4.4% for mining and iron/steel and 5.1% for smelting/refining. At a global level, the mining sector is one of the world's largest users of energy, accounting for between 5 and 10% of world energy use.

Mining is energy intensive. Large quantities of ore and rock have to be transported by the industry. Cooling of deep underground mines is energy intensive, as are the operation of pneumatic equipment, and the smelting and refining processes. Without changes in the industry's efficiency measures, the demand for energy is only going to increase over time, as higher-grade, more easily accessible ores are mined out, and mining moves to lower grade deposits with more overburden. The trend is already underway – in Canada, between 1990 and 1995, energy intensity increased by 14% in the Canadian mining industry.[132]

If one compares the mineral sector's use of energy to its contribution to the economy the figures are stark. Energy consumption is at 8%,[133] while employment is at 2.7 %, and contribution to the national gross domestic product 3.7 %.

4.4 Air: Source of life, industrial sink

4.4.1 Sulphur Dioxide Emissions

In Canada, 40% of sulphur dioxide emissions come from the mineral sector.[134] The leading cause of acid rain, sulphur dioxide discharged to air brings a host of health and environmental problems.

Sulphur dioxide reacts with other chemicals to form very fine particles, which, once airborne, can lodge in the lungs and cause inflammation and damage to tissues. Recent studies have identified strong links between high levels of airborne sulphate particles and increased hospital admissions for heart and respiratory problems, as well as higher death rates from these ailments.[135] Recent studies in the United Kingdom have concluded that when hourly average concentrations of sulphur dioxide are in the range 0.125 ppm to 0.4 ppm asthmatics may experience symptoms including tightness of the chest and coughing and reductions in lung function when exposed to concentrations at the upper end of this range.[136] For long term exposures, sulphur dioxide levels above 0.15 ppm have been linked with increased hospital admissions for cardiac or respiratory diseases. Exposures to levels of 0.027 to 0.031 ppm with high levels of particulate matter have been associated with increases in respiratory illness in children.[137] An Ontario Ministry of the Environment report concurs that exposure to SO2 at levels in the rage of 0.1-0.5 ppm and above for periods as short as 5 minutes can adversely affect asthmatic individuals.[138]

In addition to deleterious effects on human health, high levels of SO2 emissions are also harmful to the natural environment, resulting in plant stress, reduced growth, and damage to leaves and needles. Jack pine, considered a moderately sensitive species, has shown injury following a 2 hour exposure to 0.25 ppm; a

one hour exposure at 0.25 ppm has been shown to injure begonias; a four hour exposure at the same level has damaged broccoli.[139]

Manitoba has a regulation written for its two smelters – Hudson Bay's smelter in Flin Flon and Inco's in Thompson – which sets the level at 0.34 ppm. The two operations, combined, account for 95% of the sulphur dioxide emissions in Manitoba, with the Hudson Bay's operation responsible for 184 kilotonnes per year, and Inco contributing 195 kilotonnes each year.[140] Noranda's Horne smelter produced more than 550,000 tonnes of sulphuric acid in 2000 as a byproduct of their SO2 control programs. Noranda recently announced plans for an additional 10% reduction in their sulphur dioxide emissions from their current level of 80,000 tonnes per year. Falconbridge's Kidd Creek Metallurgical Site reduced their sulphur dioxide emissions by 25% in 2000[141], to 4,090 tonnes.[142] In Ontario the regulatory limit is 0.25 ppm, although the Sudbury basin smelters (INCO and Falconbridge) both operate under a control order that allows double the regulatory limit to be discharged. Even the 0.25 ppm is very permissive when compared to other standards internationally, such as the limit of 0.100 ppm on a 15 minute average set by the U.K. Expert Panel on Air Quality Standards.[143]

4.4.3 Air Emissions

The chief sources of air pollution from the mineral sector are smelters and metal refineries. Nationally, the mineral sector is responsible for 7.2 % of greenhouse gas emissions, and Canadian mining smelters released more than 2.3 million pounds of heavy metals in 1998, including arsenic, mercury, lead, cadmium and nickel compounds, according to a January 2001 report by the Canadian Environmental Defence Fund.[144]

Facility	zinc	lead	copper	cadmium	arsenic	nickel
Hudson Bay Flin Flon MB	244,556	172,570	131,565	26,218	18,825	
Inco Limited Thompson MB			9.930		2,280	69,639
Kidd Creek Mett Falconbridge Timmins ON	34,312	28,694	55,629	484	1,417	224
Horne Smelter Noranda Mining Rouyn QC	37,910	115,300	143,920	2,320	69,200	960
Mines Gaspe Noranda Mining Murdochville QC	3,360	24,000	2,400	240	9,600	960
QIT - Fer et Titan Havre Saint-Pierre QC	2,813					
Total	322,951	340,564	343,444	29,262	101,322	71,783

Source: National Pollutants Release Inventory

In the boreal region, 6 operating smelters dump 1.24 million kilograms of toxic heavy metals and 45 tonnes of toxic gasses into

the air each year.[145] Hudson Bay Mining and Smelting's operation in Flin Flon – detailed in the regional overview found in Section 7.4 of this report – is the largest single contributor, spewing out 245 tonnes of zinc, 173 tonnes of lead, 132 tonnes of copper, 26 tonnes of cadmium, 19 tonnes of arsenic, and one and a half tonnes of mercury. Other notables include Noranda's Horne smelter and its output of over a hundred tonnes of lead, 144 tonnes of copper, and 69 tonnes of arsenic.

Smelters are major emitters of sulphur dioxide, carbon monoxide, nitrogen oxides, particulate matter, and other toxics and metals. These pollutants are released into the atmosphere, which becomes a sink for industrial contaminants. Although the atmosphere is kept relatively constant through a number of self-regulation mechanisms, air emissions can overwhelm natural balances and serious problems are created.[146]

Every contaminant goes somewhere. Heavier particulates and metallic dusts settle close to their source, while finer dusts and gases go further afield. Heavy metals, deposit in the soil and plants absorb them and transfer them up into the food chain. Air borne particulates enter the lungs.

Some of the pollutants released from smelters are toxic at even very low levels. Arsenic can be acutely toxic at even low concentrations, causing reproductive and behaviour abnormalities in birds and chronic exposure to low doses of arsenic have been shown to cause cancer and nervous disorders in humans. Mercury and cyanide are both highly toxic, even in small doses. Some, like lead, are not toxic to plants, but bioaccumulate in plants, and affects the health of organisms further up the food chain. Many, like chromium or manganese, are essential nutrients at low levels, but very harmful at higher levels. Zinc, the biggest toxic output from the Flin Flon smelter, is acutely toxic to fish, very harmful to humans, and reduces growth and vigour in plants.[147] Cadmium has been shown to cause "brittle bone" syndrome, and nickel is a known carcinogen.

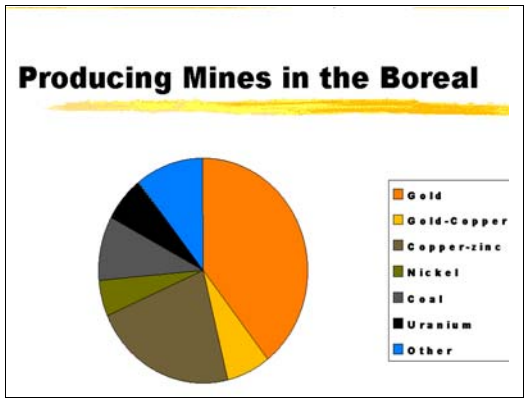
5.0 The Canadian Mining Scene

5.1 Mining the Boreal

Canada's boreal forest is host to approximately 7,000 abandoned mines (10,139 are "on file" across Canada), 69 operating mines, 53 mines which have recently closed or where operations are currently suspended, and 10 smelters. In 1999, there were 10 mine openings and 23 mine closures recorded.[148] Approximately 62 projects are in "advanced exploration" or under development, with thousands more properties under mineral claim.

Vital Statistics for the Mineral Industry

2.7 % of national employment[149]
3.7 % of national GDP[150]
7.2 % greenhouse gas emissions[151]
8 % of national energy use[152]
40 % of SO2 emissions[153]
>95% of solid waste generation[154]



Canada is the world's leading producer of gold, and Canadian companies lead the world in exploration investment around the globe. In Canada, 5.2 million ha were staked as mineral claims in 1999. The year 2000 saw $473 million in exploration expenditures in Canada, with Ontario, Quebec and the North West Territories accounting for 70% of those expenditures. Overall, 80% of the mining activity that occurs in Canada occurs in the boreal forest region. To date, an estimated 40 million hectares have been used for mining purposes, excluding much of the related infrastructure, such as road systems, power-lines and power generation projects.

Exploration and Deposit Appraisal Expenditures (by Mineral Commodity Sought)

Mineral Commodity	1999	2000	2001
	Percentage of Canadian Total		
Base Metals	27.6	28.2	27.7
Precious Metals	35.8	37.9	36.6
Iron Ore	0.9	0.8	1.0
Uranium	7.0	6.0	6.0
Other Metals	3.0	3.2	n.a.
Nonmetals	2.4	2.4	n.a
Diamonds	21.6	21.1	n.a.
Coal	1.6	0.3	n.a.
Unspecified Commodities	0.1	n.a.	n.a.

n.a - not available for 2001

The mix of mining operations is dominated by gold production, with the remaining precious and base metals joining gold to make up approximately 66% of mineral production.[155] Canadian reserves of copper, nickel, molybdenum, lead, zinc and silver have declined steadily since the early 1980s, and gold began a gradual decline in 1988.[156] Particularly for nickel, copper and gold, new low-cost additions to mine supply are coming on stream in other countries. Generally, the viability of mines is most strongly related to commodity prices. A high rate of supply around the world and low commodity prices intensify pressure on the ability of mines to remain operational.[157]

Overall, there has been a downward trend in exploration expenditures between 1998 and 2001, with total investment at $655.9 million in 1998, $504.3m in 1999, $473.4 million in 2000, and $457.7 million projected for 2001. Interestingly, throughout that four year period, the expenditures of the junior companies have held steady, while the major companies expenditures dropped quite dramatically.

Exploration expenditures by metals group roughly match current production percentages, with one important exception: diamonds. Accounting for roughly 1/5 of exploration expenditures, diamonds are the new favoured commodity for the mineral investment sector. While diamond exploration activity is spread across the boreal region, concentrations are notable in northern Manitoba and the James Bay area of both Ontario and Quebec.

Exploration Expenditures, by Province/Territory, 1998-2001

	1998		1999		2000		2001	
	$	%	$	%	$	%	$	%
Newfoundlan	47.9	7.3	31.3	6.2	24.9	5.3	24.5	5.4
Quebec	127.1		113.5	22.5	100.6	21.2	69.6	15.2
Ontario	114.8		87.4	17.3	89.7	19.0	99.0	21.6
Manitoba	29.9	4.6	22.8	4.5	27.4	5.8	30.5	6.7
Saskatchewan	62.1	9.5	43.6	8.6	39.2	8.3	41.2	9.0
Alberta	27.5	4.2	14.7	2.9	7.8	1.6	7.8	1.7
BC	54.5	8.3	41.3	8.2	34.8	7.4	45.1	9.9
Yukon	20.1	3.1	12.7	2.5	9.8	2.1	10.7	2.3
NWT	155.6	23.7	84.1	16.7	63.1	13.3	60.1	13.1

Source: Natural Resources Canada, from a federal-provincial survey of mining and exploration companies; estimates are national, ie. represent entire region rather than boreal portion of the region; Nunavit, New Brunswick and Nova Scotia are not included; approximately 20% of B.C., 50% of NFLD and NWT would occur in the boreal region, and approximately 80% for all other jurisdictions would be activity in the boreal

In terms of geographic spread, Quebec was the first choice for exploration investment from 1998 through 2000, drawing 19, 23 and 21 per cent of the investment dollars respectively. In 2001 Ontario moved from second to first place with 22% of the investment, after hovering just below Quebec for the three previous years. Manitoba showed a steady increase through the period; Alberta a steady decrease; Saskatchewan held relatively steady. The Yukon showed an overall decrease, albeit with a slight rise followed by a fall mid-period. The Northwest Territories showed a dramatic decline, going from almost a quarter-share, occasioned by the diamond rush in 1998, to just 13% in the last two years.

5.2 Canadian Mining Companies at Home

The big players at home in Canada and in Canada's boreal are also the big players abroad: Noranda, Teck-Cominco, Inco, Placer Dome, Barrick Gold and Cameco. These major companies are also among Canada's major corporations, and have integrated holdings, including exploration, mining and refining operations. Each

occupies a niche, albeit over a wide geographic range: INCO operates in nickel, in both northern Ontario and northern Manitoba; Placer Dome plays in gold, primarily in northern Ontario. Barrick is a major gold player. Noranda is the main player in copper-zinc production, primarily in Quebec. Cameco traffics in uranium, and is the primary cause of Canada being the world's largest uranium supplier, with one third of the global uranium feed coming from northern Saskatchewan. Very big companies – Noranda, for one – own majority shares in other big companies, such as Falconbridge, which is 55% owned by Noranda. And large multi-nationals based outside of Canada have considerable holdings in Canada. For example, Rio Tinto owns 100% of Diavik, 56% of the Iron Ore Company of Canada, 100% of Kennecott Explorations, and 100% of the QIT-Fer et Titane mine and smelter complex.

Other large-but-not-quite-so-large players are companies like Cambior or Inmet, with geographically diverse operations, and international interests. Other players, such as Hudsons Bay Mining and Smelting in northern Manitoba, a wholly owned subsidiary of Anglo American, play a more regional albeit significant role.

Diamond companies are also increasing their mark in Canada, with Debeers (also known in Canada as Monopros, and owned by Anglo-American), BHP and Rio Tinto's Kennecott all significant players, while more junior companies such as Spider Resources, Ashton Mining or Oasis Diamonds are also locking up large pieces of the land base for diamond exploration.

Cross ownership is common, as is shared ownership. Teck and Homestake are co-owners of the Williams Mine in Marathon. Homestake and Barrick, previously co-owners of the depleted Renabie Mine near Chapleau, are now merging into a single company. Teck was previously the biggest shareholder of Cominco; now the companies have merged to form Teck-Cominco. A recent trend has been the consolidation or take-over of companies, including the take-over of Canadian mining companies by international players, such as U.K. based Billiton's takeover of Rio Algom, followed by the merger of Australian-basedBHP and Billiton to form BHP-Billiton.

5.3 Canadian Mining Companies Abroad

More than half of the money raised worldwide for mineral exploration in 1998 was raised in Canada, to a total of US $4.5 billion. The Canadian mining industry has emerged as a "world leader", with interests in over 8,300 properties worldwide, 3,400 of them outside Canada, in 100 foreign countries. Canadian mining companies held the dominant position in the 12 Central and Latin American countries in which they concentrated their investments. Canadian companies also dominated exploration in the United States.[158]

Canadian mining companies have been involved in the most notorius mining disasters of the last decade. Boliden Ltd's mine in Los Frailes, Spain suffered a huge dam collapse, releasing tailings downstream into farmland, a nature reserve and water sources. Cameco is 33% owner of the Kumtor Gold Mine in Kyrgyzsta which has had 3 major accidents in the past few years, including a "spill" of 2 tonnes of sodium cyanide into a local river in May 1998. Potentially even more serious are concerns over the mine waste containing structures at the Kumtor Mine being built on perma-frost which is melting.[159] Placer Dome's Marcopper Mine in the Philippines spilled 3.4 million tonnes of tailings into the Boac River in March 1996. Cambior and Golden Star's Omai Mine disaster in Guyuana dumped 3.4 million cubic metres of cyanide and heavy metal laced sludge into the Omai and Essequibo Rivers in August 1996.[160]

Several major Canadian companies have an on-the-ground presence around the world. Inco runs operations in New Caledonia and in Indonesia; Alcan operates in thirty different countries.[161] Placer Dome has mines in Papua New Guinea, Chile and the Philippines. Barrick is in Tanzania, Chile, Argentina and Peru.[162]

5.4 Industry Associations

Many – but certainly not all – of the companies currently operating mines in Canada's boreal are members of the Mining Association of Canada, which is the industry's main lobby group and industrial organization. The Mining Association of Canada, headquartered in Ottawa, plays a major role in supporting its members in their efforts to affect Canadian regulation of the mineral sector, as well as public and government's perception of the mining industry. The Association's 31 members represent the major players in the base and precious metals market, but neither the major uranium producers nor the coal companies choose to participate. Other significant regional players, such as North American Palladium, operating in northwestern Ontario, or Cambior, with its several Quebec operations, are also missing from MAC's membership list. The net effect of this can be that the industry is able to increase their representation at multi-stakeholder consultative tables. For example, during the lengthy process to review and revise the federal mine effluent regulation, the industry was represented not only by the Mining Association of Canada, but also by representatives who are not members of MAC, and argued that their interests were unique enough to warrant additional industry seats at the table.

Dating back to the mid-thirties when it was known as the "Canadian Metal Mining Association", MAC describes it mission as being "to promote, through the collective action of members, the growth and development of Canada's mining and mineral-processing industry, for the benefit of all Canadians." The

Association occasionally plays a positive role in some consultative processes, working with its members to develop positions that may find some support with other stakeholders.

At the same time, MAC's primary purpose is to act as an advocacy agency for industry's interests, which are frequently at odds with the public interest. For example, MAC played a key role in the "Keep Mining in Canada" campaign, which promoted an industry agenda of deregulation and increased subsidies. Now flying under the banner of the "Mining Works for Canada " the newly packaged campaign's "signature event" was a March 2001 lobby day in Ottawa, during which 43 mining c.e.o.'s split into 10 "teams" to swarm Parliament Hill, meeting with 60 federal decision-makers, including several Ministers and Caucus Chairpersons. As described by MAC, "the day involved focused, concerted advocacy on three key federal policy challenges: tax reform, proposed amendments to the Canadian Environmental Assessment Act and the regulatory climate in Canada's North". MAC organizes an annual lobby day and reception on Parliament Hill each November.

The Prospectors and Developers Association of Canada is another major, country-wide industry organization. Based in Toronto, the PDAC represents the interests of the Canadian mineral exploration and development industry. In existence since the early '30's, PDAC purports to speak on behalf of 5,000 individual and 200 corporate members. An aggressive lobbying organization, PDAC describes its mandate as being threefold: advocacy, information, and networking. A recent coup for PDAC was the award of funding from the Government of Ontario for the industry group's "Mining Matters" program. A registered charity, "Mining Matters" is an "information" campaign promoting mining to school children. PDAC puts a number of lobbying successes at the top of its achievement list for this past year, including the introduction by the federal government of the 'super' flow-through exploration investment tax credit. Also on the list are the increased focus on geoscientific activities across Canada, the decision of the Ontario Securities Commission to retain its rule on exempt distribution, and the creation of a "special industry-government committee" to "resolve regulatory problems in northern Canada". Still not satisfied, PDAC claims that "raising working capital, access to land, and onerous regulations are just some of the continuing challenges."

Other national organizations that promote the interests of the mining industry include the Canadian Association of Mining Equipment and Services for Export, Canadian Institute of Mining, Metallurgy and Petroleum, Canadian Mining Industry Research Organization, and the Coal Association of Canada. In addition, each province or territory has at least one – and often several – industry organizations, operating at a regional or provincial / territorial level, including

groups like Alberta Chamber of Resources, B.C. and Yukon Chamber of Mines, the Mining Association of British Columbia, the Mining Association of Manitoba, the Northern Prospectors Association, the New Brunswick Mining Association, Northwest Territories and Nunavut Chamber of Mines, the Ontario Mining Association, the relatively newly created Ontario Prospectors Association (recipient of a $4 million start up grant from the Ontario government) the Northwest Mining Association, the Quebec Mining Association, the Saskatchewan Mining Association, and the Yukon Chamber of Mines. Some companies are members in several organizations, both provincial and national, and the mandates and activities of the provincial and national organizations are generally similar, albeit more focused on a particular level of government.

Not surprisingly, given the global reach of Canadian mining companies, these same players are also active in international organizations and pro-mining campaigns, such as the Global Mining Initiative, the Metals, Mining and Sustainable Development project, and exercises like the Asia-Pacific Economic Countries' Group of Experts on Mineral and Energy Exploration and Development (GEMEED).[163] Singly and in combination, these exercises have the intention of "greening" the image of the mining industry, and recasting the fundamentally unsustainable extraction of non-renewable resources in a "sustainable development" framework. With the 10-years-after Rio convening of a United Nations summit on sustainable development looming in September 2002, activities are becoming more focussed on producing paper products and creating the right optics for the U.N. conference.

5.5 The Governments

Mining is primarily regulated by the provincial/territorial governments, with the federal government having a lesser, albeit potentially still important role. Federal players include Natural Resources Canada, Environment Canada and the Department of Fisheries and Oceans. Provincial and territorial departments are those charged with management of natural resources, lands, water and air quality.

5.5.1 The Federal Government

Federal responsibilities include the regulation of activities which may impact on fish or on waters where fish are found – in accordance with the federal Fisheries Act – and environmental assessment of certain projects, under the Canadian Environmental Assessment Act. Natural Resources Canada has a very minor role as a regulator, given their authority over explosives, which are used in mining operations. Through the Canadian Nuclear Safety Control Act, the federal

government and its regulatory Nuclear Safety Commission also have authority over uranium mines, mills and refineries, including their development, operation and closure. The federal government also has responsibilities for transboundary waters, navigable waters, import and export of hazardous wastes. The Canadian Environmental Protection Act provides the federal government with some regulatory control of toxic substances.

The Metal Mining Effluent Regulation is a regulation pursuant to three different sections of the Fisheries Act[164] which provide authority to set regulations establishing pollution limits and require companies to report their discharges. The Fisheries Act is generally administered by the Department of Fisheries and Oceans. However, the delivery and oversight of the MMER has been delegated to Environment Canada. Throughout an 8 year multi-stakeholder review of the MMER, Environment Canada played a lead role in the consultations, with the Department of Fisheries and Oceans and Natural Resources Canada both in "supporting roles". It must be noted that DFO and Natural Resources Canada invariably lent their support to very different positions, with DFO supporting a more protective regulation which would seek to lessen impact on fish and fish habitat, and NRCan supporting a regulation which would least impact on mining companies and their profitability. This role is the one that Natural Resources Canada generally plays, whether in a review of the effluent regulation, the development of regulations under the Canadian Environmental Protection Act, or more broadly in the public and political arenas.[165]

The Canadian Environmental Assessment Act is administered by the Canadian Environmental Assessment Agency, which reports to the Minister of the Environment. However, more than 99% of all environmental assessments done under CEAA are "self assessments", meaning that they are assessed by the departments who are either permitting, funding, or carrying out the project. As discussed in Section 5.6.3 on environmental assessment, weaknesses with the delivery of environmental assessment in Canada become evident in any evaluation of the track record in assessing mining projects.

A role that seems to be common to all levels of government is that of subsidy giver and tax-cutter, as is discussed in later sections of this report.

5.5.2 The Provincial and Territorial Governments

There are variations across the provincial and territorial governments in how departments are structured and responsibilities related to mining are distributed. However, the key departments are those which administer laws and regulations related to the disposition of crown land, protection of water quality, and allocation

of rights to natural resources. More discussion of the approaches taken and standards set by the various jurisdictions is found in Section 7, which provides overviews and case studies from the provinces and territories.

5.6 Key Canadian Issues

5.6.1 Abandoned Mines

While definitions vary, abandoned mines are most consistently defined as those mine sites where the mine operator or exploration company has ceased or suspended indefinitely their activities, be that exploration, mining or mine production, without rehabilitating the site.[166] Some parties make a distinction between abandoned mines, those being all mine sites in the condition just described, and orphaned mines, those being abandoned mines for which an owner cannot be identified.

Abandoned mines create a number of problems, including public health and safety concerns and environmental hazards. These problems stem from both the physical hazards related to abandoned mines, including open pits and shafts, trenches, dam collapses, and ground subsidences (when an underground mine collapses, creating new pits and openings from surface to underground), and environmental hazards, including acid mine drainage, metal leaching, and contamination from process agents, fuel and other pollutants that may have been left on site. Cost estimates vary, but a conservative estimate would place the price to clean up all abandoned mines in Canada at $6 billion or higher.[167]

Mines become abandoned for a variety of reasons, changing over time and varying by jurisdiction. Historically, mines became abandoned because there was no legislative mechanism to prevent them from becoming so, and not enough understanding of the physical and environmental hazards involved. In the first few years of World War II, mining was frequently driven by the war effort. The federal government operated Ontario's more notorious abandoned mine, the Kam Kotia near Timmins, as a source of copper, and gold mining was classed as a "war industry", with gold production essential to Canada's funding of the war effort.[168] There were no rules in place to require clean-up, and, over the decades, many records were lost or destroyed that would have matched owners with sites. Through legislative and regulatory developments during the 1980's and '90's, rules were slowly developed to require companies to clean up after themselves, and to put aside funds in order to do so. Tragically, these same rules are now either being rolled back, as in Ontario, or are not yet fully developed or implemented, as in Manitoba and the Yukon.

An Abandoned Mines Subcommittee of the Inter-Governmental Working Group, which includes the provincial, territorial and federal governments, convened a national workshop on abandoned mines in June 2001. Participants included government, industry, First Nations, environmental non-governmental organizations and municipal leaders. The workshop conclusions included recommendations that an ongoing national working group be established to develop a work program to address issues around abandoned mines, and report to the Mines Ministers meeting in 2002.

5.6.2 Taxation and Subsidies

For the mineral sector in Canada, tax breaks and subsidies are two sides of the same coin, with the coin coming out of the public purse and into the collective pocket of the mineral exploration and development industries and their respective shareholders.

The mineral sector may claim “poor”. In fact, sinking commodity prices have had a negative effect on the sector’s profitability. However, the last half decade has been a period of incredible public generosity, often exercised on the public’s behalf without their knowledge or consent.

The mining industry frequently complains of uncompetitive taxation levels, saying they are a significant disincentive for investment in Canada. Two sets of facts discredit such a claim: a) more money is raised in Canada for mineral exploration than in the rest of the world combined; and b) studies by Natural Resources Canada determined mid-decade that Canada's taxation of the mining industry ranked low to middle range on an international scale, especially when allowable accelerated capital cost allowances, tax deferrals, tax credits and tax holidays are taken into account.[169] Since that study, there have been additional financial concessions to the sector, including accelerated write-off of development expenses for mine expansions in the 1996 federal budget,[170] cuts to mining taxes in several jurisdictions, and reintroduction of flow-through share programs both provincially and federally.

"Flow-through shares" are a form of tax shelter that make a direct link between tax relief and subsidies. They allow investors to deduct exploration expenses and related depletion allowances against their income. Individual taxpayers seeking tax shelters made extensive use of this program representing over $150 million of the exploration capital raised in 1996.[171]

Numerous other subsidies are provided to the mining sector. In fact, every province and territory provides some form of subsidy, and in many cases, there

are multiple subsidies. The first and perhaps most obvious form of subsidy is in low-cost access to land and to the mineral resource, but most jurisdictions go well beyond just giving away the public resource – government actually pays the mining companies to take it!

In 1994, British Columbia introduced a 5 year, $100M mine development funding pool, as well as providing other large direct government grants, loans and incentives for particular mines. Manitoba funds up to 35 per cent of eligible project expenditures to a maximum of $400,000 per recipient each fiscal year, to a total of $2.75 million each year.[172] These handouts go not to individual prospectors but to major mining companies with millions of dollars in assets, including Falconbridge, BHP, Debeers, and the like. The North West Territories provides individual prospectors with up to $8000 per individual per year in grants.[173]

The Saskatchewan Government is one of several to provide flow-through shares. The program is in addition to the federal government's new 15% federal mineral exploration tax credit, and adds a10% tax credit on purchases of flow-through shares of eligible mineral exploration companies. The program was announced to be retroactive to October 2000 , with the program to run through to January 1, 2004.[174]

Ontario has provided $23 million dollars in direct subsidy to the mining industry since March 1998, including a $4 million dollar grant to the Ontario Prospectors Association to support the creation of their provincial lobby for the mineral exploration industry. Ontario has also re-instituted the flow-through share program, providing a 15% tax credit in addition to the 15% federal tax credit.

In addition to the many direct subsidies and tax shelters, government also provides an indirect subsidy to the mining sector through institutional and research support, including geotechnical surveys, no-cost access to claim maps and records, and numerous technical and administrative services.

5.6.3 Environmental Assessment

Both the federal and provincial governments have environmental assessment legislation, although with many differences of approach among the provinces, territories and federal regimes. Since the passage of the Canada Wide Harmonization Accord in the late '90's, the federal government has been developing "harmonization" agreements with the provinces. In some cases, such as British Columbia, the "harmonization" agreement between the Province and Canada means that, in effect, environmental assessment is a hybrid, and there is a shared process. In other cases, such as Ontario, there is little overlap between

those projects which are subject to the provincial Act and those subject to CEAA, although there is potential for joint federal/provincial assessments. However, deregulation over the last several years in Ontario has already robbed that provincial process of many of its best attributes, such as intervenor funding, the substantial address of technical issues, and broadly scoped hearings.

The "self assessments" carried out under the Canadian Environmental Assessment Act are often done by the private sector proponent, particularly in the case of mining projects, with resulting reports and conclusions adopted by responsible federal department. The Department of Fisheries and Oceans is most frequently the federal department which is responsible for issuing a permit for the project, and therefore becomes the "responsible authority", within the language of the Act.

To date, there is a very low level of satisfaction among public interest groups with the effectiveness or fairness of environmental assessments of mining projects done under CEAA. In those few cases where the review of proposed mining projects have been conducted by an independent panel, the federal government has ignored key recommendations. One such as case is the McLean Lake Mine in northern Saskatchewan, where despite the review panel recommending a five year delay to permit further studies, the provincial government proceeded with an approval without delay.[175] In the Cheviot Coal Project in Alberta, the joint provincial-federal panel approved the project without requiring a full environmental assessment to be done. A legal challenge was filed and the Federal Court found that the EA had failed to consider cumulative impacts and alternatives to the project – two key elements of the EA process – and ordered the approval quashed and the review reconvened.[176]

How cumulative effects are assessed is of serious concern. A comprehensive study report – the most rigorous class of self-assessment – of the Aquarius Mine illustrates this problem.The gold mine, projected to operate for only 5 years, is going to impact on a provincial park, a remote cabin, trap lines, moose habitat and a bear management area. The project includes filling a small valley which is host to a fish bearing cold water stream, and is located in the same watershed as other mines and industrial operations and transportation routes, none of which were considered in terms of assessing cumulative impacts. The mine proponent claimed that effluent from other mines in the area discharging into a common water body met provincial standards, and that the effluent from the Aquarius mine would meet provincial standards. Further, the proponent put this information forward as their assessment of cumulative effects. In fact, area mines were not consistently in compliance, and the Aquarius was also expected to have some exceedences of the provincial standard. More significantly, simply establishing pass/fail on water quality standards does not constitute a cumulative effects assessment.[177]

Despite the significant potential – even certainty – of environmental impacts, some mine projects escape environmental assessment reviews altogether. Such is the case with the expansion of the Lac Des Iles palladium mine, in the north end of the Lake Superior basin. The expansion will quadruple the production at the mine, and will involve a major expansion of the mine's footprint, including additional effluent discharge points, dewatering of a bog, water taking of up to 30 million litres per day, and creation of waste rock piles twice the height of the highest point of land in the area. The Department of Fisheries and Oceans has reportedly "worked things out" with the company in order to avoid issuing a permit, and so avoid triggering an environmental assessment review.[178]

Regrettably, despite the positive role that the Department of Fisheries and Oceans is perceived to have played during the revision of the Metal Mining Effluent Regulation, that approach is not replicated during the day-to-day delivery of the Fisheries Act, particularly as it relates to environmental assessment of mine projects. There is increasing concern among public interest groups with the Departments's willingness to provide "letters of advice" as a means of avoiding the triggering of environmental assessments[179]

5.6.4 Land Access

Access to land also means access to water, to air and to wildlife.

Land access is perhaps the premier issue with respect to mining in Canada, not only because it is the open door to the entire sequence of mining related environmental and social impacts, as discussed in earlier sections of this report, but also because of its ability to impinge directly and profoundly on indigenous land rights and uses. Indigenous rights are discussed in Section 8.

5.6.5 Lack of Regulation

A key issue is the lack of adequate regulatory mechanisms to protect the environment from the adverse impacts of mining. In some instances, this is as a result of relatively recent de-regulation, such as the rollbacks under Ontario's Public Lands Act and changing or removal of key sections of the Mining Act in Ontario. In other cases, such as the exclusion of both placer mining and impacts of mining on groundwater from Metal Mining Liquid Effluent Regulation under the Fisheries Act, the regulation(s) simply do not address the range of environmental impacts. These issues are discussed in later sections.

6.0 Canada as a Mining Jurisdiction

6.1 An Introduction to Political and Regulatory Trends

The past two decades have seen a variety of changes in the global mining industry, with significant environmental consequences for Canada. The influence of these global changes on the domestic political and regulatory climate cannot be underestimated.

From an environmental perspective, increased political notice of environmental issues in the mid 1980's to the mid 1990's encouraged federal and provincial legislators to begin developing a comprehensive legislative and regulatory framework to control the environmental impacts associated with the various stages of the mining cycle.

These long overdue and positive measures varied in nature and degree from province to province, but included such important measures as reclamation funds to ensure existing and new mines were properly closed out by mining companies. Provincially, the nation's largest mining jurisdiction, Ontario led the way with tighter controls over exploration and activities on Crown lands, and the setting of new standards for limiting toxic effluent through the Metal Mining regulations under the Municipal/Industrial Strategy for Abatement (MISA). At the federal level, new environmental assessment legislation and the passage of the Canadian Environmental Protection Act both affected the mining industry and reflected the public's desire for increased environmental protection. In 1990, attempts by the federal government to reduce its deficit led to a cancellation of the flow-through share program that had been an important, and lucrative, investment mechanism for the mineral exploration industry in Canada.

Flow-through shares are a financial instrument that allow exploration companies to "flow through" 100% of their exploration costs associated with unsuccessful exploration activities to shareholders. Under the liberal flow-through share programs of the late 1980's, shareholders could write-off a significantly higher percentage of their investment, against any source of income, than would otherwise have been the case. This increased tax incentive is justified by both participating governments and the industry as being necessary to offset the high risk involved in finding economically feasible deposits for exploitation.

During this period provincial and federal governments broke with the cooperative federalism of the previous decade and competed for voter sympathy through new policies designed to protect the environment and align economic and social structures with "sustainability". Historically, the mining industry has been a shrewd manipulator of the federal state, playing one level of government off

against the other to achieve self-interested ends.[180] But during this brief period of heightened public environmental concern governments competed with one another in the environmental arena, passing new laws and promulgating regulations, thereby increasing environmental protection, but also increasing industry costs.[181]

Some within the mining industry view the tide of 1980's environmentalism as having caught companies "flat footed" and unprepared to resist the significant legislative and regulatory changes introduced by Canadian governments.[182] The industry's historically sound clientele relations with governments and regulators were suddenly threatened by the rise of environmental stakeholders and demands for increased environmental protection, transparency, and accountability on the part of industry.

The green agenda was short-lived, and by the mid-1990's, in mining jurisdictions such as Ontario, most of the more progressive elements were being deregulated or weakened. New significant gaps opened in the environmental regulatory framework governing mining, particularly problematic given the significant environmental impacts of mining related activities.

The nature of the mining industry, particularly its high capital needs compared to other industries, and the increasing concentration of mining interests globally, creates a determination on the part of industry to lobby potential host governments for the conditions most favourable to their operations. Government policy, unlike capital markets and mineral prices, can be influenced by mining interests, and the mining industry seeks to control the costs occasioned by policy.

While competition among countries and within them to attract industries like mining is not new, it has intensified in recent years. A concise summary of the origin of this relationship is this:

> *"The increased mobility of capital that has come with globalization limits governments' ability to require industries to internalize environmental and other costs. The mining industry has been particularly aggressive in its use of threats to move investments away from those jurisdictions with more stringent regulatory standards."*[183]

For example, as a result of corporate lobbies the rules requiring repatriation of capital no longer apply in many South American countries. Under former repatriation laws governments forced foreign companies to re-invest earned profits locally in order to bring growth and development to the indigenous economy. Relaxing this requirement results in greater mining company interest in those countries, and in turn industry mounts pressure for relaxed rules in Canada.

As a result of these and other pressures in the international political economy, the regulatory structures touching on the mining industry in the past several years have changed markedly.

6.2 Increasing Public and Environmental Liability through Deregulation

The context for deregulation includes the concentration of economic power in fewer companies, increasingly multinational in character in the mining and forest industries, and the movement from legislated, binding rules to the adoption of voluntary systems. These voluntary measures are adopted into law in some cases, but generally lack the backstop of state sanction for non-compliance.

This section explores deregulation in a thematic sense, and considers trends in deregulation that have occurred in each stage of the mining process.

6.2.1 Budget cuts, reduced government presence and non-compliance

Cuts to budgets of federal and provincial ministries have meant a decreased capacity to monitor environmental change caused by human activity, including mining. Cuts have also lowered government capacity to provide baseline environmental information against which to track these changes, and to allow a comprehensive approach to enforcement. This pattern is well documented.[184] The often remote location of boreal mines compounds this problem.

The mandates of ministries of the Ontario Northern Development and Mines (MNDM), and Natural Resources (MNR) reflect those ministries perception of the mining industry as a client. As a result, the budget cuts to those ministries since the Progressive Conservative Party took power in Ontario in 1995 have been soft in terms of any adverse effects on the Party's industry clients. While operating and capital budgets to these ministries have been partly reinstated in recent years, the budget of the Ministry of Environment has not been restored from the 40% cuts it has suffered since 1995.[185]

Along with cuts to government programs and services comes, inevitably, a decrease in traditional government presence in compliance monitoring and enforcement of environmental laws. In 1996, the number of mine closure inspectors in Ontario dropped from 16 to 2.[186] When government fails to monitor and enforce its laws, regulated industries can be expected to achieve lower levels of compliance with those laws. Studies show enforcement presence as a strong incentive, usually the primary incentive, as motivation for compliance.[187]

As regulated companies lobby for or develop their own voluntary codes and systems for environmental performance, they also lobby for the dismantling or non-application of regulatory requirements that, it is said, are adequately replaced by the voluntary systems. This in turn helps governments in rationalizing their budget cuts, which are implemented in part by eliminating government presence and rules.

6.2.2 Deregulation by restructuring

Along with budget-cutting, Ontario has also experienced radical changes to its regulatory systems and restructured relationships among the provincial government, municipalities and the private sector, especially in terms of re-allocation of responsibility for delivery of traditional government services.[188]

Even before budget cuts, shortcomings in the ability of existing laws to protect the environment or ensure the sustainability of boreal communities could be seen. For example, non-lethality requirements in the Ontario Metal Mining Sector Monitoring and Effluent Regulation (EPA) are not very stringent, and apply only to operating mines, not the thousands of closed or abandoned mine sites that dot the province.[189]

The mining industry has a poor track record in terms of compliance with Ontario's Municipal-Industrial Strategy for Abatement (MISA). For example, the effluent of twenty-five percent of metal mines in Ontario failed the test for acute toxicity over two months (August and September) in 1997, and nineteen metal mining facilities in Ontario failed to comply with MISA requirements throughout that year.[190]

Swaigen and Winfield wrote in the early 1990s that "many provinces have been unwilling to pursue prosecutions under the federal *Fisheries Act* as a result of fears that this would reinforce federal jurisdictional claims in the environmental field,"[191] preferring instead to address water pollution through their own laws. Canada's signing the Canada-Wide Accord on Environmental Harmonization with nine of the ten provinces in January 1998 should temper any provincial concern over perceived federal domination. Some view the Accord as a federal abdication of its responsibilities, as it arguably focuses as much on the dubious problem of duplication of regulatory efforts as it addresses substantive environmental problems. The federal Department of Fisheries and Oceans resumed enforcement of fish habitat provisions of their Act in Ontario, after the withdrawal of the Ontario Ministry of Natural Resources from a Referral Progress agreement with DFO in 1997.[192]

Another pattern that can be observed is the transfer of decision-making in all jurisdictions from specialized government departments to Cabinet, in turn exposing such decisions to political rather than sound policy-based considerations.[193]

In other cases, decision-making powers are transferred from ministries (formally, the Minister) to "any agency, authority, corporation or person," as in the case of the *Ontario Red Tape Reduction Act (Ministry of Natural Resources), 1997*, which permitted such changes to both the *Public Lands Act* and the *Lakes and Rivers Improvements Act*.[194] These changes often attempt to mask the fact of ministerial responsibility.

That Ontario, Canada's largest industrial and largest mining province, has led the way with these reforms could mean that other Canadian provinces and like jurisdictions abroad – hoping to attract mining investment – will follow suit.

6.2.2.1 Deregulation of Exploration

Many provinces are facing dramatic deregulation in the mining sector. Mines require access to land, and this is being facilitated through the relaxing of laws and regulations to ensure easy access to public lands. Mineral exploration has by its very nature impacts over a large area in terms of water quality, wildlife habitat disturbance, etc. Governments have nevertheless deregulated obligations for exploration. The Government of Alberta, for example, had this to say about the environmental impacts of exploration, which may signal the tendency of other governments to minimize regulatory obstacles to access to lands:

> *Through its regulatory reform initiatives, Alberta implemented codes for activities that had low potential for adverse effects and where few or no statements of concern had been received under the approval process. Exploration met both criteria*. [195]

In Ontario, a regulation made under Bill 26 (the *Savings and Restructuring Act* introduced in January 1996) enabled profound changes to the *Public Lands Act*:

> *These amendments replaced the existing statutory requirement to obtain approval from the Minister of Natural Resources before undertaking any activities on public lands or affecting public waterways, with a structure which permits the Cabinet to make regulations defining when approvals will be required.*[196]

In November 1996, regulations were adopted to implement the Bill 26 provisions:

> *Mineral exploration activities on public lands were completely de-regulated, including clearing, mechanical stripping, bulk sampling, drilling and blasting, moving heavy equipment and drilling rigs and building trails.*[197]

Other activities on Crown land previously requiring permits and eliminated by the regulation included "most fire, travel and work permit provisions", most permit requirements respecting dams, docks, water works, most new trails and small-scale fires. These changes reduced the need for work permits on Crown land by a remarkable 80%.[198]

Another regulation made under Bill 26 (the *Savings and Restructuring Act* introduced in January 1996) amended the *Environmental Protection Act* to grant mine developers immunity from liability for pre-existing mine hazards on brownfield sites.[199]

Included in the Ontario Forest Accord, announced in March 1999, were government promises to respect existing mineral rights in lands selected for new parks and conservation areas. "Low impact" staking and exploration would also be allowed in new parks, in those areas designated as having "provincially significant mineral potential." Park lands could be "borrowed" for mining purposes, and would be returned to parks after mining operations ceased; meanwhile, land of equal natural heritage value would be substituted for the "borrowed" lands. [200]

Similar changes could be seen in British Columbia. The *Mining Rights Amendment Act, 1998*, made two fundamental changes. It establishes a right of access for holders of mineral claims to all areas outside of parks. Secondly, it establishes a right to compensation to holders of mineral tenure where there is expropriation of that tenure right by a government to establish a park.[201] When the Act was introduced, BC Premier Glen Clark said it was intended to make mining "an easier and more certain process in this province."[202]

In its successful election campaign in early 2001, the BC Liberal party promised to "increase access to Crown lands and resources, to create jobs in tourism, mining, forestry, farming, ranching, and oil & gas," to "eliminate the backlog and delays in Crown land applications, which have cost over $1 billion and 20,000 lost jobs," and to "encourage mineral exploration which has dropped by 80% under the NDP." [203]

6.2.2.3 Deregulation of mining operations (mining, milling, smelting, refining, etc.)

In Ontario, the potential for compliance with the Municipal Industrial Strategy for Abatement (MISA) standards was diminished with the reduction of monitoring requirements, and the disbanding of the MISA advisory committee in 1995. The mining industry lobby in Ontario called in 1996 for weakening of effluent testing requirements under MISA, and complete exemptions from testing for operators using "Best Available Treatment Economically Achievable" pollution control equipment.[204] Although the lobby effort failed, the weak regulatory mood is evidenced by the industry's assessment of government's openness to such a scheme.

6.2.2.4 Decommissioning and closure, reclamation and rehabilitation

Ontario's contaminated site guidelines, originally established in 1989, were loosened in 1996. In addition to the previous standard of ensuring contamination is at "background levels", the guidelines now allow remediation to "a generic standard", or "on the basis of a site specific risk assessment." No longer does MOEE have to approve the acceptability of the remediation. Only those lands where the "site-specific approach" is taken require registration on title of the history of contamination.[205]

Ontario legal requirements for the reclamation of mine sites and other measures including the posting of security for reclamation costs were implemented relatively recently. Amendments to the *Mining Act*[206] requiring progressive rehabilitation, site closure plans and financial assurance requirements came into force in 1991.[207]

In keeping with the deregulation agenda of the current Ontario government, many of the only recently achieved mining reforms were dismantled in the mid and late 1990s, some before they had been fully implemented:

- The requirement to post "realizable financial securities" against the risk of bankruptcy and public liability for mine closure costs was eliminated, and replaced with an option for mining companies to "self assure", meaning they could meet a financial means test instead for posting real securities, the net effect being that taxpayers are more likely to pay for the costs of remediation or clean-up;
- Information respecting financial assurances for mine closures and submitted to government was exempted from access to information legislation, making public access to such information less likely;
- Annual reporting requirements to the Ministry of Northern Development and Mines on mine closure plans were eliminated, which implies the loss of a key

measure of accountability in implementation of plans;
- Holders of mining claims were exempted from statutory liability for "pre-existing mine hazards", if they surrender their leases within twelve months of the Bill 26 amendments to the *Mining Act.* [208]

Another key change to the *Mining Act* was to allow the approval of mine closure plans to be delegated to any person designated by regulation, a change that would allow self-regulation of mine closure systems by the private sector. [209] Prior to these changes, the practice of the Ministry of Northern Development and Mines (MNDM) was to co-ordinate review of closure plans among the ministries of Environment, Labour, and Natural Resources before acceptance by MNDM. With the changes, a mine owner could still seek the approval of the Director of Mine Rehabilitation, however the option now exists to simply file the closure plan, so long as it is certified by the company's Chief Financial Officer and then "accepted" by MNDM. [210]

Coupled with this self-regulation of closure plans, Ontario's having replaced required posting of financial security with a "corporate financial test" as part of the deregulation of the closure regime is extremely significant. Called a "soft security instrument" because there is no guarantee funds will actually be available at a given time, the "test" is a requirement that operators have a minimum credit rating when filing the closure plan.[211] This is assumed to be a guarantee that the same operator, if one still exists at all, will have funds sufficient to conduct an expensive clean-up at an unknown time in the future. This policy is only likely to increase the number of abandoned mines and public liability for clean-up in the boreal forest of Ontario.

The situation in other jurisdictions is not demonstrably better. While some provinces may appear to have comprehensive mine closure regimes in place, "a successful mine closure has never been achieved in the Yukon." [212] Governments and taxpayers are on the hook for the costs of those mines that ceased to operate before remediation obligations came into force, or that were otherwise "orphaned" because of companies' inability to pay for cleanup.

Posting of security against clean-up costs is discretionary in British Columbia. [213] Rules for posting security against the risk of environmental damage vary among other Canadian jurisdictions. Many of these regimes are subject to discretion that may compromise the public interest in consistency and certainty that sites are well-maintained. Manitoba, for example, accepted several alternative forms of security as recently as early 2001. Some of these forms, such as cash deposit, bond and pledging of assets, may provide better guarantee than letters of credit or good rating, which are also accepted. [214]

6.4 Synthesis: Mining and the Boreal Forest in 21st Century Canada

The trends delineated above point to increasing direct environmental impact throughout the mining cycle. The magnitude of the impact can be expected to increase in the immediate future as the effect of flow-through shares, re-introduced by the federal government in the 2000 budget, begins to stimulate previously low exploration spending levels.[215] In general, these trends are driven by Canadian governments' desire to create a mineral investment climate that continues to privilege resource-driven economic growth, resulting in a failure to fully internalize the environmental and social costs of mining.

In attempting to understand the forces producing the deregulation and weakening of the environmental regulatory regime as applied to mining, both national and international factors need to be considered.

6.4.1 International Factors

If it is true that global forces are playing a greater role in determining domestic policy issues today in general, it is particularly the case with respect to environmental policy as applied to mining. As an industry in which Canada is a long-time leader with considerable expertise, the importance of mining – and perhaps more importantly the mining industry – has been growing as the Canadian economy adjusts to the forces of globalization. Although the mineral sector has seen its percentage of national GDP fall in half from a peak of 8.4% in 1965, as a sector which exports over 80% of its production with most to the United States, it still plays an important role in providing Canada with a positive balance of trade.[216] Canadian resource exports play a seminal role in offsetting trade deficits incurred as we import highly manufactured machinery and equipment, consumer goods, and cover deficits in services resulting from the outflow of dividend and interest payments, as well as tourism.[217] Consequently, the importance of resource exports and resource companies is not lost on governments in Canada. In a globalizing world in which governments look to domestic-based, internationally proven multinational corporations to increase wealth and jobs at home, the decreasing foreign ownership of the domestic mining industry, from approximately 50% in the early 1970's to 31% in 1986, is important.[218]

Given Canadian economic dependency on resource exports it comes as no surprise Canadian governments have been, and remain, major proponents of expanding global trade liberalization. Canadian mineral companies were both strong advocates of the Free Trade Agreement (FTA) with the United States, and big winners as a result of the trade deal.[219] The FTA provided Canadian mining

companies with increased access to their largest market and protection from countervailing suits launched by higher cost American producers, as well as tariff protection from lower cost mining operations in Mexico, Central and South America.[220] As our domestic manufacturing base shrinks because of rationalization by largely US multinationals, increasing resource exports is seen as the most viable way for Canada to pay its way in the world. This first phase of North American trade liberalization is an example of the mining industry's ability to convert its economic interests into political currency. Federal and provincial governments feel compelled to work cooperatively to ensure Canadian-based resource exporters remain globally competitive.[221]

A further problem for Canadian governments in the 1990's was that while the FTA (and later NAFTA) was being implemented at home, the international political economy was undergoing massive transformation after the fall of the Soviet Union. The implications of this transformation for Canadian-based mining were far-reaching. First, the political risk equation, which is central to the determination of where mineral investment dollars should be spent and new mines developed, shifted. For decades, mineral rich western nations such as Canada had enjoyed the lion's share of mineral investment partially based on attractive geology, "favoured nation" trading status with the US, and a low political risk profile. Many Central and South American nations with high mineral potential were simply considered too politically unstable for major long-term investment, regardless of their attractive geology.[222] The fall of the Soviet Union both fueled and legitimized the liberalization of economic and mining policy within many Central and South American, and South East Asian countries – Canada's key competitors for mineral exploration and investment dollars. Publicly owned mines were privatized; mining codes were re-written; foreign investments courted.

The rise to prominence of neo-classical economic ideology in the 1980's and early 1990's, reflected in the restructuring policies of the World Bank and the IMF, meant foreign direct investment (FDI) was no longer conceived to be a barrier to development as had been the case in earlier decades.[223] Conversely, FDI was now argued to be the principal vehicle for national development, and changes to Third world laws meant that capital could flow freely across borders.[224] This shift in the international political economy brought many mineral rich but otherwise poor and often indebted nations into the global competition for mineral investment dollars. Many of these countries have less developed and less stringent environmental regulatory regimes than Canada and place a very high premium on resource development.[225]

Another implication of the fall of the Soviet Union was that the ore deposits of what is now known as Russia, as well as other republics, were released onto the

"free" market.[226] This created significant instability in world commodity markets during the early 1990's as Russia dumped metals, especially precious metals, to gain hard currency.[227] The negative impact on commodity prices had a dampening affect on the ability of juniors to raise money for exploration both at home and abroad. Ironically, in the early 1990's the Bank of Canada also sold large quantities of gold on world markets in an effort to keep the deficit under control, weakening the financial position of Canadian gold exploration and mining companies and fueling the rationale that the mineral investment climate in Canada was no longer competitive.[228]

Overall, the implications for mining in Canada were severe. Canadian junior mining firms, arguably comprising the best exploration sector in the world, increasingly headed to Central and South America, South-East Asia, and Africa in search of the motherlode.[229] Among other factors, exploration firms said that many of the more progressive environmental regulatory changes in the late 1980's and early 1990's had driven their exodus from Canada.[230] With Canadian reserves low even after an extended and costly run of flow-through shares failed to find substantial new reserves, clientele departments such as Natural Resources Canada and their provincial counterparts began sounding the alarm that Canadian-based mining was in decline because mining companies were being regulated out of existence.[231]

6.4.2 Domestic factors

The preceding discussion describes some of the external factors helping produce downward pressure on the environmental regulation of mining in Canada, stimulating deregulation in the worst-case scenario and "regulatory chill" in the best. It is not an exhaustive picture of the international forces affecting mining in Canada in the 1990's and the present, nor does it tell the whole story behind the weakening of the environmental protection regime governing mining. However these global forces interact with domestic politics and policies to negatively impact the environmental protection regime governing mining in Canada.

6.4.2.1 Control Over Domestic Costs

International factors, for example, are reflected in the rationalization of federal and provincial environmental responsibilities as established under the Canada-Wide Accord on Environmental Harmonization. The Accord's development was cloaked as a response to national unity concerns, but was also a means to achieve the efficiencies required to keep resource industries internationally competitive through guaranteeing them greater certainty over their domestic cost structure. The consensus-based decision-making structure of the Accord translates into

provincial success in putting significant restrictions on future federal unilateral action on environmental issues, as well as increasing the probability that lowest common denominator standards will prevail.[232] When viewed within the context of the provinces' historically complicit relations with resource companies, the Canada-wide Accord does not instill confidence that the mining industry will face environmental re-regulation any time soon.

6.4.2.2 Land Access

Uncertainty with respect to access to Crown lands, especially in light of the British Columbia government's decision to expropriate the Windy Craggy reserve on the Tatshenshini River for a park, is a primary concern of the mining industry and helps drive the rationale that exploration is best done outside Canada. Issues surrounding Aboriginal title are a further concern for governments and the mining industry, especially in light of the *Sparrow* and *Delgamuukw* decisions respecting Aboriginal title in the Supreme Court of Canada.[233] The Delgamuukw decision clarified that subsurface mineral rights are part of Aboriginal title, while the earlier Sparrow decision affirmed the Aboriginal rights which are ensconced in the Canadian Constitution. Sparrow also determined that Aboriginal people are not limited to a pre-colonial use of the resource.

A principal objective of the recent "Lands for Life" land-use planning strategy, undertaken by the Ontario Government and implemented as Ontario's "Living Legacy", was resolving land access issues for the mining industry. However, in bypassing meaningful consultation with affected Aboriginal communities it is more probable that greater uncertainty, not less, will be the final legacy.[234] One certainty the mining industry was able to negotiate is that mining claims in Ontario's 378 new parks and conservation reserves will be honoured, with mineralized areas re-classified as "forest reserves" and mining being allowed to proceed.[235] Initially the public were led to believe that this would represent a small fraction of the overall lands set-aside under the Living Legacy, however recently the Environmental Commission of Ontario has stated that 190 of the proposed 378 parks and conservation reserves have mining claims in them.[236]

6.4.2.3 Investment Conditions

In the mid-1990's, Canadian exploration company "Bre-X Resources" made fraudulent claims with respect to reserves on its gold properties in Indonesia, exploration spending in all mining jurisdictions in Canada fell significantly even though commodity markets remained relatively strong.[237] The Bre-X scandal created "market carnage" and, although there is a complex set of factors determining Canadian governments' complicity with the domestic mining industry in the 1990's, the Bre-X situation certainly contributed to problems junior firms were having attracting exploration investment dollars post April,

1997.

Increased competition for risk capital from more lucrative sectors (e.g. the “dot com” technology sector), again helped bolster the industry rationale, especially among juniors, that both regulatory and subsidy relief were required if the domestic industry was to survive. Other factors include mergers and acquisitions with the industry, and controls over production volumes, which affect market conditions.

7.0 Across Canada's Boreal

7.1 Atlantic

7.1.1 Overview of Mining in Newfoundland and Labrador

While two other Atlantic provinces – New Brunswick and Nova Scotia – have long and abundant histories of mining, only Newfoundland-Labrador has mining areas which are in the boreal forest region.

Newfoundland's first mineral "rushes" came early. In the 1550's three different English explorers took both tales of mineral wealth and actual ore samples back to England. One set sail with a barge full of copper, iron, lead and silver ores from the Avalon Peninsula, only to disappear in a shipwreck off Sable Island. It would take three more centuries before the first working mines would take root in Newfoundland. But by between 1855 and 1860 more than thirteen mineral deposits were being worked, producing copper, silver, galena and lead. The great majority of the early mines were in the boreal forests that swath the rugged coasts of Notre Dame Bay, the Great Northern Peninsula, and the south east coast.

Some of the early mines were more notable in terms of struggle than ore production, with rapid openings and closings, and dealmaking galore. One of the first to register as a serious producing mine was the Tilt Cove Copper Mine, just west of Notre Dame Bay. The copper was in irregular deposits, and first the miners removed ore from horizontal adits, but as surface ore became depleted they reached deeper into the heart of the hillside and worked by the light of candles stuck onto canvas hats with resin and pitch. The mines were worked from 1864 to 1917 and from 1957 to 1967; the small community grew from just three families in 1863, to become Newfoundland's first mining town by 1869, with 300 miners supporting the community's 768 inhabitants, on salaries ranging from £10 to £21 per month.

After a roller coaster ride over the next three decades, new discoveries in the smelting process meant the Tilt Cove mines could add gold and silver to their list of products, and the American market opened up. This reduced shipping costs since the ore no longer had to make the long trip to Swansea, England for smelting. The mid 1890's was a prosperous period for the community of Tilt Cove, now with a population of 1000, marked by the issuing of a 5 cent stamp depicting miners at work underground in the Tilt Cove mine. Issued in 1897, the stamp was entitled "Mining: One of the Colony's Resources", and was the first mine-motif stamp issued in the world.[238]

By the time of confederation with Canada in 1949, there had been an estimated 64 mines in production on the island of Newfoundland, primarily in the areas of

Notre Dame Bay, the southeast coast between the Bay of Islands and the Bay of St. George, and the north end of the Avalon Peninsula. Many of these were still in production, or were to reopen, including the Tilt Cove and Little Bay copper mines, and the Whalesback, Gull Pond and Rambler copper prospects. The period shortly after confederation saw a great deal of effort on the part of the Newfoundland government to encourage mineral development, including some fairly extraordinary measures, such as numerous agreements granting exclusive mineral rights. In the period between 1950 and 1970, 28 companies or individuals acquired mineral rights to almost all of Newfoundland and Labrador.[239]

The Island of Newfoundland has numerous mineral resources, including iron-ore deposits in western Labrador and at Bell Island in Conception Bay; copper, lead, asbestos, gypsum, fluorite, and talc are found on the Island; and uranium is found in eastern Labrador.[240] The mainland of Labrador consists of both the Newfoundland mainland coastal areas, and the Quebec portion, called "Ungava", which includes the principal towns of Schefferville in Quebec and Labrador City and Wabush in Newfoundland.

For the Province of Newfoundland, mining accounts for about 4 percent of the annual gross domestic product. By far the most important mineral is iron ore which accounts for more than 90 percent of the value of the province's mineral output, and, by weight, constitutes more than half of the Canadian total.

Snapshot: Labrador City

Labrador City has been host to two iron ore mines since the early 1960's. Canada's largest iron ore producer – Iron Ore of Canada – produces 18 million tonnes of concentrate from its open pit mines, employing 1,450 people in the mine, mill and pellet plant. Iron Ore Company of Canada's parent company was purchased by Rio Tinto in August 2000, making it the 2nd largest producer of iron ore products in the world. IOC has an estimated 5.5 billion tonnes of ore in reserve. The smaller operator, Wabush Mines, produces just over 6 million tonnes per year, employing approximately 440. The Wabush Mine project, including the Scully Mine, is managed by Cleveland Cliffs, on behalf of Dofaso, Stelco, Cliffs Mines, and Acme Steel.

Since start-up, both mines have deposited their tailings directly into area lakes, despite the federal Fisheries Act prohibition against doing so. As Wabush Mines explains their history, the selection of Flora Lake as a depository for the mine wastes came through a process of elimination. Long Lake was closest but is a prime fishing, cottaging and recreational lake. The next closest lake is the water supply for the town. Third to be studied was Flora Lake, 3 miles east of the plant site. Flora was not a source for town water or a favorite fishing lake, and was obscured from the hamlet of Wabush as a result of low lying hills, and so, by some logic, was deemed appropriate. Thirty years later, 3 square miles of Flora's floor is now covered with ten million tonnes of Wabush Mine's tailings. IOC puts their tailings in Wabush Lake, at a rate of 23 million tonnes per year, and have been doing so since their operations began.

The unconfined deposit of tailings into lakes is not permited under the federal Fisheries Act, and the "historic" practise of the Labraodor City operations dumping the iron ore tailings into Flora and Wabush Lake was a subject of debate during the mine effluent regulation's review in 1999. The notion of the Labrador City operations being brought into compliance was not one that was readily accepted by the companies or the provincial government of Newfoundland. Most recent indications are that the companies may be listed in a "schedule" to the regulation which allows them to continue placing their tailings in Flora and Wabush Lakes. Iron Ore of Canada is currently involved in a federal environmental assessment review of alternatives to their historical practice of in-lake tailings disposal.

Other metals mined include silver and gold. The mining of nonmetallic minerals such as asbestos and gypsum also makes some contribution to the economy. [241]

Some of Newfoundland-Labrador's current and past mine properties are outside the delineation of the boreal forest being used for this report,[242] but are within the broader boreal definition. Most notable is INCO's proposed Voisey's Bay nickel project, on the north-east coast of Labrador in the northern taiga.

The Nugget Pond gold mine is the only fully operating mine on the island, with a projected life span to 2003. In the boreal forest region of Labrador, two iron ore mines continue to operate at Labrador City.

Several advanced exploration or development projects are expected to come into production on the island, although production dates are, as always, tentative. Queenston Mining's Duck Pond is a proposed open pit copper-zinc-lead project in central Newfoundland, approximately 30 km southwest of Buchans. The project is reported to have registered under the Environmental Assessment Act in March 2000 and initial production is projected for late 2002, with full production in 2003.[243] Two new gold projects are also on the books: Richmont Mine purchased the Hammerdown gold property in March 2000, with plans to develop the property and truck the ore to the Nugget Pond Mine for processing, 142 kilometres away, extending the mill life for a possible seven years. The Pine Cove Mine is another gold property, also on the Baie Verte Peninsula, which is undergoing a comprehensive study under the Canadian Environmental Assessment Act. The EA start up date was March 1997, but no report has been produced to date.[244]

Certainly the mineral rush in northern Labrador following the Voisey's Bay discovery made mineral exploration loom larger in both the Province's ledgers and outlook, although the expenditures dropped to half of their 1998 levels by 2000. During the rush of 1995-1997 there were more than 245,000 active claims, covering more than two-thirds of Labrador.[245]

Newfoundland is one of the few jurisdictions to have fully converted to a map staking system, although some ground staked claims are still being worked. Ground staked claims can be converted to map staked claims through a simple application process. Map staked claims are 500 metres square, and can be recorded for $10 each. Mineral exploration licenses can include up to 256 claims, and are issued for 20 year terms. To maintain the claims, a minimum amount of money must be spent on mineral assessment each year, ranging from $200 per claim in the first year, to $1200 per claim for years 16 through 20. Any exploration work that may result in major ground disturbance or disruption of wild life or wild life habitat must have an Exploration Approval from the

Department of Mines and Energy prior to beginning the activity. Mineral licenses can be converted to mineral leases after the equivalent of the first 3 years of assessment work has been done and reported on, for an annual rental fee of $80 per hectare.

Newfoundland's boreal forest is host to many acid generating abandoned mines, as well as the recently closed Rambler Mine and Roycefield Resources antimony mine, which is on care-and-maintenance, awaiting change in market conditions.[246] While reports indicate there were at least 64 mines on record at the time of Confederation, the Newfoundland government currently has only 39 abandoned mines on file, of which approximately 3/4 have been verified by field inspections.[247] Several of the pre-confederations mines are now abandoned and are acid generating, including the Tilt Cove, Whalesback and Little Bay mines.

As in so many other locations across the country, Royal Oak Mines gave the Government of Newfoundland a parting gift when it went into receivership in 1999. The Hope Brook Gold Mine operated from 1978 to 1997 on the south coast of the Newfoundland. Costs are estimated at $2 million dollars, and work is expected to get underway in the spring of 2002, including removal of mine structures, construction of tailings dams, and movement of waste materials.[248]

7.2 Québec

7.2.1 Overview of Mining in Québec

One of the earliest discoveries of placer gold was in Québec's Eastern Townships, in 1823. Placer mining in the Chaudière River yielded tens of thousands of ounces of gold through the 1800's – not large volume by today's standards, but a "boom" in its own time. Other mining firsts came in 1878, with the first mining of asbestos, and in 1888, with the first asbestos mill.

By the early part of the next century, mining had the Abitibi-Tèmiscamingue region in northwestern Québec well in its grip. Mining activity later spread north, with the beginning of operations at the Springer mine in Chapais in 1953, followed by the development of deposits in the Joutel-Matagami region in 1954.

Québec's contemporary mining activity can be generally grouped into metallic minerals – copper, zinc, nickel, gold, silver, iron – which are concentrated mostly in the Abitibi region, with exception of iron, which is found on the North Shore, and non-metallic minerals – asbestos, graphite, mica, salt, silica, talk, peat – concentrated in the Eastern Townships, Beauce and the Laurentides.

There are currently 16 metal mines operating in Québec's boreal forest region, plus an asbestos mine, a wollastonite mine, and a titanium mine. Five of the mines produce primarily copper and zinc, eight are primarily gold producers, and two are iron mines. Seven smelters are operating, including Noranda's copper smelters in Murdochville and Rouyn-Noranda, QIT Fer et Titan's titanium smelter in Havre Saint-Pierre, and four aluminum smelters operated by Alcan.

Despite the high level of subsidy and financial incentives for mineral exploration in Québec, there are relatively few mine projects under development. McWatters is in the latter stages of evaluating the East Amphi Project, an underground operation near Val d'Or, with ore from the development stages sent to the Sigma-Lamaque mill for processing. Noranda's Bell Allard Mine in the Matagami region has expanded production. The Lac Doré vanadium mine, a new mine development, has been put on ice since Cambior pulled out of the project.

One very significant development in Québec has been the opening of Noranda's Magnola magnesium extraction plant in Danville, near Asbestos. The plant will produce 58,000 tones of magnesium per year, making it the second largest producer worldwide, processing approximately 300,000 tonnes per year of asbestos tailings, containing magnesium concentrations of up to 24%. While on the face of it this is a good news story, getting new product from mine wastes, the reality is that the high tech treatment processes used at the Magnola plant will produce a number of environmental consequences, including the release of dioxins, furans and hexachlorobenzene into the environment, and the production of polychlorinated byphenols (PCBs) as a byproduct of the process.[249]

The extraction process is a chlorine-based hydrometallurgical process. The tailings are leached with hydrochloric acid to produce a magnesium chloride solution knowns as brine; a silica and iron residue is also produced. The brine is then subject to chlorine gas injection to precipitate residues of nickel, boron and manganese and then dried to produce magnesium chloride. The magesium chloride granules are then melted, injected with a hydrogen chloride gas, and subjected to electrolysis to produce the magnesium, and chloride. The chloride is reacted with hydrogen to produce hydrogen chloride gas, and the magnesium is further processed into marketable products. In the midst of this process, a certain portion of the chlorine will react with the carbon of the anodes, resulting in the creation of highly problematic organochlorines.[250]

The project underwent a review under Québec's *Bureau d'audiences publiizues sur l'environment* (BAPE) process in 1997, where a technical review of the project identified the likelihood of these releases as a serious cause for concern. For example, five independant experts consulted by the Commission identified concerns with the large volume of organochlorines that will be released from the

facility as components of a slurry to be deposited in a tailings lagoon. Large amounts of these organochlorines might subsequently volatize. The Commission itself concluded that 80% of the hexachlorobenzene and 10% of the dioxins and furans might pass into the atmosphere.[251] The BAPE gave the project only conditional approval, requiring modifications to achieve the virtual elimination of organochloride releases, but in 1998 the government of Québec authorized the construction of the Magnola facility, and production began in 2001. A doubling of the capacity is planned for 2010.[252] The federal government has been criticized for simultaneously claiming that to take a leading role in reducing the release of persistent organic pollutants and standing idly by as the Magnola operation was proposed, reviewed, approved and put into operation.[253] The plant marked its first year of operations with an explosion and fire in August 2000, when an overflow in one of the cells caused the explosion and subsequent fire.

While definitely south of the boreal region, this project and its polluting effects are expected to adversely affect the boreal forest ecosystem, particularly given the long range nature of the persistent organic pollutants which will be released.

Regardless of the lack of new mine development in the province, the Québec exploration industry enjoys a high level of financial and regulatory support. Québec is consistently in one of the top two spots for exploration spending per jurisdiction, beating Ontario for the #1 spot for 1998 through 2000, and coming in second for 2001. Exploration investment was at $127 million in 1998, and saw gradual declines to $114 and $101 million in 1999 and 2000 respectively, before dropping to a projected $70 million in 2001.[254] Perhaps in response to the projected drops in company spending for 2001, the Québec government provides generous support to the exploration sector, including $3.65 million for a general mining exploration program, $5 million for a new program to support junior exploration companies in financial difficulty, and $4 million to support mineral exploration in the Abitibi region. These exploration funding programs are in addition to $3.5 million to support mining industry investments in mine development, and another $3.5 million for the government's contribution to a mineral research program.

In addition to the approximately $20 million in direct subsidies, Québec offers a number of tax advantages related to flow-through shares, and other tax credits for mineral exploration expenditures. The 2000-2001 budget included the continuation of the flow-through share program, although the Québec government has since announced an intention to replace the flow through share equity plan with direct tax assistance to companies.[255]

Québec recently overhauled its tenure system with mining claims now the only form of exploration title granted. Previous to recent changes to the Mining Act,

mineral tenure also came in the form of mining leases, mining concessions and exploration licences. The changes to the Mining Act came into force in the fall of 2000, "simplifying" the claims system, and making map staking the main method for acquiring a claim. Claim staking is now limited to a few specific areas or "staking parks", on unsurveyed territory and on Iles-de-la-Madeleine. Based on Québec's principle of "Free Mining", which – at least in theory – grants any interested party a "right" to the resource, the map staking system does not require a licence, and requires only that the applicant file a map designation notice with the appropriate identifying information. Exploration must then be done on the claims, at varied rates, depending on whether the property is north of south of the 52nd parallel, and reports filed on the work and expenditures. Mining leases may be granted for mineral development activities.[256]

The Québec government has undertaken a number of inventories related to abandoned mines, including a inventory of sites needing reclamation work in 1994, an inventory of industrial sites which was started in 1998, and an inventory of tailings deposits in 1999. In total, there area 1000 mine sites on file, of which 700 sites have had security work and 95 tailings areas have undergone remedial work.[257] The cost of rehabilitation of those areas is estimated at $80 millions to $100 million. The Québec government has stated that it would be prepared to cover 50% of the costs and has asked that Ottawa and the mining industry be responsible for the remaining 50%.[258]

In 2000, the Ministère des ressources naturelles did some rehabilitation work on the Sullivan mine site, while carrying out other work on abandoned mine sites in the Abitibi-Témiscamingue and Gaspé

Snapshot: Arsenic-laden Tailings at Duparquet

The gold deposit in the village of Duparquet was discovered in the 1920`s and mined from 1933 to 1957. The ore contains arsenic, sulfur and antimony. In 1937 a roaster was installed to increase the recuperation of gold by eliminating arsenic from the concentrate. Twenty years later, the company ceased operating, leaving on the site with some 10,000 tons of arsenic stored in three cement reservoirs. In 1976, Eldorado Gold Mines bought the site in order to use the roaster for molybdenum concentrate.

In 1981, cracks were discovered in the cement reservoirs. In response, Eldorado emptied two of the reservoirs into sealed barrels and partially patched the third one. Between 1981 and 1987, Eldorado Gold Mines managed to sell half of the 2,500 forty-gallon barrels, and, in 1990, the remaining arsenic was transferred into plastic containers.

In 1981, the Department of Community Health carried out a study to measure the level of arsenic contained in the urine and the hair of three distinct groups from Duparquet: the workers who had handled the arsenic, children below age 15, and a certain number of adults.Workers registered very high levels of arsenic, and the studies also revealed that the levels of arsenic present in the urine of the children of Duparquet were higher than those of La Sarre, the reference town. The Department of Community Health made a number of recommendations, including the decontamination of play areas for the children. To date, much of the arsenic that has been transferred to plastic barrels has been re-transferred into a cement reservoir. Given that the reservoir is less than totally watertight, arsenic is still leaking from the tailings area. Today, there is concern that in the long-run this arsenic might contaminate the phreatic table. There is also a concern that water runoff from the tailings area may end up in Lake Duparquet, a popular recreational lake.

regions. Work included the installation of an experimental biofilter on the Wood Cadillac site, and continued treatment of contaminated effluent at the East Sullivan site. Work was also carried out on 48 dangerous mine openings, mostly in the Eastern Townships and Outaouais regions.[259]

In total, there are an estimated 385 mine tailings sites in Québec, with more than half of them in Abitibi, covering 13,650 hectares, with 40% located in Abitibi.[260] Almost all of Québec's one hundred or so acidic tailings areas are located in Abitibi.[261] Approximately 3,000 have been reclaimed to date, for an estimated costs of $115 million. An investment of an additional $225 million would be required for the reclamation of tailings areas located on sites still in use, and approximately another $75 millions for inactive sites. The reclamation of "orphan" sites where the owners cannot be found or have become insolvable, would cost an estimated $40 million.[262]

It is only since the late seventies that Government introduced regulations aimed at reducing pollution created by the mining industry, and it is only since 1995 that mining companies have been required to prepare a site reclamation plan and deposit, in trust, funds required for implementation of the closure plan.

7.2.2 Case Study: Abitibi Tèmiscamingue

7.2.2.1 Introduction

The first evidence of an important gold-bearing vein in the Abitibi-Tèmiscamingue district was discovered by James O'Sullivan and Hertel Hauthier in July, 1911. In 1915, in the Val d'Or area, prospector Stanislaw Szyszko discovered the deposit that was to become the Siscoe Mine. The next year Edmund Horne discovered an important copper-bearing deposit.

A decade later, the mineral processing industry in Abitibi was born around 4:00 o'clock in the morning of December 17, 1927 when the Noranda foundry produced its first copper casting. In the Val-d'Or area, the Siscoe Mine delivers its first two bricks of gold in 1929.

7.2.2.2 Overview

Mining activity peaked in the mid-1960's, when some 50 mines were in operation. However, through the years, it has fluctuated considerably. Today, only some 15 mines are operating.

The declining number of mines was not accompanied by a decline in the quantity of mineral that is being processed. More than 19 million tons of ore were extracted in 2000, 7 million tons more than when there were three times as many mines in the region.

From the beginning of the first mine's operations until the year 2000, 195 mines were active in Abitibi-Témiscamingue. In total, they produced 2,000 tons of gold, 6,650 tons of silver, 16,000 tons of nickel, 28,000 tons of lead, 5.2 million tons of copper and 6.7 tons of zinc. Over a period of 73 years, 11 million tons of metal were extracted from the region. While those numbers may sound enormous, but in contrast to the total amount of ore mined – over 608 million tons – the volume of metals derived is relatively small.

7.2.2.3 Issues

Water Quality

In 1978, the Bureau for Studies on Toxic Substances (BEST) conducted an analysis of watercourses in the Rouyn-Noranda region. Around the same time, the Service for Water Quality of the Department of Environment and Fauna (MENF) also collected water samples in a dozen lakes and rivers near Rouyn-Noranda and Val d'Or.

These two studies revealed that lakes Dufault, Pelletier, Rouyn, Séguin and Trémoy are all displaying serious impairments of water quality, due to elevated levels of copper, cadmium and/or zinc. Additionally, the concentration of mercury and cyanide were very high in certain lakes. The majority of the rivers studied showed levels of copper and zinc in excess on an quasi-continuous basis, while cadmium was a frequent minor problem.[263]

Later studies, conducted by the Department of Natural Resources between 1994 and 1997 to examine water quality around Val d'Or, Cadillac and Rouyn-Noranda, showed that certain lakes and rivers remained heavily polluted while others had achieved a certain level of improvement over the readings of 1978.[264]

Mining activities do not pollute only the surface water, but also the sediments. Studies undertaken by the BEST and the National Institute for Scientific Research (INRS), some 20 years ago, confirm the presence of significant quantities of metals in the sediments.[265]

Impacts on Wildlife

While it is not possible to know the full impact of mining activities on the regional aquatic ecosystems, two important studies carried out by the BEST and

the INRS some 20 years ago do provide some general indication. The studies demonstrated, at the time, that life was virtually absent from lakes Osisko, Rouyn, Pelletier, Arnoux and a portion of the Bourlamaque river. Fish in eight other lakes were contaminated by significant concentrations of mercury, arsenic and cadmium.

In lakes Montbeillard, Beauchastel and La Bruyère, the flesh of a variety of mollusks was found to be highly contaminated by copper and zinc. The samples were collected in three lakes that were not among those most affected by mining activities. A study carried out by BAR Environment on the site of the Poirier Mine also showed a decrease in the biodiversity of dipterous insects, a category of insects with a single pair of wings.

Impacts of Air Emissions from the Horne Smelter on Human Health

While the extraction and crushing of minerals do not generate significant air pollution, air discharges from smelters and refineries generally have a profound and negative impact on local and regional air quality.

Smelters discharge sulphuric acid, contributing to – or causing – the acidification of lakes and rivers and impacting on vegetation. For example, twenty years ago there was a 4 square kilometre area with no vegetation north-east of Rouyn-Noranda. That this "kill zone" was the result of emissions from Noranda's Horne smelter has never been questioned.

The smelter also discharges particles of metals in the air : arsenic, cadmium, copper, lead and zinc. In 1978, a study of the Bureau for Studies on Toxic Substances revealed high concentrations of metals in the soil within a radius of several kilometres around the facility. At that time, the Horne smelter was spewing 552,000 tons of S02 into the atmosphere. Under public pressure, the figure had been reduced to 80,000 tons by 2000, and is projected to fall to 50,000 in 2002. In 1988, the Horne foundry discharged in the air 1,573 tons of metals. The discharge of lead alone reached 850 tons. By 2000, the figure reported for discharge of metals was 255 tons.[266] Despite these improvements, the fact remains that the smelter has had a profound impact, including the acidification of watercourses in the region and heavy metal contamination of the soil and fauna.

In the past, residents of Rouyn-Noranda have often expressed concerns about the impact of the smelter's operations had on their life, including respiratory problems, and sudden die-off in local vegetable gardens. Even today, the emissions often damage the paint on cars. Noranda has not denied its responsibility, even paying the bill for numerous paint jobs. A part of the population has been forced to learn how to live with dust that settles on their property, gets into their houses, and dirties clean clothes hung to dry on back yard clotheslines.

In 1979, a first public health study on a small group of children revealed higher levels of lead in the blood of the children from the Notre-Dame neighbourhood – located closest to the smelter – than anywhere else in Rouyn-Noranda or in the city of Évain. In 1989, a screening was done to verify if some children in the neighbourhood had high levels of lead in their blood. At the time, regional health authorities determined that the level of lead present in the blood of young children should not surpass 100 mg/L.[267] The screening reached most of the children between age 2 and 4 in the Notre-Dame neighbourhood, and results indicated that 50% of the children had plasma lead levels exceeding 100 micrograms per litre (mg/L). In its final report, the Department of Community Health (DSC) recommended that soils be decontaminated and that discharges be reduced.

A task force was set up to find concrete solutions to the problem. The committee was made up of citizens from the neighbourhood, representatives from the city of Rouyn-Noranda, of the company, of the Department of Environmnent and of the DSC. In its intervention plan, the group proposed that, by 1995, no more than 10% of children between age 1 and 5 in the Notre-Dame neighbourhood should display plasma lead levels exceeding 100 mg/L. To achieve this objective, various corrective measures were implemented, including soil decontamination and a reduction of the sources of lead emission in the air at the foundry, as well as improved hygiene habits in the affected families.

Following the soil decontamination of 80% of the residential properties in the Notre-Dame neighbourhood in 1990-91, only 25% of the children had plasma blood levels exceeding 100 mg/L. In 1993, a third screening of plasma lead level was undertaken with the children of the same neighbourhood for the purpose of measuring the impact of the work done to reduce certain sources of diffused and fugitive emissions of heavy metals. The proportion of children with plasma lead levels exceeding 100 mg/L had dropped by half, going from 25% down to 13%. Moreover, not a single child displayed a level over 150 mg/L. A last screening took place in 1999. Of the 98 children identified, 95 participated in the screening. The geometric mean of plasma lead level was slightly below 50 mg/L, the level corresponding to the upper limit of normality according to data from the Toxicology Centre of Québec. As in 1993, no children displayed plasma lead levels above 150 mg/L. This last screening also showed that only 6% of the participating population had plasma lead levels exceeding 100 mg/L, confirming that the objectives of the five year intervention plan (1990-95) had been met. Tests results also revealed a systematic decrease in plasma lead levels exceeding 100 mg/L between 1989 and 1999. It was the first time that this proportion had fallen below the 10% mark.[268]

While the results are very positive in terms of the decreasing levels of lead in children's blood, it must be noted that release of particulate matter, as measured

by the instruments of the Department of Environment, has not really diminished, meaning that lead continues to be discharged, and presumably to concentrate in the soil, albeit at a rate probably reduced from the period prior to 1990.

In 2000, the DSC proceeded to analyse a small quantity of soil samples from the eastern part of the neighborhood (the sector that had been almost completely decontaminated in 1990-91). The soil in the zones located immediately to the south of the smelter reached contamination levels in the area of 500 ppm, a figure 10 times higher than the levels found in the replacement fill used during the decontamination operations of 1990-91. This renewed contamination decreases progressively as the distance from the smelter increases.[269]

If this situation continues, children run the risk of becoming re-contaminated. Since lead is present in the child's environment in slowly increasing quantities every year, all that is required is for the child to be exposed to it long enough and his/her plasma lead level will go up. Since 1993 the average plasma lead level among the children has not gone down. This is perhaps the result of accumulation in the soil. Therefore, the problem cannot be considered dealt with.

7.3 Ontario

7.3.1 Overview

Canada's first metal mine opened in 1850, in Bruce Mines, on the north shore of Lake Huron in northeastern Ontario.[270] Two of the first discoveries of major deposits, copper-nickel ore at Sudbury in 1883 and silver at Cobalt in 1903, were both made accidentally by railway blacksmiths, who were forging the way west or north for agricultural settlement. Discoveries in the Timmins camp followed soon after, with the Dome Mines Company Limited forming in 1910 and producing its first 214 ounces of gold and 19 ounces of silver by the end of the same year. The Dome Mine, the foundation stone for what is now Placer Dome International, has been in continual production for more than 90 years.

Ontario continues to have the largest metal mining sector of all the provinces in Canada, and accounts for one-third of Canada's mineral production.[271] Ontario's mining industry generates $5 to 7 billion each year (including aggregate materials), primarily through exports, with nickel, gold and copper generating the greatest value. Approximately 18,800 people are employed directly in Ontario's mines and quarries and associated smelters and refineries.[272] Currently, there are 37 metal mines in operation in Ontario, 14 of them located in the boreal forest region.[273]

Over 6,000 inactive or abandoned exploration or mining sites litter the province.[274] Ontario's Ministry of Northern Development and Mines announced a $27 million commitment to an abandoned mines rehabilitation program in 1999, with an emphasis on "eliminating risks to public safety" through the capping of abandoned mine shafts, removal of mine structures, and backfilling physical hazards, such as pits and trenches.[275] To date, approximately $5 million has been spent on remediation of physical hazards, and $9 million has been spent or committed to the first phases of environmental clean up at the Kam Kotia mine site near Timmins. While the abandoned mines program is a very positive development, its overall benefit has been offset by changes to mining legislation over the last half decade which have weakened requirements around mine closure. In particular, changes have been instituted to replace the requirement for real financial assurances to cover closure and post-closure costs with financial means tests for some companies. There is no public or independent review of the amount of money that is to be set aside in closure bonds, companies are not required to disclose the amount of funds they have set aside for mine close-out, and the information is not available through the access to information law. Ministry staff no longer review and approve closure plans – they "accept" plans that have been prepared and approved by the companies – but companies can now request an "exit ticket" which allows them to hand mined-out properties back to the crown, after having met their closure plan requirements.

Snapshot: Acid Mine Drainage at Kam Kotia

The Kam Kotia Mine, located 15 km northwest of the city centre of Timmins, was originally operated as the "Wartime Metal Corporation" from 1942 until 1961. In 1961, the property was acquired by Kam Kotia Mines Ltd., principally owned by Robison Mines Ltd., and was operated until 1972, when it was abandoned, becoming a public liability. The site includes a partially filled open pit, old mill remnants, 200,000 tonnes of waste rock, and over 400 ha containing 6 million tonnes of impounded and unimpounded tailings.

The Kam Kotia mine tailings are reported to have the highest tailings sulphide concentration in Canada and are strongly acid generating. Surface water runoff from the site is very acidic, and has been reported at pH 1.8 - 2.5, and containing elevated levels of arsenic, zinc and copper. It has been estimated that 35,000 tonnes of tailings are currently clogging the Kamiskotia creek bed, much of which is flushed out and replenished on an annual cycle. Cost of rehabilitation has been estimated to be as high as $50 million for this single site. To date, the province has committed $9 million towards cleanup, and engineering studies have been completed for the first two phases of remediation work.

Mineral exploration in Ontario is heavily subsidized, through both direct grants to mining industry associations, government funded mineral reconnaissance and research, and flow-through shares, which provide tax benefits to those who invest in mineral exploration, regardless of whether a mine is ever found. Last year, the provincial government announced $4 million in direct funding to help restructure the Ontario Prospectors Association. One of the largest areas

"It is part of the Mike Harris government's ongoing support for the mining industry and it is one of the reasons Ontario was last year ranked by the Fraser Institute as the top jurisdiction in Canada – and number three in the world – for mineral potential and mining investment attractiveness."

Hon. Dan Newman, Ontario Minister of Mines, July 2001

of subsidy to the mineral exploration sector is in the direct funding by government of research and development for the mineral exploration business, including a $29-million Operation Treasure Hunt investment announced in July 2001 to generate “new geoscientific data that promotes Ontario’s standing as one of the best jurisdictions in the world for mineral exploration.”[276] In 2000, the Province announced an $8 million program to develop advanced technologies for mineral exploration.[277] Perhaps one of the most environmentally threatening of the Province’s financial incentives is the re-introduction of flow-through shares; a move that has been matched by the federal government. The programs provide tax breaks for those who purchase a “flow-through share”. The federal government provides a 15% tax credit, and the Province a 5% tax credit.[278]

7.3.2 Case Study: Operations at Placer Dome’s Campbell Mine

7.3.2.1 Introduction

Placer Dome Incorporated (PDI) is an international operation, with its roots in northern Ontario. Now stretching around the globe, the company has attracted international attention, both as a major gold producer and as a key player in environmental crisis, such as the Marcopper tailings spills in Marinduque in the mid-90's. Placer Dome has three operating mines in northern Ontario- the Dome Mine, near Timmins, Musselwhite, north of Sioux Lookout, and Campbell, in Balmerton near Red Lake – and two closed mines, Dona Lake and Detour. All are gold mines. Each brings its own particular set of concerns to the discussion of mining in Ontario’s boreal.

7.3.2.2 Overview

The Campbell Mine is a gold mine owned by Placer Dome and located about 180 kilometres north of Vermillion Bay, in the small community of Balmertown, near Red Lake. Campbell Mine has produced more than eight million ounces of gold since production began in 1948. Most of the employees reside in Balmertown (population of 1,500), with others in the town of Cochenour (population 1,000) 6.5 km to the northwest, or in the Town of Red Lake (population 3,000), 13 kilometres southwest of the mine site.[279]

Owned by Placer Dome Incorporated and operated as the Campbell Mine, the Campbell Mine and the adjacent Red Lake Gold Mine currently owned by Goldcorp Inc. were discovered during the 1940's gold rush. The Campbell Mine was incorporated in 1944 by the brothers who had staked the property. Dome Mines optioned the property in late 1944, and completed the initial exploratory drilling which discovered the high grade low sulphide "A" zone. Six main ore

zones and numerous scattered quartz carbonate veins were subsequently discovered and expanded to constitute the contemporary ore body.

The mine produces approximately 1,500 tons of ore per day, with the mine operating on two 8 hour shifts per day. The mill runs continuously, with three 8 hour shifts per day. The catchment area for Campbell Lake tailings facility is 520 hectares. The mine property includes the mine complex, the main tailings pond, the abandoned tailings areas, the primary and secondary treatment ponds, and natural ground to the west of the tailings ponds.[280]

The underground mine is accessed by a shaft that was developed in 1946 and has been deepened on four separate occasions to a depth of 1,316 metres. In 1995, the Campbell Mine Depth Development Project was approved by the Placer Dome Inc. Board of Directors. Phase I consists of a new shaft (1,920 metres below the surface), associated surface facilities, a service decline from 27 level to 30 level (1,356 metres below the surface) and secondary stope development.[281]
Sub-level longhole mining was introduced in 1989 and is now the predominant method of extraction at Campbell Mine. Mercury amalgamation was used for the recovery of free gold until 1982. In 1991, the roasting circuit used to concentrate the gold was replaced with a pressure oxidation circuit, resulting in a reduction of arsenic levels in water and air discharges. The INCO SO_2/Air treatment process was added in 1992. Control points were also moved, effectively removing Balmer Lake from the tailings management system.[282]

7.3.2.3 Issues

Arsenic in Balmertown Neighbourhood
If there is a villain in the Campbell Mine cast of environmental contaminants, it is arsenic. Arsenic-laden tailings in the backyards of Balmerton, 20,000 tons of arsenic trioxide lying deep in the Campbell Mine, and an arsenic plume steadily making its way to Red Lake.

From 1949 through to 1960, tailings were discharged into Detta Lake and the area bordering on 6th and 7th Streets, now a residential part of Balmertown. The tailings were the waste products from the milling process during the first years of operation of the roaster, the use of which resulted in high levels of arsenic in the air and water discharge. As a result, arsenic levels were high in the neighbourhood where the tailings had been deposited. A 1992 a monitoring program found arsenic concentrations from 500 ppm to 1000 ppm at a depth of 0 m to 1 m below the yards.[283] In 1995, Placer Dome contracted the consulting firm Gradient Corporation from Cambridge Massachusetts to conduct an arsenic exposure assessment. Gradient found that those living in the Balmertown neighbourhood built on the tailings had higher levels of arsenic in their urine than

the other groups.[284] Subsequent to that report, Placer Dome Canada has maintained the course set out in the closure plan, ie., that no plan for immediate remedial action is necessary, and that the environmental programs established in 1992 would continue at a reduced pace.[285]

Arsenic Plume from the Tailings

Studies to date have established that there are arsenic pyrites in the tailings, and that some of the arsenic has migrated down to the aquifer. The current tailings impoundment area began receiving depositions in 1983. The tailings impoundment has an underlying layer of clay. Beneath the clay is a layer of sand, which is the host to the local groundwater aquifer. Below the sand are strata of till and bedrock. Several years ago groundwater sampling showed that arsenic from the tailings had penetrated the clay below the tailings impoundment and had reached the underlying aquifer, and that the groundwater was flowing toward both Balmer Lake and Red Lake. The majority was flowing toward Red Lake.[286]

Two plumes are travelling toward Red Lake. The frontrunner is a plume of dissolved sulphate. The other is an arsenic plume travelling at a slower rate. Studies over the last several years have measured the volume and rate of groundwater movement, estimated the presence of arsenic within the plumes, and developed estimates of the potential for attenuation or adsorption of the arsenic prior to the groundwater discharge into Red Lake. The potential for arsenic adsorption might be reduced, given the plume of dissolved sulphates that is traveling ahead of the arsenic plume.

Studies done in the early 1990's indicated that these groundwater plumes will report to Red Lake in three or more locations. There is an aquifer discharge directly into Red Lake, there is seepage into a stream entering McNeely Bay, and there is seepage into a marshy area adjacent to Red Lake. The aquifer may also discharge into the mouth of McNeely Bay. The earlier studies estimate that the dissolved sulphate plume has migrated approximately 200 metres from the tailings area towards Red Lake, and will reach Red Lake in 10 to 20 years. The arsenic plume was predicted to reach Red Lake in 30 to 55 years.[287] More recent estimates are that the arsenic could reach Red Lake within five years.[288] Estimates of potential arsenic loadings range from 170 kilograms per year to 2500 kilograms per year. Continuing to place the tailings in the current impoundment area is expected to result in higher groundwater velocities, which in turn could mean speedier migration of the arsenic from the tailings to Red Lake.[289]

Arsenic Underground

Between 1975 and 1991, an estimated 20,000 tons of arsenic trioxide was air-blown into the underground workings at the Campbell Mine. The Company reported in its 1995 closure plan that no detailed records are available, so the

20,000 tons is only an estimate. The Company also reported that it had no plan for the long term control or containment of the arsenic trioxides.

Arsenic trioxide is a known carcinogen, with no safe level of exposure. Skin contact can cause irritation, burning, itching, thickening and colour changes. Breathing arsenic trioxide can irritate the nose and throat and can cause ulcers and/or a hole in the inner nose. Exposure can cause poor appetite, nausea, stomach cramps, vomiting, diarrhea and even death. Arsenic trioxide may also damage the nervous system, causing numbness, "pins and needles," and/or weakness in the hands and feet. In the presence of acid or acid mist, Arsenic trioxide may release a very deadly gas called *Arsin*e.[290]

The 1995 closure plan says that Placer Dome was receiving assistance from the Ontario Waste Management Corporation to review options for the treatment of the arsenic trioxide stored underground, and acknowledges that it did not – as of 1995 – know if it would be possible to remove the arsenic from the underground stopes in a manner that was safe and environmentally responsible. The plan does describe an "alternate reclamation plan" which consisted of simply leaving the arsenic trioxide uncontained in the stopes, sealing the bulkheads to minimize water flow, and pumping the water from below the levels where the arsenic trioxide is placed. In the longer term, the mine would be allowed to flood.

Finally, the closure plan states that a number of studies related to the closure were in progress at the time of writing, including a study on the management of the arsenic trioxide stored underground. The Ontario Waste Management Corporation (OWMC) was identified as the responsible agency. However, the OWMC had ceased to exist by late 1995.

In 2000, five years after filing the closure plan, Placer Dome indicated that they were restarting their search for an environmental solution to the arsenic trioxide problem. Company representatives recounted how, after the closure plan was submitted, they realized they could not find a safe method for removal, and so decided to defer action for a period of time, in the hopes that a better option would come along. Placer Dome was spurred back into action, in part, by developments around a Royal Oak property in the Northwest Territories with a similar problem, on an even larger scale. When Royal Oak collapsed financially last year, responsibility for the Giant Mine and its 270,000 tonnes of arsenic trioxide transferred to the federal government. A project team was established by the federal government, and given a year of funding with a mandate to focus on Giant's arsenic stockpile. Placer Dome was hoping the fed's would find a way out for the mess at the Giant mine – which they have not – and PDI could follow suit. However, the Company is by no means committed to going down the same path.[291] More recently, Placer Dome officials have indicated that they are

expecting to bring the materials to surface for treatment. Details on the timeline and treatment methods are not yet established.[292]

7.3.3 Case Study: North American Palladium's Lac Des Iles Mine

7.3.3.1 Introduction

North American Palladium, Canada's only primary producer of palladium, operates a large open pit mine 85 kilometres northwest of Thunder Bay. The Lac des Iles Mine recently began commissioning a major expansion, moving from a 2,400 tonnes per day mill production to 15,000 tonnes per day by the end of the year, with an expected mine life of 11 years. The massive scale of the mine will be visible from a distance, with waste rock piles towering above the local terrain at 80 metres high, twice the height of the highest natural feature in the region.

7.3.3.2 Overview

Platinum group mineralization was discovered in the area in the 1960's. Products from the mine are palladium, platinum, gold, copper and nickel. It is the only developed mine in the area, which is otherwise used mainly for logging, trapping and some recreation; there has been a high level of exploration in the area in recent years, primarily for platinum group metals.

Mine production began in 1993 and ran at 2,400 tonnes per day until the expansion, which was commissioned in June 2001. The mine is expected to be to full production of 15,000 tonnes per day by the end of the year. The expanded mine is projected to provide for 5% of the world's annual palladium supply by 2002. Concentrate from the mine is trucked to Sudbury for custom processing and then to Europe for refining. The size of the property is currently 8014 hectares and landholdings total 15,000 hectares. Between 1993-2000, 7,627,055 tonnes of ore and 23,448,980 tonnes of waste were mined. Projected mining for 2001-2011 is 70,901,400 tonnes of ore and 154,483,000 tonnes of waste.

1997 to 2001 has been a period of tremendous change for the Lac des Iles Mine. In 1997, Lac Des Iles was operating as a high grade, low tonnage open pit mine and reported a $70.2 million loss. With the massive expansion, the mine will become a low grade, high tonnage operation. NAP reported a $37 million net income for the first nine months of 2000 – the first profit making year since operations started in 1993.[293]

At full production, the Lac Des Iles Mine will be producing approximately 15,625

pound of palladium, 1,500 pounds of platinum, a thousand pounds of gold, 6 million pounds of copper and 2 million pounds of nickel per year. The mine is the biggest palladium producer in Canada, with a workforce of 130 people pre-expansion, expected to rise to 275 at full production. The current expansion includes the construction of a new mill, warehouse, maintenance shop, assay laboratory and water treatment plant in addition to the expansion of the mining operation itself.

Palladium is used in autocatalysts to reduce hydrocarbon emissions from gasoline engines, as well as in electronics, dental work and jewelry. Platinum group metals are experiencing an all time high demand, and traditional sources in Russia are potentially shaky. The other primary producer in North America is the Stillwater mine in Montana, which has also recently undergone a major expansion.

7.3.3.3 Issues

No federal EA

The expansion of the mine from 2,400 t/d to 15,000 t/d has not been assessed under the *Canadian Environmental Assessment Act*. Under federal environmental assessment law, any mine expansion that would increase ore capacity by 50% or 1,500 tonnes per day is to go through a comprehensive study – a more thorough review than simple projects require – because, as the regulation states, "certain projects are likely to have significant adverse effects" given their size. But, according to sources in the provincial government, the company has "worked with the Department of Fisheries and Oceans" in order to avoid having to do an environmental assessment of the expansion. Provincial reviews have been piecemeal, with the Ministry of the Environment amending already existing approvals to accommodate the increase in mine effluent treatment and discharge and air discharges, and the Ministry of Northern Development and Mines accepting an amended closure plan.

According to industry reports, the mine received the necessary construction permits just 60 days after deciding to expand.[294] The Department of Fisheries and Oceans took more than twice that time to respond to public inquiries about the federal review of the mine expansion.

Under the Canadian Environmental Assessment Act, potential triggers for a review include permits for the destruction of fish or fish habitat, including destruction through the deposit of deleterious substances – such as mine effluent – into waters occupied by fish. The Lac des Iles mine expansion includes numerous areas of environmental concern, including impacts and activities which seemingly fall into those categories which should have triggered a federal review,

including:

- installation of a sewage treatment plant
- new mill and concentrator plant, expanded open pit
- living complex including kitchens and recreational facilities, and related infrastructure
- dewatering of the Walter Bog
- water-taking of 30 million litres per day, through pit dewatering and taking from Lac des Iles
- discharge of mine effluent from multiple discharge points into Camp Creek and Hasson Lake
- construction of additional dams for tailings impoundment, including in an area with fish habitat

Water Quality Impacts

To date, the Lac des Iles has experienced some difficulties in meeting water quality standards for their mine effluent, including incidents in 1997 when effluent failed toxicity tests, and in 1998 when effluent exceeded the total phosphorus limit. Perhaps of greater concern is the potential for long term water impacts in the future, as a result of acid mine drainage and subsequent metal leaching. A review of the mine closure plan by Northwatch, a regional public interest group, revealed that characterization of mine waste had been carried out on only 11 tailings samples to determine potential for metal leaching, and only five samples of tailings have been assessed for acid generating potential. The five samples were assessed for acid mine drainage potential using acid base accounting and were found to have a strong net neutralizing potential. One leach test was performed on a single tailings sample (using a method in Ontario Regulation 309), and from this one sample it was determined that the tailings mass is not leachate toxic waste. Furthermore, only tailings have been sampled whereas the *Mine Rehabilitation Code of Ontario* requires that all materials remaining on site be sampled for AMD/ML e.g. waste rock, pit walls, drill core.[295]

Discharges from the tailings at DAM 4A and from the water treatment plant south of the mill drain to Second Pond. A third discharge point is to be established at DAM 2 of the tailings and will flow via Camp Creek and via surface drainage into Hasson Lake. Hasson Lake receives mine effluent from the mine via Second Pond and these two waterbodies act as the “mixing zone”, so that the outflow of the Hasson Lake should meet Provincial Water Quality Objectives (PWQOs) or conform to background concentrations.[296]

According to the closure plan, baseline water quality assessment was completed

but no post-operations monitoring was evident from the closure plan. The mine has been operating for 8 years.

Impact Benefit Agreement

The Company "certifies" that it has carried out reasonable and good faith consultations with the appropriate representatives of all Aboriginal peoples affected by the project, and states that there are no inhabited or uninhabited reserves located in the same watershed, ie. Lake Superior. North American Palladium correctly identifies that the nearest inhabited Aboriginal community is the Gull Bay First Nation, located approximately 80 km north of the mine site.[297]

Both the company and Gull Bay First Nation acknowledge that there have been some discussions between the two parties, with the company describing itself as having entered consultation with the Gull Bay First Nation regarding mine related employment and business opportunities.[298] Gull Bay First Nation has broader objectives. Gull Bay First Nation has identified a number of mining-related environmental impacts that could adversely affect their unceded traditional and treaty rights in and around the operation's area. They want to be included in planning, and want to share in the benefits of the mine, including through training and job opportunities, as means of mitigating adverse impacts on their Aboriginal and treaty rights. They want compensation for adverse consequences of mine operation on the environment and their traditional lifestyle. Gull Bay First Nation places their aspirations in the broader context of self-sufficiency and self-determination.

To date, there have only been some initial discussions between North American Palladium Ltd. and the First Nation.

7.3.4 Case Study: Closure at Barrick Gold's Renabie Mine

7.3.4.1 Introduction

The Renabie Gold Mine, now closed, is located 20 km east of Missanabie in Ontario, and straddles the height of land between the watersheds of Lake Superior and Hudson Bay, in the heart of the land claim area being negotiated by the Missinabi Cree First Nation. The joint owners of the property, Homestake Canada Inc. (55%) and Barrick Gold Corp. (45%) have applied for an "exit ticket" for the Renabie Mine, asking the provincial government to allow them to "surrender" the land back to the Crown. This means that for a one-time payout – in this case a nominal fee of $102,290[299] – the companies will be exempted from any further liability for the site, even if it arises as a direct result of the companies' past operations, actions or inactions.

7.3.4.2 Overview

The mine operated from 1947-70, 1974-76 and from 1981-91, and the mine site was badly managed throughout its operations. Approximately 17 tailings spills into nearby Braminco Lake occurred between 1982 and 1984. The mine released highly toxic effluent discharges resulting in contamination of sediments and waters downstream of the mine.[300]

Current conditions are those of a mine site which is far from remediated. Surface water flowing from the property contains elevated levels of zinc, cobalt, iron and copper. Acid mine drainage/metal leaching potential has not been fully assessed. There is a gaping hole on site where a crown pillar of the mine failed.

7.3.4.3 Issues

Unstable Ground

An engineering assessment of ground stability in 1992 concluded that there was "very high probability of long-term crown pillar stability" and that "very little additional site work would be required to ensure a successful rehabilitation."[301] In 1995 reclamation and clean up of the Renabie Mine was identified as having been completed, with the only outstanding issue being vegetation sustainability of the tailings area. Then, in 1998, two small sinkholes were noted at the former mill site. Even more dramatic, however, was the partial collapse of one of the crown pillars in 1999, leaving a gaping hole through to the underground workings. As a result, additional reclamation work has been required, including the filling of sinkholes and fencing off the area of crown pillars, as well as repairing areas of erosion in the tailings area.

Questionable Water Quality

As a result of toxic effluent and tailings spills into Braminco Lake, the mine incorporated Braminco Lake (renamed pond 4) and a swampy area downstream (renamed pond 6) as additional waterbodies for polishing effluent. Towards the end of the mine life, additions of lime, ferric sulphate and hydrogen peroxide were made to ponds 4 and 6 in order to breakdown cyanide and precipitate heavy metals so that mine discharges would comply with permitted limits. Pond sediments then became highly contaminated, with samples showing levels as high as 4,000 mg/L cyanide and 8,000 mg/L zinc.[302] Annual freshet flushing of tailings, notably of cyanide species, are expected to continue indefinitely at the mine.[303]

Surface water at the outflow from the mine does not meet Provincial Water

Quality Objectives, showing exceedances for zinc, iron, cobalt and copper. It appears that background levels have not been scientifically established for the outflow and documentation discussing a mixing zone beyond the outflow from the mine is absent. Based on water quality, closure work at the Renabie Mine has not met the requirements of the Mine Rehabilitation Code of Ontario, which stipulates that surface water quality of a closed site must meet Provincial Water Quality Objectives, or scientifically established background levels, or that the proponent may use a mixing zone based on a sound rationale. The Ministry of Northern Development and Mines has responded to these concerns by saying that the closure plan was received in 1991 and approved in 1992, and so was "grandfathered" into the new legislation. By MNDM's reasoning, this means that Renabie is not subject to today's standards.[304]

Acid Mine Drainage and Metal Leaching

The Renabie Mine includes over 5 million tonnes of tailings as well as a significant amount of waste rock. Information provided on the acid mine drainage and metal leaching (AMD/ML) potential of this mine waste, as described in the closure plan, is inadequate. A single study on AMD/ML potential at Renabie determined that the tailings have a higher sulphide content than waste rock and they were found to be only marginally non-acid producing. The study also found that newer tailings have higher concentrations of sulphides than older tailings.[305] Assessment of AMD/ML at Renabie Mine does not appear to comply with standards set out in the Mine Rehabilitation Code of Ontario. Acid Mine Drainage prediction work was inadequate with no kinetic testing and no review of metal leaching potential. Sampling of materials disturbed by mining was minimal and not necessarily representative.

Metals Uptake by Wildlife

The Missanabie Cree First Nation reports that many forms of wildlife make extensive use of the tailings areas of the Renabie Mine, which is also located in the Chapleau Crown Game Preserve. The First Nation have posed a number of questions with respect to possible impacts of wildlife consuming salts on the tailings surface and vegetation on the tailings with potentially elevated levels of metal, asking whether and how wildlife is affected by the mine and mine wastes, or if there are any related impacts on human health as a result of consuming the wildlife.[306] The Ministry of Mines has responded to these concerns by stating that there is little information about the uptake of metals by wildlife, and that there are no standards related to cadmium levels on Ontario moose and deer.[307]

Exit Ticket

The application for the Renabie Mine "exit ticket" is the first such application in Ontario under the amended Mining Act. Prior to the amendments coming into force, companies retained responsibility for mining properties and their associated

liabilities indefinitely. A public notice of June 28, 2001 of the proposed transfer of title (i.e. the "exit ticket") was posted on the Ontario Environmental Bill of Rights electronic registry with a 30 day comment period.

Under the new Mining Act, a new mechanism was created to allow the surrender of mining lands to the Crown. Section 183(1) of the Mining Act, states that:

> *183. (1) The owner, lessee or holder or any mining lands or mining rights granted under this Act or any other Act may surrender such lands or mining rights to the Crown only upon such terms as are acceptable to the Minister, and thereupon the Minister may cause a notice of determination to be filed in the proper land registry office.*

Section 183(1) of the Mining Act (above) is vague in its conditions for granting an "exit ticket". However, the Ontario Ministry of Northern Development and Mines (OMNDM) claims that "the Renabie Mine has been rehabilitated in accordance with the Mining Act", as justification for the "exit ticket".[308] Other amendments to the Mining Act in 1996 introduced a “no liability” clause whereby once mining lands are surrendered to the Crown, provisions in Ontario’s Environmental Protection Act no longer apply.[309]

An independent assessment of the concept of the "exit ticket" commissioned by the OMNDM in 1996 found that the likelihood of the payout by a mining company equalling perpetual care costs was "very remote".[310] For the "exit ticket" at the Renabie Mine, it appears absolutely remote, given the number of concerns with the mine site conditions and the inadequate efforts to decommission and restore the mine property.

Issues related to the proposed exit ticket include:

- the proposed transfer of the land to the Crown is likely to result in an opening of the land to new mineral exploration. Such development is incompatible with the intended land uses and aspirations of the Missanabie Cree First Nation, who are currently engaged in claim negotiations for a land base which includes the Renabie property. The First Nation is not in favour of seeing further mineral development on their land before their claim is settled.
- it is uncertain whether acid mine drainage and/or metal leaching will occur. If it does occur, then a perpetual water treatment facility will be required at a cost of millions of dollars.
- fencing off the collapsed crown pillar in perpetuity is, on its own, a costly prospect.

It seems highly improbable that the proposed "exit ticket" fee will cover all of the many costs associated with long term care and maintenance of the site, including the requirement for fencing this safety hazard into perpetuity. The fee of $102,290 could not possibly cover costs of long-term monitoring or the necessary perpetual care for the mine, even without the water quality treatment that may be required to meet provincial water quality objectives or in the event of acid mine drainage or metal leaching.

Ontario has, in recent years, made efforts to address the unfortunate legacy of abandoned mines at great effort and expense. Ironically, the "exit ticket" process appears to be another mechanism for creating abandoned mines, in the case of Renabie allowing the largest gold producer in Canada to walk away, freed of their responsibilities, while all subsequent care and costs are transferred to the taxpayers.

7.4 Prairie Region

7.4.1 Overview of Mining in Manitoba

Over a century ago, when the transcontinental railway moved west to Winnipeg, it found a town already built on mineral extraction, with stone quarries and salt works already operating, and new discoveries of gypsum and coal about to be exploited.[311] In the early 1900's, mineral exploration moved north, with the construction of the railway up to The Pas and to points further north.[312] As the Mining in Manitoba website proudly claims "over the last century, our mining industry past and present has come a long way, leading railways, roads and airports into the great northern reaches of Manitoba and giving birth to the towns of Flin Flon, Snow Lake, Thompson, Leaf Rapids and Lynn Lake.[313]

Manitoba is currently host to 11 operating mines, including 3 mines in Inco's nickel complex, 6 in Hudson Bay Mining and Smelting's copper-zinc complex, plus a gold mine in Snow Lake, a relatively new nickel mine near Wabawden, 115 km southwest of Thompson, and a lithium mine and a tantalum mine in Lac Du Bonnet. Inco and Hudson Bay each operate a smelter, in Thompson and Flin Flon respectively. Projects under development include a new mineral reserve, the 777 Project, in Flin Flon, and the Maskwa gold mill, in Nopiming Provincial Park.

Diamond exploration is rampant in the province, with all of the major players – Debeers, Kennecott, BHP and others – crowding the landscape, including in the pristine wilderness area north of Gods Lake, in northeastern Manitoba. According

to a 2000 report of the Manitoba government, there were 7 major diamond exploration projects underway in the area north of Gods Lake alone, along with 6 gold exploration projects, 5 for lead/zinc, and one for base metals. Overall, there were 64 mineral exploration projects underway in the boreal region, including an estimated 35 searching for a combination of copper, zinc and nickel; 25 searching primarily for gold; and 11 diamond exploration projects.[314] Mineral exploration subsidies have boosted the exploration industry in Manitoba, with the opportunity for companies to have up to 35% of their exploration expenditures, to a maximum of almost half a million dollars per company, paid out of the public purse. Companies lining up to collect include major operators such as Debeers, Falconbridge, and BHP.

Manitoba has no publicly available inventory of abandoned mines, and it is unclear the degree to which the mines departments has a sound assessment of both numbers and condition of the abandoned mines in the province. Unofficial estimates range from 30 to 100 and more, based simply on historical maps and mining history which is broadly available.

In July 2001, the Province announced a $2 million fund to begin the process of rehabilitating abandoned mine sites in Northern Manitoba. Five specific sites were identified for assessment over the next four years including: the Lynn Lake Sherritt Gordon Mine, Sherridon Mine, Baker Paton Mine, Gods Lake Gold Mine and the Snow Lake Arsenopyrite Stockpile. The program includes $1 million to be spent by Industry, Trade and Mines over four years to cap and close off open mine shafts, and $1 million from Manitoba Conservation's Environmental Health Risk Assessment Program is to research and assess the environmental impact of abandoned mines. In addition, an Orphan Mine Site Advisory Committee, involving representatives from First

Snapshot: Lynn Lake, Manitoba

The town of Lynn Lake, Manitoba is suffering the effects of mine shutdown. Both long-time operators such as Sherritt-Gordon Mines Ltd. and more recently occupants like Blackhawk Mining Inc. have closed operations in the area, leaving behind a legacy of contaminated sites and environmental degradation.

Acid mine drainage is occurring throughout the 1200 ha of inactive mining properties adjacent to the town. Surrounding water bodies are contaminated, including the aquifer that supplies the town with water, and there are local concerns that contamination of waters downstream may have a negative effect on both tourism and commercial fishing and processing. Residents of Lynn Lake report elevated cancers and early deaths, which has led to the Lynn Lake Adjustment Committee requesting an environmental health risk assessment for the region.

Lynn Lake received funds from the Mining Reserve Fund in the early '90's to help offset the deficit in the local budget after mine closures, but was refused funding to help cover hydro payments after the most recent mine closures, pending a court decision on the $3-4 million Black Hawk Mining owes the Town in back taxes. The Mining Reserve Fund currently pays for an economic development officer and the community adjustment committee in the Town of Lynn Lake.

Cleanup of the 11 contaminated sites and the 25 million tonnes of tailings left from mine operations in the 1970's would require more than the total monies in the Mining Reserve Fund.

Nations communities, industry, the mining sector, local communities, environmental groups and the public will be established to provide on-going advice and direction for policy development related to the rehabilitation of abandoned mine sites.[315] There appears to be no movement to address abandoned mines in other parts of the province. A concentration of abandoned mines in the Bernic and Bisset Lake region, east of the south end of Lake Winnipeg, includes a number of sites with associated tailings areas. Several of these, such as the Gunnar and the Diana mines are considered to have a high potential for related environmental problems.[316]

On May 25, 1999, a new regulation under the Mines and Minerals Act entitled the Mine Closure Regulation came into effect. The regulation requires that mining companies be held liable for the full cost of all rehabilitation measures at mine sites as well as provide sufficient financial surety up front to pay for the cost of rehabilitation. All present and future mine sites fall under this regulation.[317]

In Manitoba, the Mining Tax Act has a provision that sets up a Mining Reserve Fund to help communities affected by mining when mines shut down.[318] Concerns have been expressed that this fund has been used in the past for purposes outside its mandate, such as for general revenue expenses or for exploration subsidies. The fund is currently at $20 million.

7.4.2 Case Study: Flin Flon

7.4.2.1. Introduction

In 1914, a local Indian, David Collins, showed Thomas Creighton a mineralized outcrop at what is now Flin Flon. The mineralized area around Flin Flon is primarily copper/zinc. The Flin Flon mine was staked in 1915. The railway reached Flin Flon in 1928 and in 1930 the first blister copper and zinc was produced from the open pit. In 1937 mining went underground when two shafts were sunk 1.6 km apart. The large capital investment by HBM&S in the late 1920's for rail, mine, smelter, refinery and as well as a hydro-electric plant on the Churchill River laid the groundwork for opening up the prolific Flin Flon-Snow Lake Belt and later the Lynn Lake belt to the north.[319]

7.4.2.2 Overview

The Flin Flon plant operated by Hudson Bay Mining and Smelting (HBM&S) now includes a copper smelter, with an annual capacity of 82,000 tonnes of anode copper, and a zinc refinery that uses a pressure leaching process, with an annual capacity of approximately 100,000 tonnes. The plant also produces refined

metallic cadmium.[320] HBM&S supplies its own feed for the plant from as far away as the Ruttan Mine in Leaf Rapids, Manitoba. Other sources in production or under development include the 777 Project, Trout Lake and Callinan Mines at Flin Flon, the Chisel North Project near Snow Lake, and the Konuto Lake Mine at Denare Beach, Saskatchewan. The Flin Flon plant also processes feed from outside sources.[321] Hudson Bay Mining and Smelting is a wholly owned subsidiary of Anglo-American, the largest mining company in the world.

7.4.2.3 Issues

Communities and Closure

In 1970, the town of Flin Flon had a population of roughly 15,000, now reduced to approximately half that size. In 1980, the USWA had 1100 members in Flin Flon; it is now reduced to 680.[322] Production over the same period has increased due to a combination of increased mechanization and corner-cutting. The town of Flin Flon is almost totally reliant on mining, and mine downsizing has led to a reduction in size of the community. Eventually, mining and smelting in the area will cease, either because reserves are depleted or because operations cannot remain competitive, and the community will most likely face its own form of closure.

The Flin Flon plant has approximately 70 million tonnes of tailings in its waste management facilities.[323] All of this waste is acid generating and will leach metals in perpetuity. Presently, the effluent draining from the tailings impoundments is being treated with lime. Loadings over time will accrue. Over 4 tonnes of heavy metals, including zinc, lead, copper, cadmium and arsenic are released annually from HBM&S' Flin Flon wastewater effluent.[324]

Health and Safety

Since 1929, 126 workers have died in the mining operations in Flin Flon, 11 of them in the last decade.[325] The health and safety record for Flin Flon operations is poor, and there appears to be a relationship between company downsizing, which has increased the labour each worker must shoulder, and health and safety concerns. In some instances, the Company has pushed unrealistic timelines for production and ignored workers input, such as in the period leading up to a deadly mid-2000 explosion.

The explosion occurred on August 8, 2000 in the furnace of the HBM&S plant.[326] Every three years, the large furnace in the copper smelter is rebricked and the furnace must be shutdown in order for the work to be done. However, in 2000, there was a rush to restart production and an underlying sense of being “behind” right at the start of this shutdown process.[327] "Washdown" began early in the cooling process, with workers directed to spray water on the furnace and the slag

launder. According to worker reports, in previous shutdowns a cooling period had been followed by a misting of the furnace, prior to any direct spraying with water hoses. In 2000, direct use of water to cool the furnace was done sooner and was almost continual, and there was a general lack of experience in the crew.

Workers and supervisors did notice water accumulating inside the furnace as much as two hours before the explosion, but workers were directed to continue applying water. At approximately 1:45 a.m., there was a small pop followed by a series of explosions, escalating in intensity, inside the furnace.[328]

As the explosions happened, workers were thrown across and to the floor, and several had respirators, hard hats and safety glasses ripped off by the force of the blast. When injured workers made it to one of the exits, they found it locked. One contractor was tethered to his machine, slowing his escape. Two employees had to run the length of the catwalk, above the exploding furnace, to reach the only exit to the west end; floor plates had been removed, blocking the way to the east end exit.[329]

As a result of the explosion, thirteen employees required hospital care. Four were rushed to burn units. Steven Ewing, aged 33, died of his injuries eight days later.[330] No one has accepted responsibility for the explosion.[331] Manitoba Justice laid four charges against HBM&S, alleging the smelter was shut down in an unsafe manner and that the people in charge of shutting it down weren't properly trained. The maximum penalty the company could face is $150,000 on each of four charges.

At the time of writing, November 2001, the company had evaded entering a plea.[332] On September 6, 2001, HBM&S filed a motion arguing that the proceedings against them had not been properly authorized. Their argument is that because the mine straddles the Manitoba and Saskatchewan borders, the mine is subject to the 1947 Hudson Bay Mining and Smelting Act, and therefore not subject to Manitoba labour law.

The company and the union, United Steelworkers of America, worked to produce a joint report regarding the accident; however, the two parties differed on their recommendations. The union concluded that the concern for production must not override the concern for worker safety at any time.[333] The union recommended that water should not be used at shut down for cleaning or cooling the furnace. The Company reportedly concluded that water might still be used, following an assessment by the Joint Safety & Health Committee.[334]

Apart from the loss of life and extremely serious physical injury, emotional injury is also severe, with some workers unable to work in the smelter following the explosion.[335] Members of the community – especially the victims and their

families – are frustrated by the tactics used by HBM&S to avoid any responsibility for the explosion, and the Company's refusal to commemorate the accident on its anniversary. However, just days before the one year anniversary of the accident, the province announced a review of workplace health and safety legislation.[336]

The workers say that the HBM&S attitude is that the Company should not be told how to operate. As another example, a worker reportedly used his right to refuse unsafe work under a supervisor. The government mine inspector upheld the worker's right to refuse the unsafe work, but HBM&S is now appealing the inspector's decision.[337]

The union in Flin Flon is under binding arbitration and cannot strike until 2012. By comparison, another local of the same union operating at Thompson operations has had more success in negotiating its collective agreement and has a better safety record. However, in a disturbing parallel of the Flin Fon explosion, at INCO's smelter in Thompson, the cooling period for anodes is now being arbitrarily shortened to speed production.[338]

Snapshot: Inco in Thompson

In 1946, Inco Ltd. began a 10 year exploration program in the Thompson area of Manitoba using newly developed geophysical and geological techniques. This culminated in the discovery in 1956 of the Thompson nickel-copper deposit along with at least 6 other smaller deposits. The mine began full production in 1961.

Inco's Manitoba Division based in Thompson is a fully integrated nickel mining and processing operation. Total Grades of ore mined in the Manitoba Division in 1999 averaged 2.47% nickel. Annual nickel production is approximately 100 million pounds. The Thompson mine is an underground nickel-copper mine. The orebody is mined from two shafts T-1 and T-3, just over 3 km apart, with an open pit mine between these shafts. The Birchtree Mine is also currently operating and processing is off-site at the Thompson Mill. A two-year ongoing project to deepen the Birchtree mine at a cost of $48 million is expected to extend the mine's life by at least 15 years. The mine is expected to reach full production by 2004 and continue producing to 2016.

Airborne pollutants in the form of sulphur dioxide and heavy metals have been dispersed over the boreal forest in the Thompson area of northern Manitoba since 1961. Metal deposition in soils and plant material has been found to a distance of 35 km from the Inco nickel smelter, being very highly elevated around the smelter. A significant inverse correlation was determined between seedling growth and copper/nickel concentrations in surface organic soils. Forest decline surrounding the Thompson smelter has also been documented.

A mortality study undertaken for INCO Thompson showed a high incidence of kidney cancer in men who had at least five years of service at the mine. This finding is consistent with a study of nickel workers in Ontario. A study of health effects being designed in cooperation with the union will examine workplace illnesses at the Thompson mine.

<u>Breathing in Flin Flon</u>

The two major mining facilities in northern Manitoba that mine, smelt and refine ore – the copper/zinc mine in Flin Flon owned by Hudson Bay Mining and Smelting Co. and nickel/copper mine in Thompson owned by Inco Ltd. – account for 46% of the Canadian mining industry's releases of sulphur dioxide[339], and 95% of Manitoba's releases.[340]

Sulphur dioxide can cause serious health

problems including: premature death, unnecessary hospitalizations, worsening of respiratory conditions, impaired lung function, shortness of breath and eye irritation. Multi-nation studies in Europe have demonstrated significant increases in hospital admissions and premature deaths at mean concentrations much lower than 0.25 ppm.[341] The Manitoba government states that for longer exposures, sulphur dioxide levels above 0.15 ppm have been linked with increased hospital admissions for cardiac and respiratory illnesses.[342] Sulphur dioxide may enhance the effects of respiratory problems caused by other air pollutants. Long term exposures to as little as 0.027 to 0.031 ppm with high levels of particulate matter in the air have been associated with an increase in respiratory illnesses in children.[343]

In 1998, Inco Ltd.'s Thompson operation spewed out 216,000 tonnes of sulphur dioxide and HBM&S's Flin Flon operation emitted 185, 000 tonnes.[344] In addition to releases of sulphur dioxide, the mines also release significant quantities of heavy metals. For example, over 595 tonnes of heavy metals are released annually into the air at Flin Flon, including zinc, lead, copper, cadmium arsenic and mercury (approximately 83 tonnes of heavy metals were released to the air from Thompson operations).[345] There are no plans to further reduce sulphur dioxide emissions from the smelters.[346]

In 1993, a zinc pressure leaching plant installed in Flin Flon replaced the zinc smelter and reduced sulphur dioxide emissions by 30% and particulate emissions by nearly 75%.[347] Since January 1994, the mine has operated under revised regulatory limits. Sulphur dioxide emissions are limited to 220,000 tonnes per year and airborne particulates to 2,500 tonnes per year.[348] Allowable emissions are still very high. Spill gas upgrades were installed in 2000, when the smelter was shut down after the furnace exploded.

The one hour air quality objective for sulphur dioxide is 0.34 ppm, the 24 hour objective is 0.11 ppm and the 1-year objective is 0.02 ppm.[349] There are no legal limits. At Flin Flon, there is a lag time of approximately 14 hours with converters in the plant which means emissions cannot be immediately shut off. In contrast, Inco Ltd. operations in Thompson can cut back its air emissions if sulphur dioxide levels exceed 0.1 ppm in the city of Thompson.[350]

By 2000, the mine achieved a 90% reduction from 1995 levels in the public warnings issued due to high sulphur dioxide, although it must be noted that the smelter was shut down for 5 months of the year.[351] A public warning system is in place, and warnings are issued when average sulphur dioxide concentrations exceed 0.34 ppm. Suggestions for the public response to the warning include staying inside with the windows closed.[352]

Air emissions are still of significant concern to those living in Flin Flon,

exacerbated by the location of the smelter operations immediately next to the downtown. Prevailing winds carry emissions over the town, including downtown, schools and residential areas.

The most recent health care study, done in 1992, showed that hospitalization for respiratory diseases was 30% higher in Flin Flon than in other areas of the province.[353] The difference was most remarkable for young people aged 5 - 29 years, and indicated a disproportionate amount of respiratory illness among this age group in Flin Flon. No higher incidence of cardiovascular disease was found in the Flin Flon population, so the study suggests that smoking alone could not be responsible.[354] Clearly, the regulation of air emissions in the town of Flin Flon does not protect its citizens, especially children, from long term exposure to poor air.

Air Emissions and the Environment

Emissions from the Flin Flon smelter have caused extensive dieback of vegetation. Timber was harvested in the Flin Flon area for fuel and lumber, and a major fire swept through the Flin Flon area in 1929. With the start-up of the smelter in 1930 and its toxic air emissions, the forest surrounding the smelter was unable to recover. A circle with a 5 km radius surrounding the mine is severely affected, with the land barren of much of its vegetation and soils. At 5 to 10 km from the smelter, effects are still evident. In 1973, the height of the stack at the smelter was increased and emissions are now scattered over a broader area.[355]

Areas in northern and eastern Manitoba that are downwind of the Flin Flon and Thompson smelters are particularly at risk from acid rain damage[356] Long-term monitoring has shown that precipitation at some stations has become slightly more acidic. Soil in the area east of Lake Winnipeg and in the northwest corner of the province (which represents approximately 30% of Manitoba) has been identified as being sensitive to acidic inputs. Lakes in the northwest corner of the province are highly sensitive, while lakes to the east of Lake Winnipeg are moderately sensitive.[357]

Snapshot: Greening Flin Flon

Over the last two years, an estimated 800 people, – roughly 10% of the population of Flin Flon – have participated in the "regreening" of their town.

Following a reduction in the amount of air emissions from the Flin Flon smelter and an increase in the height of the smelter smokestack, residents involved in the project say regreening of the barren area surrounding Flin Flon now seems possible.

Experimental plots on the Flin Flon barrens that were treated with lime in 1994 now have poplars and birches over 1 metre tall, and other species are becoming established.

Regreening is being undertaken by applying lime to de-vegetated areas. The lime neutralizes acidity in the soil and reduces metal toxicity. Calcium present in the lime has a strengthening effect on the plasma membranes in root cells that are responsible for determining what is absorbed by the roots.

Wind is the main agent for seeding areas naturally. Some grass seeding and planting of tree seedlings is being undertaken. While most of the organic layer of the soil has been eroded, the underlying horizon formed of glacial till remains over much of the area. Lime is locally available, which project organizers say makes the project affordable.

Emissions of heavy metals from the Flin Flon smelter are noted by increased soil concentrations of heavy metals above background to a distance of 70 - 104 km from the smelter.[358] Metals include zinc, lead, copper, cadmium, arsenic and mercury. A 1983 study found that lead levels in blueberries within 5 km of the Flin Flon smelter were 20 to 30 times higher than the average value for Canada. Lead is a metal that bioaccumulates and potentially biomagnifies in the food chain.[359] A 1981 study of fruiting shrubs downwind of the Flin Flon smelter concluded that the toxicological implications for wild herbivores consuming metal contaminated forage were difficult to determine because of the known nutritional interactions that the range of heavy metal contaminants have with each other.[360] Acidity in soils also increases the bioavailabity of many metals.

7.4.3 Overview of Mining in Saskatchewan

The first gold discovery in Saskatchewan was in the North Saskatchewan River, near Prince Albert, in 1859. Gold was produced in small quantities in the early 1900's by panning and dredging operations in the North Saskatchewan River, but it was not until after the transfer of lands from the federal crown to the province of Saskatchewan in 1930 that the first metal mine went into production. By the late 1930's and early 1950's, gold was being produced in significant amounts in the vicinities of La Ronge, Flin Flon (on the Saskatchewan-Manitoba border), the Crackingstone Peninsula, and Prince Albert. Uranium also came into production in the 1950's, with 16 ore bodies and 3 separate milling facilities developed in the Uranium City area, where production continued until 1982. In southern Saskatchewan, both coal and potash are mined extensively, producing one third of the world supply of potash and constituting approximately 14% of Canadian coal production.[361]

In Saskatchewan's boreal region, there are currently 5 operating uranium mines, producing one quarter of the world's uranium supply. Operated primarily by Cogema Resources or Cameco Corporation, the mines produce very high grade ore which is found close to surface, making the mines lucrative to operate and dangerous to mine.

Mining uranium creates special hazards, due to the radioactive nature of the ore. Uranium is a radioactive element, which means that it is unstable. As it breaks down or decays, uranium gives off energy in the form of radiation. Each of the new elements or "daughters" – radium, thorium, radon, bismuth, lead and polodium – have specific characteristics that pose distinct problems in terms of health and environmental impacts. Cancer, leukemia, birth defects, genetic damage and weakened immune systems are all associated with exposure to radiation. The uranium being mined in Saskatchewan is extremely high grade,

ranging from 4 to 9 percent pure uranium, or 90 times more radioactive than the uranium that was mined at Elliot Lake in Ontario.[362]

The Seabea Mine near La Ronge continues to be the sole operating gold mine, despite a rush of activity in the late '90's that saw the opening – and then closing – of gold operations in La Ronge Provincial Park, including the Cameco Corporation's joint venture Contact Lake Mine. The Konuto Lake Mine, near Denare Beach, feeds copper-zinc to Hudson Bay Mining and Smelting operations in Flin Flon, Manitoba.

Eligible Saskatchewan Flow Through Shares
Net After-Tax Cost of $1000 Investment

Initial Investment	$1000.00
10% Saskatchewan tax mineral exploration tax credit	- 100.00
15% federal tax credit	- 135.00
Less Value of deduction at combined federal-Saskatchewan top marginal income tax rate	- 344.25
Equals Net After-Tax Cost of $1000 Invesment	**$ 420.75**

Mineral exploration has been in overall decline in Saskatchewan over the last several years, decreasing from over $62 million in exploration investment in 1998, to a projected $30.5 million for 2001. Investment by the senior companies has declined most dramatically – from $55 million to $21 million, while the junior companies have increased their investment from just under $7 million in 1998 to a projected $20 million in 2001. The reintroduction of a federal flow-through shares program and introduction of the Saskatchewan Mineral Exploration Tax Credit can be presumed to be largely responsible for the increased investment on the junior side. Mergers and consolidation of some of the larger mining companies may account for some – but certainly not all – of the decline in investment among the senior operators.

Uranium is the major area of exploration activity, capturing 75% of the mineral exploration dollars in 1998. Exploration activities are largely in the Athabasca basin, where the currently operating mines are located, and the areas just to the north and south of Athabasca. Approximately 30 major uranium deposits have been identified, in addition to those already in operation or previously mined out or closed.

Precious metal and base metal exploration make up just under one quarter of mineral exploration activity in Saskatchewan, with gold exploration concentrated in the La Ronge and Glennie domains, both in the north central part of the province, and base metal exploration concentrated largely in the Flin Flon area and the area north of Lac La Ronge.[363]

Diamond exploration has been big in Saskatchewan for the last decade, with a peak in 1994, when over 4 million hectares of land was under disposition for diamond exploration. While the concentration of interest for diamond exploration has been concentrated in the area north of Prince Albert, particularly in the Fort à

la Corne kimberlite province,[364] the Saskatchewan government considers the entire province to be prospective ground for diamond exploration, and provides ongoing technical assistance to the exploration industry.[365]

There are an estimated 500 plus abandoned mines in the entire province of Saskatchewan, with a great number of them being coal mines in the southern part of the province. A 1976-1977 inventory was conducted of Abandoned Mines in Uranium City Area, and in 1988-89 an inventory was developed of abandoned coal mines in the south and metal mines in the northern part of the province. Only 37% of the more than 100 metal mines had been visited as of early 2000. Twenty-three percent of metal sites (60% with tailings) have undergone remedial work.[366] The 2000-01 fiscal year was the first year of the new Abandoned Mines Assessment Program. Twenty-eight abandoned mines and associated waste disposal sites were inspected and a draft assessment report was completed.[367]

Snapshot: Uranium City

Uranium was discovered on the north shore of Lake Athabasca in 1936. Commercial production started in 1953 at the Beaverlodge mine on Beaverlodge Lake. The town of Uranium City was established in 1952 to service the Beaverlodge mine and others that followed. By the late1950s, ten mines were in production; the boom lasted almost three decades, ending with the closing of the Beaverlodge mine 1982.

All of the mines in the vicinity fed into three processing facilities, at Beaverlodge, Lorado, and Gunnar. Laredo, in operation from 1957 to 1960, is the smallest, with 0.6 million tonnes of tailings covering 14 hectares. Gunnar was in operation from 1955 to 1964, and left 4 million tonnes of tailings over 75 hectares, while the Beaverlodge operation left 6 million tonnes over 25 hectares. Although the uranium ore was not of a high grade (unlike the newer mines), the tailings still contain 85% of the radiation of the original ore (thorium, radium, polonium etc. are left behind when the uranium is extracted) as well as other metals and, in the case of the Lorado and Gunnar sites, they are also acid-generating.

At the Gunnar site, the tailings were simply bulldozed into a small lake, which eventually overflowed into Lake Athabasca. At the Beaverlodge mine, tailings were dumped into Beaverlodge Lake. The Saskatchewan and federal governments have been arguing about who will pay for the cleanup for years, with no resolution in sight. Cameco Corporation, formed when Eldorado Nuclear was partially privatised, has stabilised the tailings at the Beaverlodge site, but the bulk of the wastes remain in the lake.

The province has estimated that cleaning up the Gunnar and Lorado sites would cost $10-15 million; based on experience with other contaminated sites a full clean-up could cost ten times that much. No estimates have been made of the cost of NOT cleaning it up, but since the downstream communities and all the other economic activities in the region depend on clean water, it is critically important to prevent any further contamination, and clean up what is there.

Source: Toxic 13 - A report by MiningWatch Canada and the Sierra Club of Canada to Establish a Clean Canada Fund, 2001

7.4.4 Overview of Mining in Alberta

In Alberta, the word for mining is “coal”. From the earliest discoveries of a century ago, through the decades of mining and dozen of ghost towns, mining in Alberta means mining coal. When the gold rush of the 1800's spilled over the

B.C. border into Alberta, what they found was coal. When the governments of Canada and Alberta approved – and re-approved – one of the country's most controversial mine projects last year, it was the Cheviot coal project that was given the green light.

Currently, there are 7 coal mines operating in the boreal forest region of Alberta, using a variety of mining methods, including open pit, drag line and strip mining. Five are operated by Edmonton-based Luscar Coal Ltd, Canada's largest coal producer. Luscar also owns the Gregg River Mine, now under closure after having produced 31 million tonnes of coal over 17 years. Luscar Ltd. is controlled by the Sherritt Coal Partnership, which is comprised of Sherritt International Corporation and a subsidiary of the Ontario Teacher's Pension Plan Board.[368] Luscar is partnered with CONSOL Energy Canada Ltd, the Canadian face for Consol Energy Inc of Pittsburgh, in the development of the Cheviot project.[369]

The Coal Valley Mine, 100 kilometres south of Edson and in the heart of the historic Coal Branch mining district, is fairly typical of the coal mining methods used in Alberta. The mine property includes a series of parallel, northwest trending ridges and narrow valleys. There are three separate and continuous coal seams, varying in thickness from 2 to 10 metres. A dragline is used to remove overburden, and a backhoe digs out and removes the coal, loading it onto a truck, which hauls it to a preparation plant for drying before being shipped out. The mine produces one million tonnes of coal per year.

Coal mining has huge environmental impacts, particularly due to the very high level of surface disturbance on site. Off-site impacts can include serious impacts on water quality, with most coal reserves being associated with high degrees of acid generating potential. Even after being "reclaimed", surface coal mines often create artificial, porous "geological recharge areas" where infiltrating water percolates through the fill and emerges as very acid seeps or springs that often flow even during drought when natural waters dry up.[370]

In the case of major projects like the proposed Cheviot Coal Mine, all phases of the mine development are expected to have an affect on groundwater flows. Local springs will be lost due due to groundwater drawdown, and surface water patterns will be altered.[371] Nutrient loading and associated eutrophication may impact as far as 100 kilometres downstream.[372]Operating mines in the area north of the Cheviot project have already caused elevated levels of a number of metals, suspended solids, nitrates and sodium in water bodies downstream.[373] For example, elevated levels of selenium are a problem downstream from the Luscar Coal Mine,[374] and the mine exceeds its limits for sediment discharges and for selenium on a frequently basis.[375]

While coal looms larger than life in Alberta's mining past and present, diamond may be the rock of the future, given the prominence of diamond exploration in mineral expenditures over the last several years. To date, approximately 45 kimberlites in three separate clusters in northern Alberta have been found, and government sources estimate the potential for 200 or more kimberlites to be found in northern Alberta. More than half the kimberlites contain diamonds, although none of the kimberlites found to date are of significant economic value. Areas of identified high potential include Buffalo Head Hills, Birch Mountains, Pelican Mountains-Calling Lake, and Cold Lake.[376] Ashton Mining of Canada and their Partners Pure Gold Minerals and the Alberta Energy Company have an 11 million hectare block under permit in the Buffalo Head Hills, and New Claymore Resources has significant mineral holdings in the area surrounding the Ashton discovery.

Snapshot: The Cheviot Coal Mine

In March 1996, Cardinal River Coals Ltd. (CRC) announced plans to develop a large open-pit mine coal mine in the foothills of the Rocky Mountains, south of Hinton, Alberta. The proposed mine area is 23 kilometres by 3.5 kilometres, and is located less than 3 kilometres from Jasper National Park, a United Nations World Heritage Site. The project requires approval under both federal and provincial law prior to the construction, operation and decommissioning of the open-pit mine. A Joint Alberta Energy and Utilities Board and Canadian Environmental Assessment Agency Review Panel was established to conduct the review and hearing.

Despite serious shortcomings in the assessment process, the Panel recommended that the project be allowed to proceed. On October 2nd, 1997, the Federal Government approved the Joint Panel's report on the Cheviot Project, despite a number of serious deficiencies. Crucial baseline information had not been provided, and a cumulative effects assessment had not been done. The consideration of alternatives to the open pit mining had been inadequate, and there had been no analysis of the public need for the Cheviot project. The project failed to meet with Fisheries Act and National Parks Act obligations. The participation of the Smallboy Cree's participation in the hearing had been unfairly limited.

The postnote to the federal government's approval was a court decision ordering the hearing be reconvened to consider cumulative impacts and other information it has previously failed to consider. The second hearing resulted in approvals by both the Panel and the federal government. The project has now been postponed indefinitely due to the loss of a major Japanese coal contract.

Source: Canadian Environmental Network E.A. Case Studies, January 2000

In 1997, there were 4,135 applications of permits filed with the Department of Energy, for an area totalling over 37 million hectares. This brought the total lands under permit or application to over 45 million hectares, or almost 90% of available crown land.[377] Exploration peaked in 1998, with a total investment of $27.5 million, and has been in a rapid downward freefall for the following three years, dropping by 50% in 1999, and sinking to under $8 million per year for each of 2000 and 2001.[378]

Alberta is unique in Canada in terms of land tenure arrangements for mineral exploration. The other provinces and territories operate on a free entry system wherein mineral properties are staked - and so tenure established - without prior consent from the crown. In Alberta, the system requires an exploration permit and

approval prior to mineral exploration, and well prior to any tenure or claim to the property being established. There are a number of steps in the Alberta process. First, an exploration license must be obtained in order to apply for or carry out any exploration program. An exploration permit is required in order to use any exploration equipment, such as a drilling rig. The exploration licenses and permits cost $50 each, and are valid for as long as the company is operating in the province. If an exploration project is to involve environmental disturbance - drilling, trenching, bulk sampling or cutting of grids that involves more than limbing trees and removing underbrush - a project approval must be obtained from the Land and Forest Service of Alberta Environment. The licensee does not have to hold mineral rights for an area to seek and obtain an approval, and approvals can usually be obtained in about ten working days. Each application has a fee of $100, and each project must have its own approval. The initial term of the permit is ten years, comprised of five assessment periods of two years each.

To maintain the permit, assessment work must be done, at a value of $5 per hectare for the first two year period, $10 per hectare for the next 2 two-year periods, and $15 per hectare for the next 2 two-year periods. At the end of each 2 year period, a report on the assessment work must be completed and filed with the Department. The report is kept confidential for one year, and then placed in an open file.

If a permit holder has met the terms and conditions of the permit, ie. conducted the necessary assessment work and filed the required work reports, they may apply for a Metallic and Industrial Minerals Lease. For a $500 initial fee and an annual rental fee of $3.50 per hectare, the leaseholder is given exclusive right to exploit the minerals within the specified location. Leases are valid for 15 years, and can be renewed if the property is in production or has an approved development plan.[379]

Provincially, 2,100 abandoned mines have been identified and are on file with the provincial government, with the majority - but not all - being coal mines. Very few of the mines have been evaluated for physical or chemical stability, and less than 1% of all mines have undergone remedial work. Abandoned mines and mine reclamation in Alberta is regulated under the Coal Conservation Act, with some regulatory oversight under environment-related legislation.[380]

7.5 The Northwest

7.5.1 Overview of Mining in British Columbia

British Columbia is the third highest producing mining jurisdiction in Canada -

surpassed only by Ontario and Québec - and the fifth most active jurisdiction for mineral exploration, with an estimated $45.1 million invested in 200l. Investment figures for 2001 showed an almost 25% increase over the previous year, following a three year decline.

B.C.'s mining history dates back to the mid-1800s, and early coal mines on Vancouver Island and placer gold camps of the Cariboo. The province encompasses the largest part of the Canadian Cordillera, a mountain belt rich in minerals and coal which has made British Columbia a major producer and exporter of copper, gold, silver, lead, zinc, molybdenum, coal and industrial minerals.[381] During the 1990's, 14 mines closed and seven opened, and the number of jobs in the mineral sector was halved to 30,000.[382] There are currently 8 producing metal mines and 6 producing coal mines in the province, and approximately 20 advanced exploration projects.

Only a small number of B.C.'s mines are located in the boreal region; the majority of metal mines are found in central and southern B.C., with most of the active coal projects clustered in the southeast corner, near the B.C.- Alberta border. However, some of B.C.'s most infamous land use conflicts have been over proposed mines in or near the boreal region, including Windy Craggy in the early 1990's and the Tulsequah Chief, a proposed copper-gold-silver-lead-zinc mine which has recently been before the courts.

Snapshot: Tulsequah Chief

In March 1998, at the completion of a two-and-a-half year provincial environmental assessment process, Redfern Resources' Tulsequah Chief mine project was approved by the BC government. In February 1999, the Taku River Tlingit First Nation (TRTFN) launched a lawsuit in the BC Supreme Court claiming that the environmental assessment process was marred by striking deficiencies and irregularities.

The TRTFN specifically charged that the process was neither "neutrally administered" nor designed to "promote sustainability" as per the *Environmental Assessment Act.* The *Act* requires environmental assessments to "promote sustainability by protecting the environment and fostering a sound economy and social well-being."

On June 28, 2000, the TRTFN won their court case. The BC Supreme Court concluded that the "statutory obligation to promote sustainability, an object of the *Environmental Assessment Act*, was not fully addressed ...[and] that the Ministers' obligations under the statute and at common law were not fulfilled."

This decision quashed the Project Approval Certificate issued to Redfern Resources until sustainability issues could be duly considered. Subsequently, the environmental assessment project committee has reconvened to address sustainability issues in the context of the Tulsequah Chief proposal.

Source: "Financial Options for the Remediation of Mine Sites". CSG Associates.

The Golden Bear Mine, a heap leach operation and the last operating metal mine in the province's boreal region, closed in late 2001. However, a half dozen advanced exploration projects are making a dramatic change in the level of mine-related impacts in B.C.'s boreal. Exploration projects are primarily for metal, with advanced projects in the boreal region including Rembrandt Gold's Polaris-Taku project, just south of Redfern Resources Tulsequah Chief project; Imperial Metals' Silvertip project, a silver-

zinc-lead property just south of the Yukon-BC border, 85 km southwest of Watson Lake; and the Taurus project, a gold property adjacent to the recently closed Table Mountain Mine.

The Bullmoose and Quintette coal mines, both owned by Teck Cominco Corporation, have both closed recently and are undergoing reclamation work. The reclamation work being proposed by the company has been challenged by environmental and labour groups as being inadequate and unsafe.[383] GlobalTex Industies' Willow Creek advanced exploration coal project, 60 kilometres west Chetwynd is not yet in operation. Willow Creek has been granted a development permit, but is awaiting more favourable market conditions before going into production.

The mining sector has seen a number of regulatory changes over the last few years, and more are expected with the recent change in government, and projected 35% budget reductions for the Ministry of Mines.[384]

A significant political achievement for the mining industry in 1998 was the "Mining Rights Amendment Act", which recognized the "right to mine", and assured access to mineral tenures, right to compensation when tenures are expropriated for new protected areas, and "timely" permitting. At the same time, the NDP government created a "Mining Advocate" position in government, and introduced a Mineral Exploration Tax Credit, worth up to $9 million annually. Combined with a recently announced federal tax-assisted exploration incentive program, BC investors net cost is reduced to approximately 35% of their original investment.

British Columbia's Mineral Exploration Tax Credit is in addition to a half million dollar subsidy already in place to promote grassroots prospecting, and government financing tied to new mine development, which tallied up to $175 million over an 18 month period in 1997-98.[385] But, despite this generous support from the public purse, according to a Price-Waterhouse survey, B.C.'s mining industry posted an after-tax loss of $8 million during 2000.[386] This loss is consistent with what appear to be cyclical trends in the industry, with the sector making having lost almost a billion dollars in the late '80's, made several hundred million in the mid 1990s, and now showing a slight loss for 2000. It should be noted that, during the mid 1990s when protected areas establishment and land use planning was at its peak, the mineral industry experienced relatively health profits in British Columbia.[387]

British Columbia is in the process of completing a data base of closed and

abandoned mines, but has had some information on record for several years, including the results of a 1992 survey of closed and abandoned mines with acid mine drainage, and a database of historic mines. The MINFILE data base identifies 247 metal mines which have produced over 10,000 tonnes.[388] The B.C. Ministry of Energy and Mines Performance Plan for 2001-2004 included the goals of reclaiming at least one abandoned mine site by March of 2003, and five more
by March of 2004.[389] Due to the recent change in government and subsequent budget cuts, work on abandoned mines clean-up has been suspended until further notice.[390]

7.5.2 Overview of Mining in the Yukon

Yukon's mining history is long and colourful, with tales of the famous Yukon gold rush woven into the cultural fabric of the Canada's most north-western jurisdiction. Prior to European colonization, the First Nations people in the White River area are known to have mined native copper nuggets, which they used both for arrowheads and in trade. The first gold discovery was in 1850 at Fortymile, and prospecting for placer gold began soon after. A discovery of gold on Rabbit Creek in the summer of 1896 sparked the Yukon gold rush, which brought tens of thousands of people flooding into the territory over a period of just a few months. Placer gold mining was the mainstay of the Yukon economy from the time of the Klondike rush through until the early 1920s, and then again from the 1940s to the 1960's. Placer mining is still a major source of gold in the Yukon, and a major cause of environmental degradation. But gone are the romantic images of gold panners crouched by the creek; current placer mining practices rely on heavy equipment, moving tonnes of material from river beds and banks, creating enormous problems with sedimentation. In 1999, 171 placer mines produced 93,000 ounces of gold, valued at $29.7 million.[391]

Yukon's mining history has also been varied and often sporadic, with many of the mines opening and closing, only to reopen and close once more. The first high-grade silver/lead veins were discovered in the Keno Hill area in 1906, and a mill was built in 1925. The mines closed in 1941, reopened in 1945, operated periodically through until 1989, and the property is once again under advanced exploration. Massive zinc-lead-silver mineralization was found in the Anvil range in 1953, and the huge Faro ore body discovered in 1965, with mine production beginning in 1970. Production was suspended in 1982, reactivated in 1985, suspended in 1993, reactivated in 1995 and suspended again in January 1998. Limited small scale mining and milling of high-grade gold and silver veins were conducted at several properties in the Mount Nansen area between 1945 and 1947, 1966 and 1969, 1975 and 1976, and 1996 and 1998.

This pattern of coming-and-going - or of mining-and-going - has left the Yukon with a legacy of abandoned mines and a confusion over title, ownership and liabilities. Approximately 120 abandoned mines have been identified and are on file with the Department of Northern Affairs Waste Management Program, but the list consists only of those sites for which no legally responsible party can be linked to the property or operation. In many more cases mine sites are inactive - and likely to remain so – and in need of environmental remediation, but still have an identifiable owner, albeit one which may be taking no responsibility for the care or closure of the site.

Currently there is only one active mine site in the Yukon, and it has ceased mining. Brewery Creek is a gold operation owned and operated by Viceroy Resource Corporation, and located 57 km east of Dawson City. The mine was licensed in 1995, and production began two years later, with the mine reaching full production May 1997. It was a year round heap leach operation, with seasonal open pit mining, with 8 mine and maintenance personnel working 12 hour days, during a 14 day on and seven day off rotation. The Company did not mine this year, and do not expect to mine next year, but have continued to operate the heap leach. They expect to process ore for one more season, but are unsure of the operation's status beyond that.[392]

A socio-economic agreement was signed with the Tr'ondek Hwech'in First Nation, which included employment, scholarships, finder's fees, and a framework for exploration and joint-venture activities on other First nations land, as well as First Nation representation at technical, operational and environmental management meetings. In 2000, the exploration agreement was terminated. As of 2000, no further exploration was planned.[393]

Mining in the Yukon is regulated under the Yukon Waters Act and the Yukon Quartz Mining Act. The Quartz Act controls and administers rights to explore and extract minerals on crown land, and sets out the process for making mineral claims and the requirements for maintaining exclusive rights to mineral claims, for the purpose of mineral exploration, development and production.

The Yukon Quartz Mining Act encourages early staking, and allows continued tenure for as long as prospecting and exploration activities are continued. No license or approval is required for prospecting and low level exploration. Exploration programs which include road building, extensive drilling, trenching and the use of heavy equipment and construction of structures required prior notification and approval from the Chief of Mining Land Use. Advanced exploration requires the submission of an operating plan for approval by the Chief of Mining Land Use, and advanced exploration which is equivalent to the pre-feasibility stage of a mining property requires that there also be notice to the public. Advanced exploration is also subject to the Canadian Environmental

Assessment Act, which may result in more public review, but only at the discretion of the federal department. Mine development is also regulated under the Yukon Quartz Mining Act, although operations under 10,000 tonnes per year do not require a mining license, and can be regulated under the Yukon Quartz Mining Land Use Regulations, with less scrutiny.[394]

The Yukon Waters Act provides authority for a Water Board to require a mine reclamation plan and a financial security as conditions to the issuing of a Water Use License. The Waters Act requires a mine closure plan in relation to a Type A or Type B Water Use Licenses. No public notice is required of the mineral grant holder with respect to their proposed closure plan, although public consultation may be required as part of either an environmental assessment review or a Water Board review.[395] There has never been a closure plan completed, approved and implemented in the Yukon.[396]

While there are no legislated criteria for reclamation bonds, the Yukon Territorial Water Board has the ability to make the placing of securities with the Minister of Indian and Northern Development a condition of the water licence that is issued by the Water Board. The Department of Indian Affairs and Northern Development (DIAND) generally calculates the bond amounts based on an estimate of what it would cost to have a third party conduct the reclamation work, plus a 10-20% contingency. However, the Water Board has consistently set bond amounts for less that the amount calculated by DIAND. DIAND has the option of challenging the Water Board's bond amounts, but has never done so. Frequently, the amount of security set aside is only a small fraction of the real cost of site clean up and long term care. For example, the security bond posted for the Ketza River mine is only $100,000, while a study commissioned by DIAND estimated reclamation costs to be more than $1 million, plus an estimated $ 7 million to construct and operate a water treatment plant needed to deal with a serious arsenic problem which would require treatment for more than 100 years.[397]

Seemingly determined to become a major mining destination, despite there not being a single operating mine in the Territory, the Yukon government provides a number of subsidies to the mining sector, in addition to other concessions and supports. Most recently, the Yukon Mineral Exploration Tax Credit was increased from 22% to 25%, and extended to April 2003.[398] To qualify for the Mineral Exploration Tax Credit, companies need only have "maintained a permanent establishment at any time during the taxation year", and have incurred some eligible exploration expenses. The METC can be claimed in conjunction with the federal tax breaks for flow-through-shares.

In addition to tax exemptions, the Yukon Government also provides direct subsidies to the mining industry, both as exploration funding and by footing the bill for mine infrastructure. Just short of a million dollars is budgeted each year

for the Yukon Mining Incentives Program, which funds exploration projects on a per project basis. Government sources estimate that the public provides $1 for every $1.55 the private sector provides in the first year of exploration on a direct grant basis through the YMIP, ie. not factoring in other tax breaks and forms of financial support.[399] An additional $500,000 was announced for the Regional Mineral Development Program in November 2001.

Not all mining subsidies flow through the mining incentive and development programs. In fact, some of the biggest financial favours are distributed through other government departments, such as a road maintenance agreement signed in mid-2001 to support the reopening of the CanTung Mine, a tungsten mine in the Watson Lake area. The Yukon Department of Community and Transportation Services will spend $730, 000 to reopen and upgrade the road, $150,000 to strengthen the upper Frances River bridge to increase vehicle weight crossing capacity, and commit to $450,000 annually to maintain the road. North American Tungsten, for their part of the bargain, will maintain the final section of the road into the mine site. The Yukon government is providing this high level of financial support to a mine located just across its border in the North West Territories.[400]

7.5.3 Case Study: Faro

7.5.3.1 Introduction

The town of Faro and its mine are named after a gambling card game.[401] Faro is located in the Mount Mye area in south-central Yukon. The lead-zinc mine opened in 1969 and its last shutdown was in 1997. In its heyday it represented well over a third of the economy of the Yukon and it was the largest private sector employer in the Territory.[402] By the mid 1970's, it was the largest lead-zinc mine in Canada and – for a brief period of time – was the largest operating open-pit lead-zinc mine in the world.[403]

> *Now no one goes there. The mine tore up half the mountain now. People from that country try other areas, could not find anything as good. After that, just like people get lost, don't know where to go. They tried back in there, up that way. Not as good as down there no more. So people don't get good living like long time ago.*
> *Arthur John, Ross River Elder*

7.5.3.2 Overview

The lead-zinc ore deposit that would become the Faro Mine was first staked in 1953. By 1965 there were over 100 men at Faro working on exploration. Dynasty Explorations, which was formed to work the claims, and Cypress Mining of California joined to become the Cyprus Anvil Mining Corporation, which opened the mine in 1969.

Construction of the town was started in 1968. In June of 1969 a forest fire swept

through the townsite, destroying most of the newly built houses, which were quickly rebuilt. Between 1970 and 1980, the mine was in full swing and the town's population peaked at 2,100 with more than 700 mine workers.[404]

The mine was bought by Dome Petroleum Canada in 1981. In 1982, prices of lead and zinc plummeted and the mine shut down in June. After a summer of uncertainty, and hope that the mine would reopen, in September the company announced that it would not be resuming operations that winter. This caused a mass exodus from the town and the population fell to 900.

The Federal government funded an overburden stripping program at the mine in 1983-84 to make the property more attractive to new investors.[405] In early 1985, Dome announced that the mine was being mothballed and the population of Faro plunged to 90. The once thriving community had became a ghost town.[406]

> "The federal government has always been fixated with large development projects for the North.... Left behind on the mountain of dreams are two open pits, the valley floor of a creek filled with mill waste, millions of tons of acid leaching rock, contaminated soil, moon terrain for miles and enough infrastructure to do it all over again."
>
> Bill Trerice, Selkirk First Nation, Assembly of First Nations National Indian Brotherhood. 2001

In 1985, the mine was bought by Curragh Resources. The purchase price was effectively zero, because federal and territorial governments threw in millions in direct grants, tens of millions in the form of loan guarantees, second mortgages, road building and other incentives.[407] The deal provided for subsidized electricity through the Northern Canada Power Commission, at approximately 80% of the generated cost. When in full operation the mine was responsible for 30-40% of Yukon's total electricity consumption.[408]

In 1985, the town's population began to "boom" again, climbing to 1,500 by 1991.[409] The mine operated until 1993 when lead-zinc prices fell again. The fall in metal prices due to a global glut in zinc concentrates[410] coincided with Curragh's involvement in the Westray Mine disaster in Nova Scotia – an event that killed 26 men in one shift – and forced the company to seek protection from its creditors.[411] The layoffs in 1993 were initially described as temporary, pending a $29-million government loan guarantee to develop the new Grum ore body.[412]

In 1994, a receiver sold the mine to Anvil Range. The town's population was at 528. Commercial production began again in November 1995 and continued until March 1997. During this period of operation, the town's population grew again to 1,312. Then Anvil Range declared bankruptcy, in April 1998, and the mine went into receivership.[413] By the end of 1998 the town's population was down at 650, 190 of whom were claiming employment insurance. By the end of 1999 the

population had declined to 350.

The federal government holds $14 million in security for the clean-up of the Faro Mine, for which costs are now estimated at over $100 million.[414] The property is currently going through the bankruptcy court process.[415]

7.5.3.3 Issues

Undermining Tradition

With the influx of workers for the mine, the Ross River First Nation community was rapidly transformed into a marginal minority. Their lives changed drastically over the 30 years that the mine operated. The changes included both direct and indirect impacts. Direct impacts were severe: some family groups of the Ross River Kaska Dena were dislocated from their traditional lands because of the mine, and the mine destroyed traditional hunting and fishing areas. Less direct impacts – but equally profound – came from changes in education, transportation, employment and social welfare programs. These caused major social problems in the Aboriginal community.

> Jobs at the mine were tried and quickly abandoned by most [aboriginal] people as unattractive for many reasons, including scheduling, discrimination, and working conditions. Other types of employment, particularly seasonal and part-time work, were in demand.
>
> Source: "Just Like a People Lost: A Retrospective Assessment of the Impacts of the Faro Miining Development on the Land Use of the Ross River Indian People"

The Ross River people saw virtually no economic benefit from the mine. There was a large influx of transient white male labourers, beginning in 1966, for construction of the mine. Many of the workers carried the prevalent negative stereotypes of native people. Aboriginal women were seen as sexual objects and the men were often seen as objects for abuse and violence. Raids by construction workers to abduct women from the village were not uncommon. There have been vivid descriptions of sexual exploitation and beatings of Natives by whites at the local bar.

With the mine, public facilities for the purchase of alcohol became available in the region. As the stresses of life in Ross River mounted, binge drinking for extended periods also increased. Deaths from alcohol related causes increased once the mine was opened, with one or more deaths from drinking almost every year between 1970 and 1989. The Ross River band experienced "drinking, open conflicts, violence, sexual exploitation... the disintegration of some marriages."[416]

To the newcomers in the early days of the Faro mine, the town had been built in frontier wilderness, but to the Ross River people it was an encroachment on land already used for hunting, trapping and fishing and land that had intrinsic cultural significance and value.[417] Kaska Dena people of Ross River remember when the townsite was a prime moose-hunting area.[418]

Environmental Liabilities

The Faro lead-zinc mine in the Yukon has had a history of problems with its tailings pond.[419] Leaks and tailings spills from the tailings impoundment resulted in elevated levels of lead, zinc and arsenic being washed into Rose Creek. In March, 1975, two tailings dams failed and 54 million gallons of contaminated slurry flowed into Rose Creek, depositing tailings downstream for a distance of 15 km. Charges eventually led to a fine of only $4,500. Over several months during the winter of 1976, highly toxic levels of cyanide were released to Rose Creek. Fisheries officials observed that this spill resulted in "the waters of Rose and lower Anvil Creek being toxic to [fish downstream to] the Pelly River." Charges led to a fine of $49,000. The tailings impoundment is currently not stable and threatens to spill.[420]

Environmental issues include the relocation of tailings in the Rose Creek valley, treatment of drainage and wastewater, and general site restoration.[421] No closure plan was prepared until 1982, when a $50 million dam was proposed across the Rose Creek Valley. When Curragh Resources took over the mine they committed to devising a different closure plan. In 1990, the company suggested reprocessing tailings to remove them from valley, but only if they could break even on sale of bulk concentrate.[422] The company failed to provide cost estimates and did not identify buyers for concentrate. A federal water licence finally required a till cover over the Rose Creek Valley tailings, worth $26-28 million if reprocessing proved unfeasible.[423] This cover has not been applied and the tailings remain in the valley, partially water covered.[424]

The mine has 55 million tonnes of acid-generating tailings and 100-150 million tonnes of waste rock, much of which is acid-generating or may become acid-generating.[425] The mine is a source of acid mine drainage and metal leaching, for which treatment will be required into the foreseeable future. Water treatment plants using lime addition have been installed on the property, and part of the mill has even converted to this purpose. Annual costs vary from $2 to 10 million.[426] Despite water treatment, perpetual drainage from the mine may result in significant loadings to downstream waterbodies over the long term. The federal government, through the Department of Indian Affairs and Northern Development (DIAND), is the regulator responsible for water use, the surface lease agreements, mining leases and an environmental agreement for the nearby Vangorda deposit.[427]

Financial Liablities

The Faro mine received more that $1 billion in public investments in its 25 year life.[428] Economic Development Minister for the Yukon Government, Trevor Harding in 1999 stated that "with three to five years of accessible ore and on-site infrastructure, the [Faro] mine can still contribute over one billion dollars in jobs and economic benefits for the economy."[429] In fact, the mine would only be

feasible at very high prices of zinc, in the region of 75 cents per pound. This is in marked contrast to the current price, which is running below 40 cents per pound.[430] The government had previously agreed to assume responsibility for present and future environmental liabilities at the mine in order to interest a company in re-mining the site.[431]

The security of $14 million currently held by the federal government was derived from $1.5 million in trusts from water licences, and the remainder from a reclamation security trust which was gradually accrued over the years, based on a sliding scale related to the price of zinc and depending on whether the company had a positive cash flow.[432] The amount of the security pales in comparison to the $100 million estimated cost of cleanup. Lengthy negotiations between Cominco - a major creditor for Anvil Range - and federal and territorial governments (other major creditors) have failed to produce a solution.[433]

7.5.4 Overview of Mining in the Northwest Territories

The Northwest Territories in its earlier days included all of Alberta, Saskatchewan and the Yukon and most of Manitoba, Ontario and Québec. But in 1905, both Alberta and Saskatchewan were created from the Territories; in 1912, the provinces of Manitoba, Ontario and Québec were enlarged; and in 1999, Nunavut was established, reducing the NWT by an additional 2/3. Still an extremely large and diverse territory, the NWT includes expanses of boreal forest in its south- central range, and much larger expanses of northern tundra in its eastern and more northern regions.[434] Generally speaking, the Territories' metal mines are located in the boreal region, while diamond exploration and developments are more predominant in the Arctic tundra.

In the early 1940's, both Yellowknife and the Great Bear Lake areas exploded with mineral exploration and small mining and exploration camps. In the late '30's, there was a sense that the "Golden Age" had dawned, with new mines opening in rapid succession, and Yellowknife a bustling cluster of tents, shacks and cabins hugging the north shore of Great Slave Lake. In the decades to come, the mining industry was to provide the Northwest Territories, and Canada, with many "firsts".

Leading up to and during the Second World War, mineral exploration and the military were playing a greater role in northern "development", which perhaps prompted more active interest in the NWT from the rest of Canada. Canada's first radium mine – and later the first uranium mine in the world – came into production at Port Radium on Great Bear Lake, in 1933.[435] Exploration for uranium increased in 1942, in response to a demand for "defence" purposes. The

Port Radium mine of Eldorado Gold Mines Limited was reopened in 1942.[436] In 1944, the federal government took over the Eldorado company and formed a new Crown corporation which later became Eldorado Nuclear Ltd. Uranium exploration was restricted to the joint efforts of Eldorado and the Geological Survey of Canada.[437]

Port Radium produced the uranium that fed the Manhattan Project, and, eventually, material for the atomic bomb dropped on Hiroshima at the end of the Second World War.[438] A smaller private uranium mine operated at Contact Lake, near Port Radium, in the early 1940's,[439] and in 1957 the Rayrock uranium mine opened near Yellowknife. Unlike its predecessor at Port Radium, Rayrock was a private uranium enterprise.[440]

The NWT's boreal region is host to the Yellowknife mining camp, one of Canada's major gold mining districts. The two largest producers in the camp, the Con and Giant mines, are also the two only operating mines in the boreal region of the Northwest Territories. Since opening in 1938, the Con Mine has produced more than 5.5 million ounces of gold. The Giant Mine commenced production about 10 years later, and has produced an estimated 7.1 million ounces of gold.[441] However, the ore mined in the Yellowknife area is associated with arsenopyrite, and therefore releases a considerable amount of arsenic when processed.

Both historical and more recently deposited tailings have been found to contain extremely high levels of arsenic: up to 25,000 ppm in the Conn Mine tailings, 4,800 ppm in the Giant Mine tailings, and 12,500 ppm in the historic Negus Mine tailings.[442] Arsenic levels on the Giant mine site are as high as several thousand parts per million, and the soils in the community are all contaminated to some extent by the gold roasting operations that only ended in 1999 when Royal Oak, then owner of the Giant Mine, went bankrupt.[443] Comparatively, soil samples set background range of arsenic in the greater Yellowknife area as being between 4 and 70 ppm.

Surface water samples show arsenic concentrations that exceed Canadian drinking water standards, which set the limit at 25 ppm. For example a popular recreational lake, the Kam Lake, showed up to 1,570 ppm. The general interpretation of recent studies is that lake sediments have high concentrations of arsenic, presumably from historic and recent mining operations, and the arsenic is remobilizing into local surface waters.[444]

But arsenic in the soil and water is not the only trouble left behind as a legacy of 70 years of gold mining. Yellowknife's Giant has more than a quarter-million tonnes of arsenic trioxide, a highly toxic byproduct of roasting ore to extract gold, stashed underground in mined-out stopes. When Royal Oak went into receivership – not before making the mine famous with a bitter strike in 1992 –

the federal government became responsible for the property. A series of deals in recent years have arrived at an arrangement where the taxpayers bear all of the environmental liabilities, including cost of cleanup of the site and the arsenic trioxide stockpiles, but also for some of the operating costs while Miramar Mining Corporation continues to mine at Giant. Additional expenses assumed by Ottawa in a new deal made in the summer of 2001 include environmental monitoring, and treating arsenic contaminated water pumped from the areas of the mine where Miramar is working.[445] In November 2001, the deal was extended, with a commitment from DIAND to pay Miramar $300,000 per month "towards environmental compliance and holding costs."[446]Estimated cleanup costs for the underground arsenic trioxide range from several million to over $1.5 billion, depending on the method used. No long-term safe disposal method has been identified, nor has any funding been secured to carry out the work.[447]

Diamond exploration and new diamond mines have thoroughly captured the economic imagination of both business and government in the Northwest Territories. City administrators in Yellowknife estimate that half of the 550 people employed in BHP's Ekati Diamond Mine – 300 kilometres northwest of Yellowknife – have chosen to live in Yellowknife. In addition, estimates are for an additional 120 direct jobs and 27 indirect jobs in the secondary diamond industry, with three diamond cutting and polishing plants expected to come on line.[448] Overall, the NWT economy relies heavily on resource industries, with mining reported to be by far the largest private industrial sector. Oil and gas exploration and development are also important.[449]

The Northwest Territories has a rich mining history, with both its economy and infrastructure being based primarily on the minerals industry. Mining is the single largest private sector industry in the N.W.T. Mineral exploration expenditures in the Northwest Territories last year were higher than in any other Canadian jurisdiction. A secure investment climate with support for mining from government and aboriginal peoples, very attractive tax rates, an eager and available workforce, and a highly favourable geology indicates the future is bright for mining in the N.W.T.

Diamondex Resources Inc

Most of the infrastructure developed around Yellowknife has been to support the mining industry. For example, hydro dams have been established at Bluefish and Snare Rapids, north of Yellowknife, to power the mines. The all-weather road was put into Yellowknife primarily as a support to the mining industry. The winter road north of Yellowknife was first developed to support the Lupin gold mine, and now also services the diamond mines; the territorial government is now expressing interest in extending the road to the Arctic coast. All of these roads and infrastructure leave a footprint, dissect wildlife habitat, and open new areas for recreational hunting.[450]

While exploration investment saw an overall decline of almost one-third across Canada between 1998 and 2001, the Northwest Territories and Nunavut have generally held steady over the same period. Investment in the NWT in 1998 – prior to the creation of Nunavut – was at $155 million, and declined by 20% in

1999, but has remained constant since, with $66.1 million projected investment in the NWT for 2001.

The Governments of Canada and of the Northwest Territories provide both direct and indirect financial support for the mining industry. In addition to ongoing technical support and publicly funding training courses and "grubstake" funding for prospectors, the NWT funds a number of specific initiatives to support segments of the industry. For example, the 1999 budget included $1.4 million in "new funding" for the Department of Resources, Wildlife and Economic Development, to promote the establishment of a diamond value-added industry in the NWT. The budget also included $265,000 for Aurora College to sponsor diamond industry pre-employment training, and $133,000 in direct support to Sirius Diamonds to assist them in providing on-the-job training to northerners to work in their newly-established diamond cutting and processing facility in Yellowknife.[451]

> "This signals Canada's commitment to sharing the cost of preparing the NWT for the oil, gas and mining development that is in our mutual best interest."
> Premier Stephen Kafkwi, November 14, 2000.

Infrastructure is one of the main areas of subsidy provided to the mineral industry in the NWT. A cornerstone of the Territories' Non-Renewable Resource Strategy, funding in recent years has included $10 million in the 1999 budget for the upgrading of 17 kilometers of Highway 3 between Rae and Yellowknife.[452] In November 2000, the federal government announced $3.77 million, matched by $2 million for the Territorial government, for the construction of permanent river crossings along the McKenzie Highway winter extension. The upgrade will extend the shipping season from 5 to 8 weeks, which the NWT views as important encouragement to the resource extraction industries.[453]

As in the Yukon, NWT's abandoned mine program – such as it is – is managed through DIAND's Waste Management Program. As of February 2000, 37 abandoned mines were on file, all of which had been visited by field staff personnel, and all of which matched the DIAND criteria of "abandoned", meaning that they had no legally responsible party in operation. Other sources identify 35 abandoned mines in the Yellowknife region alone, plus another nine more recently closed mines.[454]

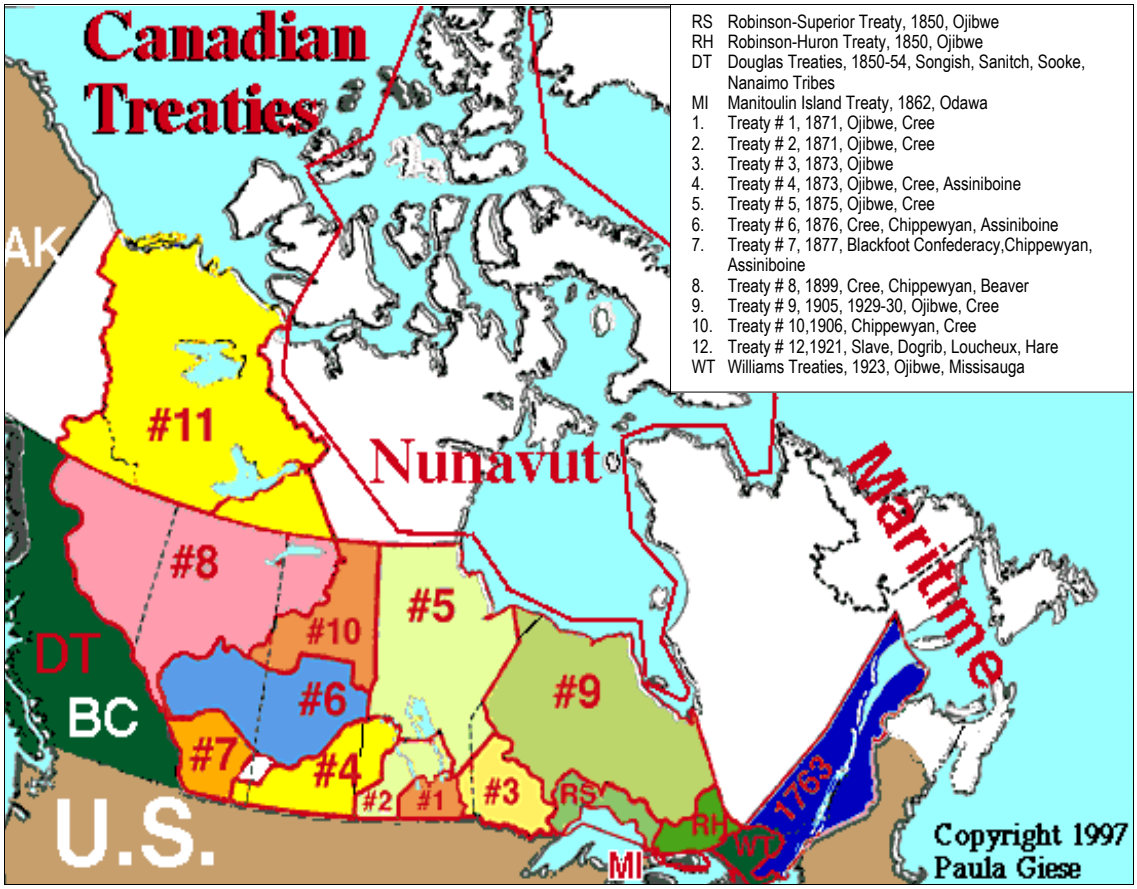
In the Northwest Territories, only BHP-Billiton's Etaki Diamond Mine and Diavik's Lac des Gras Mine have ever been required to post anything resembling full securities to cover costs of reclamation. After ten years of DIAND working on a mine site reclamation "policy", there are still no reclamation standards in place for the NWT. A protected areas strategy was approved in 1999, but no new protected areas have been designated since the strategy was put in place. There are also no approved regional land use plans for anywhere in the Northwest Territories.[455]

8.0 Between a Rock and a Hard Place: First Nations and the Mineral Sector

8.1 Introduction

First Nations people are forest dwellers: the Innu of Labrador, the Cree of Northern Quebec, Ontario, Manitoba, Saskatchewan and Alberta, the Dene of northern Saskatchewan, the Deline of the Northwest Territories, the Tlingit and Tsmishian peoples of northwest BC and the Yukon. Forest dwellers, the indigenous people have lived with the land since time immemorial.

In mineral development, impacts are borne first and foremost by First Nations people. Certainly, it may seem that there are some present-day exceptions to this truth, where the First People have already been removed from the land or relocated to other parts of their traditional territory, such as the older mining "camps", where mining has been taking place for a number of decades. However, those same relocations were often motivated by the Crown's interest in mineral or other natural resource development. The impact only came earlier, in the form of relocation rather than contamination.



In the last 150 years of mining in Canada, First Nations communities have gained considerable experience with the effects of mining. Some of this experience has been tragic, such as the exposure of the Deline people to radioactive hazards of uranium mining at

Port Radium in the Northwest Territories. The result, however, includes a body of knowledge and expertise within the Aboriginal community about the impacts of mining on indigenous culture and lifestyles. They have also developed strategies to protect communities from some of the adverse effects and gain some economic benefits. However, many communities still find they face the mining company alone, and have to learn the same lessons that others learned before them, through bitter experience.

Mining and mineral exploration affect First Nations people in variety of ways, beginning with the social and environmental disruption of mineral exploration, and continuing long after the mine has closed, often leaving behind a slow steady source of contamination of water and country foods. Two key messages emerge repeatedly in discussions among First Nations people about mining and its impacts. First Nations are interested in economic development, and – by extension – are not necessarily opposed to all mine developments. Aboriginal culture and lifestyle rely upon a relationship to the land and the safekeeping of the lands and waters.

At the same time, two common experiences repeat themselves from one First Nation territory to another: mining has had adverse impacts on the land and water upon which First Nation people rely; and First Nation communities often lack the background information and technical support they need in order to deal with the mining companies on an equal footing when they are confronted with mine development proposals.

8.2 Issues and Impacts

Before the mine, before any assessment, and certainly before any agreement to share economic benefits is made, mineral exploration takes its toll on the land and the people who live with it. While the impacts of mineral exploration are significant, there are few rules in place, with environmental assessment of mining projects coming after the exploration activities, rather than before.

In 1995 alone, more than 250,000 claims were staked in Nitassinan, covering nearly half of the vast Innu territory. With the exploration boom came base camps, cut lines and fuel caches; a few years later, the boom was over, leaving behind abandoned camps that now resemble garbage dumps.[456] While they were active, the camps themselves, with their drilling rigs, helicopter flights and stripping of the land, were affecting wildlife and so the opportunity for people to continue to practice their traditional life style.

The Innu also observed that mineral exploration alienates land. They came to

believe that where lands are explored and minerals found, their lands were no longer available for selection in the land claims process.[457] This experience and concern is shared by many other First Nations, including the Kaska First Nation in the Yukon and Missinabie Cree First Nation in northern Ontario.

In addition to all of the environmental problems that come with a mine, there are social and cultural problems that loom large for First Nation communities. Large numbers of transient workers arrive during exploration and construction of a mine, bringing with them threats to community stability and changes to community dynamics. Social problem escalate, including alcohol abuse, spousal and child abuse, sexual assault and harassment, and erosion of cultural traditions and customs. Food sources are threatened by increased hunting from outsiders, and disruption of migration patterns and wildlife habitat. As traditional foods become harder to get, new financial and nutritional problems emerge.[458] In some communities, elders have noticed more parasites and diseases in fish and wildlife found near mine sites, and, in these same communities, some of the elders have developed allergies to the fish and wildlife that they had eaten all their lives.[459]

> "When people are afraid to eat their wild meats, we see more and more people are getting diabetes, heart disease and high blood pressure. They are also too poor to afford store bought foods." (Yukon health worker)
>
> Gaining Ground: Women, Mining & the Environment

From coast to coast to coast, Canadian mining operations have left behind a nasty legacy of contamination, which will impair water quality and affect fish and country food for the foreseeable future. There has been a decline in wildlife population around the Faro Mine since operations began.[460] Many First Nations have expressed concerns about contamination of wildlife, including the Little Salmon Carmacks First Nation, whose members have been concerned to see caribou, moose and bison drinking contaminated water from the tailings pond at BYG's closed Mount Nansen gold mine.[461]

In response to similar concerns, the Crees of Northern Quebec hired an independent expert to study ground water and environmental contamination coming from mines in the territory of the Ouje-Bougoumou Cree Nation. The study, released in October 2001, found high levels of arsenic, cyanide, lead, mercury and other heavy metals in the water, fish and human beings. The study, undertaken to find out why the fish the Cree depend on for food have deforming mutations, looked for traces of contaminants near three mining sites. The report concluded that the problem dates back to the 1950s when the mines started dumping their waste tailings into Lac Dore and Lac Chibougamau. The study found the mines are still leaching contaminants, and proposed that epidemiological studies of the Cree should be carried out to establish a clear link between the contaminants and the deaths they have caused. In examining sediments in Lac Dore – where the Cree fish – sediments were found to have 101

mg of arsenic per kilogram, compared to the Canadian environmental quality guideline for arsenic is 5.9 mg per kilogram. The level of cyanide in Lac Dore water was 40 times the allowable limit. In Lac Chibougamau the arsenic level was 243 milligrams per kilogram, or 41 times the allowable limit. The study also found high levels of heavy metals in fish caught in the lakes and in hair samples from Ouje-Bougoumou residents. All the metals detected are toxic to human health and are known to cause cancers of the kidney, liver, lung and skin and have other negative effects on human health. The report author recommended that another 27 mines in northern Quebec also be studied.[462]

Employment, while seen as an economic benefit, has a downside as well, particularly in situations where the miners stay at the mine site, resulting in separation from home and family, and leaving one parent at home with all of the responsibilities for child rearing. Many First Nation people experience discrimination while on the job site. There are also difficulties in getting access to training. Language differences increase the challenge, often making the mine workplace a formidable environment.[463]

8.3 Rights and Responses

While the "right to mine" may appear to be paramount in mining laws and in the attitude of regulators across Canada, in fact and law it is actually the rights of Aboriginal people that are paramount. Guaranteed in the Canadian Constitution and the Canadian Charter of Rights and Freedoms, numerous court cases have upheld and are giving definition to Aboriginal and treaty rights, most notably the Sparrow decision in 1990 and Delgamuukw in 1997. Many challenges remain, however, in having those rights recognized by both government and industry in the day to day struggles over mine development.

In the early 1990's, the mining industry initiated the Whitehorse Mining Initiative, a multi-sector process involving government, industry, labour organizations and aboriginal groups. Many hoped it make significant progress in the recognition of Aboriginal rights and access to the economic benefits from mining, as well as improving standards for environmental care and mine-related decision making. The two year process culminated in the signing of an Accord in September 1994. It included shared goals of settling land claims fairly and expeditiously, supporting negotiation processes, ensuring open communication between the mineral sector and potentially affected Aboriginal communities, and removing barriers that prevent Aboriginal people from maximizing benefits from mining activity. It was signed by representatives from federal and

Whitehorse Mining Initiatives Principles

- Aboriginal people have rights protected under the Constitution Act, 1982, which include, among others, rights to lands and resources.
- Aboriginal peoples are entitled to opportunities to participate fully in mineral development at all stages of mining and associated industries and at all employment levels

Whitehorse Mining Initiative Leadership Council Accord, 1994

provincial governments, Aboriginal organizations[464], major mining companies and industry associations, labour and environmental groups.[465]

Almost a decade later, there is little evidence of the Whitehorse Mining Initiative "commitments" being part of the industry's current approach, at least with respect to notice, consultation and sharing of economic benefits, and references to the Accord have virtually disappeared from the political landscape in Canada. The WMI is still used by industry to promote the "responsibility" of Canadian companies when working abroad. However, the commitments remain, and no major industry player has yet repudiated them.

More meaningful in today's context is the 1997 decision of the Supreme Court of Canada in the case of *Delgamuukw v. British Columbia*. The case has been widely seen as a turning point for treaty negotiations in British Columbia and has broad implications for issues around resource development across Canada. The decision confirmed that aboriginal title does exist in British Columbia and determined that aboriginal title is a right to the land itself. This right is not just the right to hunt, fish or gather, but means – among other things – that when dealing with Crown land, the government must consult with and may have to compensate First Nations whose rights may be affected.[466] The *Delgamuukw* decision also ruled that, if a First Nation has Aboriginal title, it has exclusive use and occupation of the land over which the title applies, including sub-surface or mineral rights. However, two constraints are placed on that right: the Court said that the land must be used in a manner consistent with the special connection between the people and the land; and non-Aboriginal governments have an ability to infringe on Aboriginal title or use of the land, including for the development of a mine. However, the Crown also has a fiduciary obligation to act for the benefit of the First Nation, so it would have to demonstrate that the infringement, such as a new mine, would reflect and accommodate the interests of the First Nation. It also must engage in good faith consultation with a First Nation before making a decision that would affect them.[467]

"There is always a duty of consultation"
Delgamuukw v British Columbia

Both the *Sparrow* decision of 1990 and *Delgamuukw* seven years set out the legal requirement for the Crown to consult with First Nation's people on decisions that may affect their Aboriginal title or the exercise of their Aboriginal rights. This includes resource development or mining proposals. This duty to consult not only requires the Crown to substantially address the concerns of First Nations, but may also require the Crown to obtain the consent of First Nations prior to any development on aboriginal title lands.[468] The *Delgamuukw* decision described a range of depth to this duty, from a duty to discuss decisions when the activity is of little or no effect on aboriginal title, to much more substantial engagement where the effect of the activity may be more profound. It acknowledges that "some cases may even require the full consent of an Aboriginal nation".[469]

First Nations are employing various strategies in their struggle to both limit the damages of mining on their land and lifestyle and gain some share in the economic benefits of mine development taking place or proposed on their territory. Over the last decade, the negotiation of impact benefit agreements and participation in environmental assessment processes have produced some – albeit frequently limited – results in addressing First Nations' concerns about impacts of mining on the environment and on aboriginal lifestyles, and on the resource drain out of their territory. In some cases, such as that of the Inuit of Labrador, it appears that the potential for large scale mineral development may have sped up land claim negotiations.

Impact Benefit Agreements are a relatively new phenomenon, and experience varies greatly from one First Nation to another, and from one company to the next. Generally speaking, impact benefit agreements are socio-economic agreements between the First Nation(s) whose territory is under mineral exploration or development, and the proponent or mine operator. IBAs generally include items like employment and training commitments and sharing of economic benefits, but can also include requirements for monitoring, reporting of monitoring results, and responses to environmental impacts. The Innu identified protection of land and animals, compensation and royalties, job quota and training, management roles with respect to the mine, and a clear outline of Innu land rights as elements they would expect to negotiate in an impact benefit agreement.

Generally speaking, impact benefit agreements are negotiated in advance of a new mine opening, but this is certainly not always the case. For example, at the Ekati Diamond Mine in the Northwest Territories, BHP completed negotiations with the North Slave Metis Alliance on July 14, 1998. The mine opened on October 14, 1998. It was not until December 9, 1998 that an IBA was signed with the Inuit of Kugluktuk and the Kitikmeot Inuit Association.[470]

At Placer Dome's Musselwhite Mine in northern Ontario, an impact benefit agreement was signed with the Windigo and Shibogama Tribal Councils in advance of the mine opening, but with a limited term. Negotiation for the second term of the IBA has been reported to be difficult, with a number of issues between the First Nations and the company, and with Placer Dome perhaps less motivated to find resolution once the mine is already operating. Musselwhite is the only one of Placer Dome's 4 Ontario mines for which there was an impact benefit agreement in place as of 1999.[471] In fact, it was the only impact benefit agreement in place for any operating mine in Ontario.

Environmental assessments potentially provide a venue for First Nations to participate in an open decision-making process that considers environmental, social and cumulative effects of mine development. The Environmental Assessment of the Voisey's Bay Nickel Project saw a Memorandum of

Understanding signed between the Innu Nation, Labrador Innuit Association, the provincial and federal governments to ensure that the EA process responded to local concerns and reflected the political and social realities of the First Nations. The MOU expanded the definition of the environment, required the Panel to make its recommendations to the four signatories, and provided a role for the signatories in appointing Panel members for the EA hearing. The MOU also enabled the Innu Nation to take control of the social and economic studies, thereby allowing them to have more control in the process. The EA process was still not fully satisfactory, but the Panel's report recommended that the project move to permitting only after the conclusion of land rights negotiations and impact benefits had been achieved with both the Innu and the Inuit.[472] Other hearing outcomes from EA processes in Canada have included a requirement that the company negotiate impact benefit agreements, as was the case with BHP and the Ekati Diamond Mine.

However, EA outcomes cannot be relied upon to fairly or adequately accommodate First Nations' interest. The Government Response is the final outcome and is not bound by EA findings. During the review of the proposed Cheviot Coal Mine, the Smallboy Cree were denied the opportunity to participate properly in the hearing. The federal crown prosecutor instructed Department of Indian and Northern Affairs officials to not respond to the questioning by the Smallboy Cree, the native community living immediately adjacent to the proposed development. This was an instruction they reserved for the Smallboy Cree alone. In the April 2001 response to the report Joint Review Panel of the Cheviot Mine, the federal government's view on the loss of traditional land-use and lifestyle was bluntly stated:

> *The federal government accepts that should significant adverse effects on traditional uses and traditional sites occur, then these effects are justified. The federal government is confident that sufficient economic benefits will accrue to the surrounding communities, including the Alexis First Nation and the Mountain Cree Camp to warrant this justification.*[473]

Outside of the courts and environmental assessment reviews, many First Nations are taking action to assert their Aboriginal title and inform and engage the mineral sector in mechanisms to protect Aboriginal rights, title and land uses.

In 1995, when 29 companies were operating approximately 120 drilling sites throughout Innu territory, the province had refused to legislate interim protection of Innu lands, and refused to stop issuing exploration permits. The Innu decided it was time to act. Their first action was to issue an eviction order to Diamond Field

Resources, and then they reclaimed the land with a 12 day protest when the company did not comply. Following the protest, the Innu made direct contact with over 50 mining companies, requesting that they recognize Innu rights and agree to certain conditions prior to working on Innu land. These conditions included: 1) establishing an environmental and cultural protection plan; 2) developing a plan to monitor impacts; 3) taking steps to mitigate against any negative environmental effects; and 4) agree to be held liable to damages. The Innu have provided these and other directions to the mineral sector in their document "A Matter of Respect: Guidelines for the Mining Industry".[474]

The Innu also requested involvement in the design of environmental impact studies in order to ensure that traditional knowledge would be used and respected. Later the same year, the Innu Nation decided to accept funding from Voisey's Bay Nickel Company to cover expenses related to the Innu oversight and participation in the project's review, including hiring technical experts, consulting with the communities, and ensuring that proper environmental procedures were being followed to minimize impacts on wildlife and the environment.[475]

Innu pressure on the Newfoundland government resulted in amendments to the Mineral Exploration Regulation in 1996, which now requires companies to conduct archaeological assessments involving the Innu prior to any work which might result in ground disturbance, as well as more rigorous environmental standards for exploration activities. The Innu guidelines have also been the basis for ongoing contractual agreements with Noranda, Falconbridge and several junior companies, providing for ongoing consultation and reporting between the company and the communities, monitoring of activities by Innu Nation staff, requirements for environmental and cultural protection, and employment and business opportunities. The most recent agreement, signed with Falconbridge and Donner Minerals, was concluded in September 2001.[476]

Also in 2001, Nishnawbe Aski Nation issued a handbook on "consultation" in natural resource development, intended to inform and assist First Nations in planning for lands and resource development, but also to assist government and industry in understanding the positions of NAN communities, particularly with respect to the duty of the Crown to consult with First Nations about any project, development, activity, legislation or amendment to legislation which may impact on Aboriginal and/or Treaty rights. The handbook clearly sets out the duty of the crown, the role of resource development companies, and NAN consultation policy, as well as outlining the expected consultation process in a step-by-step fashion.[477]

9.0 Looking Back, Moving Forward

Given the trends of the 1990's that have continued into this century, the impacts of mining on the boreal forest are likely to increase. As mineral exploration and development and their related infrastructure spread further north and provinces and territories compete globally for mineral investment dollars, it is unlikely that the present environmental policy regimes governing mining will become progressive. If anything, present trends would suggest further downward pressure.

Countering these downward trends will require a variety of strategies and approaches. Key among them will be mobilization of grassroots organizations in an attempt to overcome the political and institutional barriers created in the mid and late '90's. On a local level it will require working in cooperation with Aboriginal communities who may have legally-based options for increasing the status of environmental concerns with respect to mining interests. It will also involve working with mining communities, or potential mining communities, in an effort to provide them with information that allows them to properly weigh the benefits and costs associated with mining, especially in terms of environmental impacts. Given that the mining industry draws significant political power from its position as an important player in terms of regional development, both nationally and provincially, working within mining communities will enhance understanding of complex issues on behalf of all parties. In addition, declining employment numbers, largely resulting from the increasing capitalization and technological change required to keep depleting Canadian deposits competitive, may eventually help de-couple mining development from governments' regional development imperatives.

At the national, provincial, and international levels there is an unprecedented need for political mobilization and coalition building. Overcoming present domestic and international political and structural barriers to increase environmental action on the part of federal and provincial governments is paramount. Given the implications of globalization discussed above, this remains a complex task.

A strong domestic strategy also needs to have an international focus, working with environmentalists in the United States and in the European nations most interested in de-materializing their economies, to ban particular toxic metals, and increase the recycling of metals in general. An important element in reducing the impact of mining in Canada's north and the boreal region is a reduction of dependence on virgin material globally, especially in the US, combined with an emphasis on the need for the Canadian governments to diversify away from a dependency on mineral exports as Canada's currency in the global economy – now much more problematic under NAFTA. These shifts make the creation, implementation and enforcement of progressive, domestic environmental policy with respect to mining less probable, and foreign leverage a more necessary variable in the equation.

As the northern portions of mining provinces such as Ontario are increasingly developed, it is probable that industry will demand increased government support for the infrastructure. Public funding of extensive infrastructure will help make projects economically feasible for industry to develop. Being able to quantify the costs of direct and indirect subsidies to the industry will provide an important weapon in the fight against increased public investment. This will not be easy as both industry and governments refuse to recognize the high level of public subsidy on which the industry depends.[478]

It is clear what needs to be done. As a society, we must ensure that the ecological footprint of mining is reduced, and that communities gain control over when, where and how mining takes place.

Environmental organizations have already been done the initial work to identify the elements of a fair and effective mining regime, including:[479]

- Controls on exploration and land access
- Assessment of impact of mining operations
- Controls on mining operations permits, approvals, pollution prevention and waste management
- Mechanisms to ensure industry responsibility for closure, remediation and reclamation of abandoned mines
- Polices to stimulate alternatives to green-field metal mining

Much remains to be done to ensure that we make that transition possible with both the speed and care that the situation demands.

In Canada, the civil society response to mining and its social and ecological impacts is growing, but there is still a crying need for solid information and analysis. On the government side, inventories are incomplete, and as a result public interest groups frequently finding themselves moving to the foreground, assembling the information needed to make the case for public investment in mine remediation and regulatory control over mine operations. More research is also needed on the environmental impacts at each stage of the mining sequence, monitoring results and their analysis, and in order to improve understanding of the mineral industry, and regulatory and market trends.

Individual First Nations and communities require extraordinary levels of support – legal, scientific, engineering and social – to hold mining companies accountable. This is not presently available.

Capacity and political clout must be developed from the ground up to identify and challenge irresponsible mining. This requires an integrated approach – and response – both in the sense of integrating the needs and understanding of mining-affected communities into regional and national campaigns and strategies, and in terms of making the connections between land access and later impacts on land, water and air, on First Nations land rights and aspirations.

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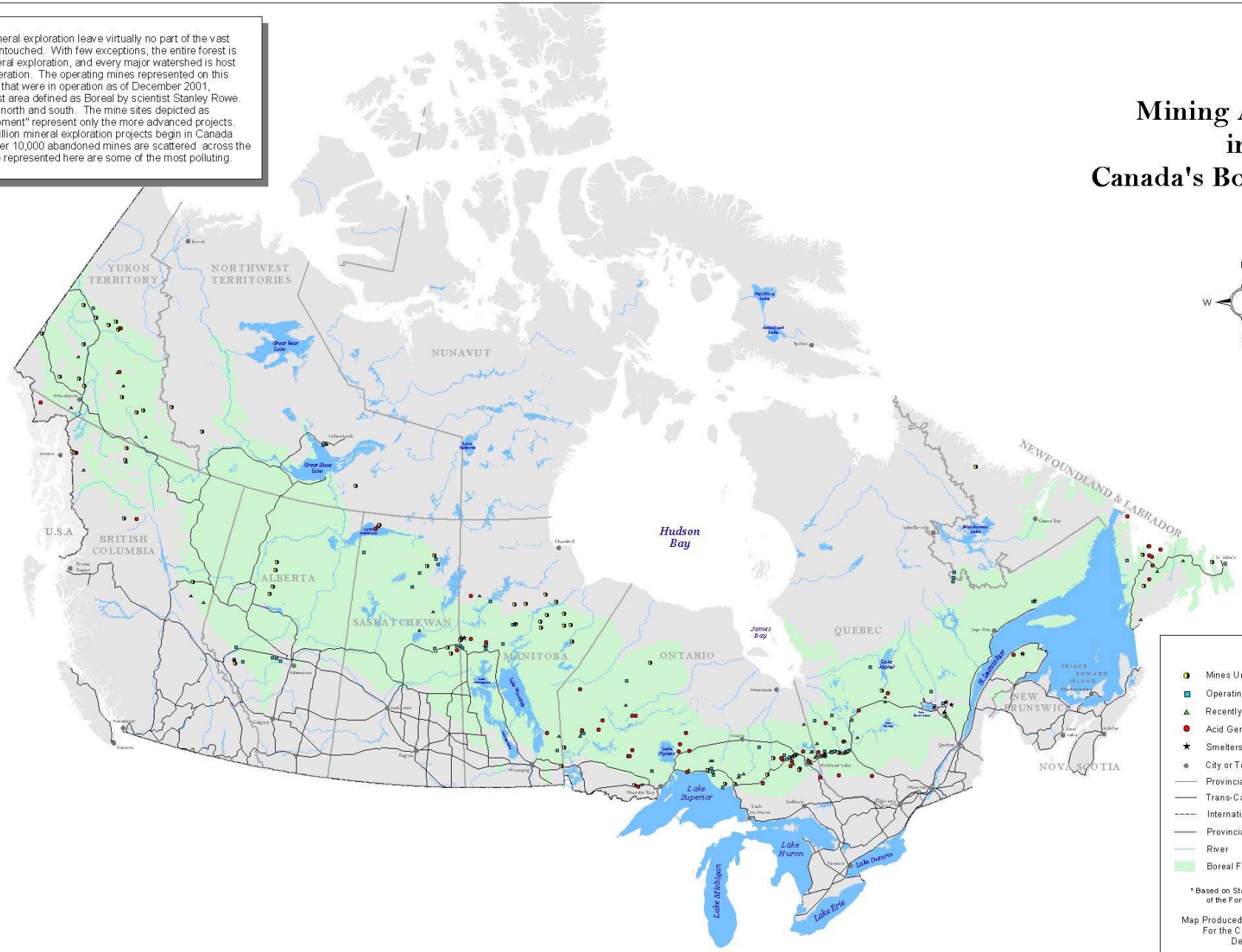
Appendix A

Map of Mining Activity in Canada's Boreal Forest

Mining Activity in Canada's Boreal Forest

Mining and mineral exploration leave virtually no part of the vast boreal forest untouched. With few exceptions, the entire forest is subject to mineral exploration, and every major watershed is host to a mining operation. The operating mines represented on this map are those that were in operation as of December 2001, within the forest area defined as Boreal by scientist Stanley Rowe. More lie to the north and south. The mine sites depicted as "under development" represent only the more advanced projects. More than 5 million mineral exploration projects begin in Canada each year. Over 10,000 abandoned mines are scattered across the country. Those represented here are some of the most polluting.



Appendix B

List of Mines in the Boreal Forest Region

Sorted by Mine Name

December, 2001

LIST OF MINES IN THE BOREAL FOREST REGION, SORTED BY MINE NAME						
MINE NAME	**COMPANY**	**LOCATION**	**PROV**	**METAL(S)**	**STATUS**	**ID #**
777 Project	Hudson Bay Mining & Smelting Co. Ltd.	Flin Flon	MB	copper-zinc-gold-silver	AE	2
Adams Mine	Dofasco	Kirkland Lake	ON	iron ore	C	300
Agrium Phosphate Mine	Agrium Products Inc.	Kapaskasing	ON	phosphate	O	122
Algoma Ore Division	Algoma Steel Inc.	Wawa	ON	iron	C	301
Alma Smelter	Alcan	Alma	QC	aluminum	S	509
Amisk Lake Joint Venture	Cameco Corp	Denare Beach	SK	gold	AE	52
Aquarius Project	Echo Bay Mines Ltd	Timmins	ON	gold	AE	2
Arvida Smelter	Alcan	Jonquière	QC	aluminum	S	501
B.C. (British Canadian) Operati	Asbestos Corporation Limited	Chicoutimi	QC	asbestos	C	332
Beaufor Mine	Louvem Mines Inc. & Aurizon Mines Ltd.	Val d'Or	QC	gold	C	333
Beaver Brook	Roycefield Resources	Glenwood	NFLD	antimony	C	340
Bell Allard Mine	Noranda Inc.	Matagami	QC	zinc-copper	O	101
Bernic Lake	Cabot Corporation	Lac du Bonnet	MB	lithium-cesium-rubidium	O	102
BHP Expl Permit 161	BHP Diamonds	Hudson Bay Lowlands	MB	diamonds	AE	46
Birchtree	INCO	Thompson	MB	nickel-copper	O	103
Bissett Mine	Harmony Gold Mining Company Ltd.	Bissett	MB	gold	C	350
Bouchard-Hebert	Cambior Inc.	Quebec	QC	zinc-copper-gold-silver	O	105
Bousquet #2	Barrick Gold Corporation	Preissac	QC	gold-copper	O	107
Brewery Creek Mine	Viceroy Resource Corporation	Dawson City	YK	gold	O	108
Bucko Lake Nickel Mine	Nuinsco Resources/Falconbridge	Wabawden	MB	nickel	O	54
Buffalo Head Craton	Ashton Mining / Pure Gold Minerals Inc.	Buffalo Hills	AB	diamonds	AE	100
Bullmoose	Teck Corp	Chetwynd	BC	coal	C	351
Callinan Mine	Hudson Bay Mining & Smelting Co. Ltd.	Flin Flon	MB	copper-zinc-gold-silver	O	111
Campbell Mine	Placer Dome Inc.	Balmerton	ON	gold	O	112
Canmine Expl Permit 99-16	Canmine Resources	S. Churchill	MB	nickel-copper	AE	42
CanTung Mine	North American Tungsten Corp. Ltd	Tungsten	NWT	tungsten	AE	41
Carmacks Project	Western Copper Holdings	Whitehorse Division	YT	copper	AE	27
Casa Berardi Mine	Aurizon Mines Ltd	La Sarre	QC	gold	C	302
Cheminis	Northfield Minerals Inc	Larder Lake	ON	gold	C	343
Cheviot Mine Project	Luscar Ltd, Consold of Canada Inc	Hinton	AB	coal	AE	3
Chisel North Mine	Hudson Bay Mining & Smelting Co. Ltd.	Snow Lake	MB	zinc	O	113
Cigar Lake Project	Cameco Corp, Cogema Resources Inc,	Cigar Lake	SK	uranium	AE	4
Clear Creek	Redstar Resources	Dawson District	YT	gold	AE	29

Cluff Lake	Cogema Resources Inc.	Saskatoon	SK	uranium	O	114
Coal Valley Mine	Luscar Ltd.	Edson	AB	coal	O	115
Cominco Expl Permit 180-181	Cominco	Baldock Lake	MB	nickel-copper	AE	48
Con Mine	Miramar Mining Corporation	Yellowknife	NWT	gold	O	116
Contact Lake Mine	Cameco Corporation	La Ronge	SK	gold	C	303
Copper Rand Mine	MSV Resources Inc.	Chibougamau	QC	copper-gold	C	304
David Bell Mine	Teck Corp, Homestake Canada Inc.	Marathon	ON	gold	O	117
De Beers Expl Permit 184-205	De Beers Exploration Cda Ltd	Gods Lake	MB	diamonds	AE	49
Debeers 167-170	Debeers Exploration	Hayes R. Upland	MB	diamonds	AE	51
Detour Lake Mine	Placer Dome Inc.	Cochrane	ON	gold	C	305
Division Mountain	Cash Resources	Whitehorse Division	YT	coal	AE	26
Dome Mine	Placer Dome Inc.	South Porcupine	ON	gold	O	118
Donalda Mine	--	Rouyn-Noranda	QC	gold	C	306
Dore Lake	Osisko Exploration Ltee (?)	Chicoutimi	QC	vanadium	AE	5
Doyon Mine	Cambior Inc.	Rouyn-Noranda	QC	gold	O	119
Dublin Gulch Project	New Millennium Mining Ltd	Mayo	YT	gold	AE	6
Duck Pond	Queenston Mining	Buchans	NFLD	copper-zinc-lead	AE	39
Eagle River Mine	River Gold Mines Ltd.	Wawa	ON	gold	O	120
East Amphi U/G Project	McWatters Mining Inc	Malartic	QC	gold	AE	7
Edwards Mine	River Gold Mines Ltd.	Wawa	ON	gold	O	121
Elsa Properties	United Keno Hill Mines Limited	Mayo	YT	silver-lead-zinc	C	307
Falconbridge Expl Perm 2001-0	Falconbridge	Gillam	MB	nickel-copper	AE	43
Faro Mine	Anvil Range Mining Corp	Faro	YK	lead-zinc	C	308
Finlayson Project	Expatriate Resource	Pelly River	YK	lead-zinc	AE	10
Flin Flon Mine and Mill	Hudson Bay Mining & Smelting Co. Ltd.	Flin Flon	MB	copper-lead-zinc	O	109
Flin Flon Smelter	Hudson Bay Mining & Smelting Co. Ltd.	Flin Flon	MB	copper smelter, zinc refin	S	500
Fonderie Gaspé Division	Noranda Mining and Exploration Inc.	Murdochville	QC	copper smelter	S	504
Francoeur	Richmont Mines Inc.	Rouyn-Noranda	QC	gold	O	123
Fyre Lake	Pacific Ridge Exploration	Finlayson Lake	YT	copper- cobalt-gold	AE	25
Gallen Mine	Noranda Inc.	Rouyn-Noranda	QC	zinc-copper-gold-silver	C	334
Geco Mine	Noranda Minerals Inc	Manitowadge	ON	copper-zinc	C	348
Genessee Operations	Fording Coal Limited	Warburg	AB	coal	O	125
Giant	Royal Oak Mines Inc.	Yellowknife	NWT	gold	O	126
Glimmer Mine	Exall Resources Ltd	Matheson	ON	gold	C	310
Golden Bear Mine	North American Metals Corp	Dease Lake	BC	gold	C	309
Golden Giant Mine	Battle Mountain Gold Company	Marathon	ON	gold	O	128
Golden Patricia	Barrick Gold	Pickle Lake	ON	gold	C	344

Goldfields Project	Greater Lenora Resources Corporation	Uranium City	SK	gold	AE	8
Grande-Baie Smelter	Alcan	La Baie	QC	aluminum	S	507
Gregg River Mine	Luscar Ltd.	Hinton	AB	coal	C	311
Hammerdown Mine	Richmont Mines	King's Point	NFLD	gold	AE	40
Highvale Mine	TransAlta Utilities Corp.	Seba Beach	AB	coal	O	130
Hislop Mine	St Andrews Goldfields Ltd	Matheson	ON	gold	C	345
Holloway Mine	Battle Mountain Canada Ltd	Kirkland Lake	ON	gold	C	335
Holt-McDermott Mine	Barrick Gold Corp.	Kirkland Lake	ON	gold	O	133
Hope Brook Gold Mine	Royal Oak	Couteau Bay	NFLD	gold	C	341
Horne Smelter	Noranda Mining and Exploration Inc.	Rouyn-Noranda	QC	copper smelter, sulphuric	S	502
Hoyle Pond	Kinross Gold Corporation	Schumacher	ON	gold	O	135
Hudson Bay Expl Permit 215	Hudson Bay Mining & Smelting Co. Ltd.	Pelletier Lake	MB	copper-zinc	AE	59
Indicator Expl Permit 2001-13	Indicator Explorations Ltd	Karloske River	MB	diamonds	AE	45
Iriana	Iriana Resources	S Hayes River	MB	diamonds	AE	47
Ice	Expatriate Resource				AE	28
Iron Ore Company of Canada	Iron Ore Company of Canada	Labrador City	NFLD	iron	O	136
Joe Mann	Campbell Resources Inc.	Chibougamau	QC	gold-copper	C	349
Joubi	Western Quebec Mines Inc.	Val d'Or	QC	gold	C	313
Kasabonika Diamond Explorati	De Beers	Pickle Lake	ON	diamonds	AE	9
Kennecott Expl Permit 2000-04	Kennecott Cda Explorations	Bear Head Lake	MB	diamonds	AE	44
Keno Hill	BLM Mines	Mayo District	YT	lead-zinc-silver	AE	30
Kerr	A.J. Perron	Virginiatown	ON	gold	C	346
Ketza River	YGC Resources Ltd.	Ross River	YT	gold-silver	AE	61
Key Lake	Cameco Corporation	Pine House	SK	uranium	O	139
Keystone	Black Hawk Mining Inc.	Lynn Lake	MB	gold	C	314
Kidd Creek Mettalurgical Site	Falconbridge Ltd.	Timmins	ON	zinc-copper-silver-lead-ca	S	503
Kidd Creek Mine	Falconbridge Ltd.	Timmins	ON	zinc-copper-silver-lead-ca	O	106
Kiena Complex	McWatters Mining Inc.	Malartic	QC	gold	O	141
Komis Mine	Golden Rule Resources	La Ronge Belt	SK	gold	C	315
Konuto Lake Mine	Hudson Bay Mining and Smelting Co. Ltd	Denare Beach	SK	copper	O	142
Lac des Iles Mine	North American Palladium Ltd	Thunder Bay	ON	platinum grp metals-gold-	O	146
Lac Tio Mine	Quit-Fer et Titane Inc.	Havre St-Pierre	QC	iron-titanium	O	145
Langlois Mine	Breakwater Resources Ltd	Val d'Or	QC	zinc-copper-gold-silver	O	147
LaRonde Mine	Agnico-Eagle Mines Ltd	Val d'Or	QC	gold-silver-copper-zinc	O	143
Laterrière Smelter	Alcan	Chicoutimi	QC	aluminum	S	508
Legend / Jazz Properties	Montella	Buffalo Hills	AB	diamonds	AE	55
Les Mines Selbaie	Biliton PLC	Rouyn-Noranda	QC	copper-zinc-gold-silver	O	148

Louvicourt	Novicourt Inc.	Val d'Or	QC	copper-zinc-silver-gold	O	149
Luscar Mine	Luscar Ltd, Consol of Canada Inc.	Hinton	AB	coal	O	150
Macassa Mine	Kinross Gold Corporation	Kirkland Lake	ON	gold	C	316
Madsen Mine	Claude Resources Inc.	Red Lake	ON	gold	C	317
Magino Mine	Golden Goose Resources	Wawa	ON	gold	C	318
Magnola Metallurgy	Noranda	Danville	QC	magnesium	O	
Marathon Project	Polymet	Marathon	ON	palladium	AE	11
Maskwa Mill Project	Canmine Resources	Nopiming Provincial Park	MB	cobalt-copper	AE	12
Matachewan Gold Mine	Royal Oak Mines	Matachewan	ON	gold	AE	13
McArthur River Mine	Cameco Corp, Cogema Resources Inc.	Key Lake	SK	uranium	O	151
McClean Lake Mine	Cogema Resources Inc, Denison Mines	Wollaston Lake	SK	uranium	O	152
McIlvenna Bay Deposit	Foran Mining Co	Hanson Lake	SK	base metals	AE	53
Mid West Joint Venture	Cogema Res.,Uranerz Ltd,Denison Mines	Wollaston Lake	SK	uranium	AE	58
Mines Gaspé Copper	Noranda Mining and Exploration Inc.	Murdochville	QC	copper	C	319
Minto Project	Minto Exploration Ltd	Dawson City	YT	copper-gold-silver	AE	14
Mishi Pit	River Gold Mines Ltd	Wawa	ON	gold	AE	15
Montcalm Project	Falconbridge	Timmins	ON	nickel-copper	AE	16
Moss Lake Gold Mines Ltd	River Gold	Shebandowan	ON	gold	AE	18
Mount Nansen Mine	B.Y.G. Natural Resources Inc.	Carmacks	YT	gold-silver	C	320
Mount Skukum Mine	Tagish Lake Gold Corp	Wheaton River	YT	gold-silver	C	153
Mount-Wright	Quebec Cartier Mining Company	Mount Wright	QC	iron	O	154
Mouska Mine	Cambior Inc.	Destor	QC	gold	O	321
Musselwhite Mine	Placer Dome Inc, TVX Normandy	Pickle Lake	ON	gold	O	155
New Britannia Mine	TVX Normandy Americas, High River Gold I	Snow Lake	MB	gold	O	156
Nighthawk Lake	Kinross Mines	Timmins	ON	gold	C	342
Niobec	Teck Corporation & Cambior Inc.	Chicoutimi	QC	niobium	O	157
Nugget Pond	Richmont Mines Inc.	Baie Verte	NFLD	gold	O	158
Oasis 2001-05	Oasis Diamonds	Ilford	MB	diamonds	AE	50
Obed Mountain Mine	Luscar Ltd	Hinton	AB	coal	O	159
Orleans Wollastonite Operation	Orleans Resources Inc.	Lac St-Jean	QC	wollastonite	O	160
Pamour Mine	Kinross	Timmins	ON	gold-silver	C	322
Pembina/Gleichen Properties	DRC Resources Corp	Evansburg	AB	diamonds	AE	57
Photo Lake	Hudson Bay Mining & Smelting Co. Ltd.	Snow Lake	MB	copper-zinc-gold-silver	C	336
Pine Cove Gold Mine	Nova Gold / Pine Cover Resources	Harbour Grace	NFLD	gold	AE	19
Pine Point Mine	Kent-Ross Group (prev. Cominco Ltd)	Pine Point	NWT	lead-zinc	AE	17
Polaris Taku	Rembrandt Gold	Tulsequa Chief	BC	gold	AE	36
Prairie Creek	Canadian Zinc Corporation	Nahanni	NWT	zinc	AE	35

Ptarmigan Mine	Calim Equity Partners LCC	Yellowknife	NWT	gold	C	323
Puffy Lake Mine	Pioneer Metals Corporation	Flin Flon	MB	gold	C	324
QIT - Fer et Titan Smelter	Rio Tinto / QIT - Fer et Titane Inc.	Havre Saint-Pierre	QC	titanium dioxide	S	505
Quintette	Teck Corp	Chetwynd	BC	coal	C	339
Rabbit Lake	Cameco Corporation	Saskatoon	SK	uranium	O	164
Rambler Mine	Ming Minerals Inc.	Baie Verte	NFLD	copper-gold	C	325
Red Chris	American Bullion Minerals	Stikine District	BC	metal	AE	33
Red Lake Mine	Goldcorp Inc	Balmerton	ON	gold	O	165
Renabie	Barrick / Homestake	Missinabie	ON	gold	C	326
Ruttan	Hudson Bay Mining & Smelting Co. Ltd.	Leaf Rapids	MB	copper-zinc	O	166
Sa Dena Hes Mine	Teck Cominco Ltd, Korea Zinc Co. Ltd	Watson Lake	YT	zinc-lead	C	327
Schleelite Dome	Copper Ridge	Mayo District	YT	gold	AE	31
Seabee	Claude Resources Inc.	La Ronge	SK	gold	O	167
Seal / Whitefish Tower	New Claymore	Lubicon Lake	AB	diamonds	AE	56
Shebandowan Mine	Inco Limited	Shebandowan	ON	nickel-copper-cobalt-plati	C	328
Sigma-Lamaque Complex	McWatters Mining Inc	Val d'Or	QC	gold	C	312
Silvertip Project	Imperal Metals	Watson	BC	sliver-lead-zinc	AE	37
Skukum Creek	Omni Resources	Wheaton	YT	gold-silver-lead-zinc	AE	24
Sleeping Giant Mine	Aurizon Mines Ltd, Cambior Inc.	Amos	QC	gold	O	170
South Africa Minerals	Southern Africa Minerals Corporation	Foleyet	ON	Anorthosite	AE	20
Spider Resources	Spider Resources	Wawa	ON	diamonds	AE	21
Stock Mine	St Andrew Goldfields Ltd	Stock twp	ON	gold	C	337
Table Mountain Mine	Cusac Gold Mines Ltd	Watson Lake	BC	gold	C	329
Taurus Project	International Taurus Resources	Watson Lake	BC	gold	AE	38
Thompson Mine (T-1 & T-2)	Inco Limited	Thompson	MB	nickel-copper	O	174
Thompson Mine Smelter	Inco Limited	Thompson	MB	nickel-copper	S	506
Tom Mine	Calim Equity Partners LCC	Yellowknife	NWT	gold	C	331
Troilus Mine	Inmet Mining Corporation	Chibougamau	QC	gold-copper	O	175
Trout Lake Mine	Hudson Bay Mining & Smelting Co. Ltd.	Flin Flon	MB	copper-zinc-gold-silver	O	176
Tulsequah Chief Project	Redfern Resources Ltd	Atlin	BC	copper-lead-zinc-gold-silv	AE	22
Voisey's Bay Deposit	Inco	Nain	NFLD	nickel	AE	60
Wabush Mine	Stelco Inc.	Labrador City	NFLD	iron	O	177
Wellgreen Property	Northern Platinum Ltd.	Haines Junction	YT	platinum-palladium-coppe	AE	32
Werner Lake Project	Canmine Resources Corporation	Werner Lake	ON	cobalt	AE	23
Whiskey Lake	Noranda Mines		YT	coal	C	338
Whitewood Operations	TransAlta Utilities Corp	Wabamun	AB	coal	O	179
Williams Mine	Teck Corp, Homestake Canada Inc.	Marathon	ON	gold	O	180

Willow Creek	Global Tex / Dire Valley Coal	Chetwynd	BC	coal	AE	34
Wilroy Mine	Noranda Minerals	Manitowadge	ON	copper-zinc	C	346
Winston Lake Division	Inmet Mining Corporation	Schreiber	ON	zinc-copper	C	330

Appendix C

List of Mines in the Boreal Forest Region

Sorted by Province and Mine Name

December, 2001

LIST OF MINES IN THE BOREAL FOREST REGION, SORTED BY PROVINCE					
MINE NAME	**COMPANY**	**LOCATION**	**PROV**	**METAL(S)**	**STATUS**
ALBERTA					
Buffalo Head Craton	Ashton Mining / Pure Gold Minerals Inc.	Buffalo Hills	AB	diamonds	AE
Cheviot Mine Project	Luscar Ltd, Consold of Canada Inc	Hinton	AB	coal	AE
Coal Valley Mine	Luscar Ltd.	Edson	AB	coal	O
Genessee Operations	Fording Coal Limited	Warburg	AB	coal	O
Gregg River Mine	Luscar Ltd.	Hinton	AB	coal	C
Highvale Mine	TransAlta Utilities Corp.	Seba Beach	AB	coal	O
Legend / Jazz Properties	Montella	Buffalo Hills	AB	diamonds	AE
Luscar Mine	Luscar Ltd, Consol of Canada Inc.	Hinton	AB	coal	O
Obed Mountain Mine	Luscar Ltd	Hinton	AB	coal	O
Pembina/Gleichen Properties	DRC Resources Corp	Evansburg	AB	diamonds	AE
Seal / Whitefish Tower	New Claymore	Lubicon Lake	AB	diamonds	AE
Whitewood Operations	TransAlta Utilities Corp	Wabamun	AB	coal	O
BRITISH COLUMBIA					
Bullmoose	Teck Corp	Chetwynd	BC	coal	C
Golden Bear Mine	North American Metals Corp	Dease Lake	BC	gold	C
Polaris Taku	Rembrandt Gold	Tulsequa Chief	BC	gold	AE
Quintette	Teck Corp	Chetwynd	BC	coal	C
Red Chris	American Bullion Minerals	Stikine District	BC	metal	AE
Silvertip Project	Imperal Metals	Watson	BC	sliver-lead-zinc	AE
Table Mountain Mine	Cusac Gold Mines Ltd	Watson Lake	BC	gold	C
Taurus Project	International Taurus Resources	Watson Lake	BC	gold	AE
Tulsequah Chief Project	Redfern Resources Ltd	Atlin	BC	copper-lead-zinc-gold-silv	AE
Willow Creek	Global Tex / Dire Valley Coal	Chetwynd	BC	coal	AE
MANITOBA					
777 Project	Hudson Bay Mining & Smelting Co. Ltd.	Flin Flon	MB	copper-zinc-gold-silver	AE
Bernic Lake	Cabot Corporation	Lac du Bonnet	MB	lithium-cesium-rubidium	O
BHP Expl Permit 161	BHP Diamonds	Hudson Bay Lowlands	MB	diamonds	AE
Birchtree	INCO	Thompson	MB	nickel-copper	O
Bissett Mine	Harmony Gold Mining Company Ltd.	Bissett	MB	gold	C
Bucko Lake Nickel Mine	Nuinsco Resources/Falconbridge	Wabawden	MB	nickel	O
Callinan Mine	Hudson Bay Mining & Smelting Co. Ltd.	Flin Flon	MB	copper-zinc-gold-silver	O

Canmine Expl Permit 99-16	Canmine Resources	S. Churchill	MB	nickel-copper	AE
Chisel North Mine	Hudson Bay Mining & Smelting Co. Ltd.	Snow Lake	MB	zinc	O
Cominco Expl Permit 180-181	Cominco	Baldock Lake	MB	nickel-copper	AE
De Beers Expl Permit 184-205	De Beers Exploration Cda Ltd	Gods Lake	MB	diamonds	AE
Debeers 167-170	Debeers Exploration	Hayes R. Upland	MB	diamonds	AE
Falconbridge Expl Perm 2001-07	Falconbridge	Gillam	MB	nickel-copper	AE
Flin Flon Mine and Mill	Hudson Bay Mining & Smelting Co. Ltd.	Flin Flon	MB	copper-lead-zinc	O
Flin Flon Smelter	Hudson Bay Mining & Smelting Co. Ltd.	Flin Flon	MB	copper smelter, zinc refin	S
Hudson Bay Expl Permit 215	Hudson Bay Mining & Smelting Co. Ltd.	Pelletier Lake	MB	copper-zinc	AE
Indicator Expl Permit 2001-13	Indicator Explorations Ltd	Karloske River	MB	diamonds	AE
Iriana	Iriana Resources	S Hayes River	MB	diamonds	AE
Kennecott Expl Permit 2000-04	Kennecott Cda Explorations	Bear Head Lake	MB	diamonds	AE
Keystone	Black Hawk Mining Inc.	Lynn Lake	MB	gold	C
Maskwa Mill Project	Canmine Resources	Nopiming Provincial Park	MB	cobalt-copper	AE
New Britannia Mine	TVX Normandy Americas, High River Gold I	Snow Lake	MB	gold	O
Oasis 2001-05	Oasis Diamonds	Ilford	MB	diamonds	AE
Photo Lake	Hudson Bay Mining & Smelting Co. Ltd.	Snow Lake	MB	copper-zinc-gold-silver	C
Puffy Lake Mine	Pioneer Metals Corporation	Flin Flon	MB	gold	C
Ruttan	Hudson Bay Mining & Smelting Co. Ltd.	Leaf Rapids	MB	copper-zinc	O
Thompson Mine (T-1 & T-2)	Inco Limited	Thompson	MB	nickel-copper	O
Thompson Mine Smelter	Inco Limited	Thompson	MB	nickel-copper	S
Trout Lake Mine	Hudson Bay Mining & Smelting Co. Ltd.	Flin Flon	MB	copper-zinc-gold-silver	O
NEWFOUNDLAND AND LABRADOR					
Beaver Brook	Roycefield Resources	Glenwood	NFLD	antimony	C
Duck Pond	Queenston Mining	Buchans	NFLD	copper-zinc-lead	AE
Hammerdown Mine	Richmont Mines	King's Point	NFLD	gold	AE
Hope Brook Gold Mine	Royal Oak	Couteau Bay	NFLD	gold	C
Iron Ore Company of Canada	Iron Ore Company of Canada	Labrador City	NFLD	iron	O
Nugget Pond	Richmont Mines Inc.	Baie Verte	NFLD	gold	O
Pine Cove Gold Mine	Nova Gold / Pine Cover Resources	Harbour Grace	NFLD	gold	AE
Rambler Mine	Ming Minerals Inc.	Baie Verte	NFLD	copper-gold	C
Voisey's Bay Deposit	Inco	Nain	NFLD	nickel	AE
Wabush Mine	Stelco Inc.	Labrador City	NFLD	iron	O
NORTHWEST TERRITORIES					
CanTung Mine	North American Tungsten Corp. Ltd	Tungsten	NWT	tungsten	AE
Con Mine	Miramar Mining Corporation	Yellowknife	NWT	gold	O

Giant	Royal Oak Mines Inc.	Yellowknife	NWT	gold	O
Pine Point Mine	Kent-Ross Group (prev. Cominco Ltd)	Pine Point	NWT	lead-zinc	AE
Prairie Creek	Canadian Zinc Corporation	Nahanni	NWT	zinc	AE
Ptarmigan Mine	Calim Equity Partners LCC	Yellowknife	NWT	gold	C
Tom Mine	Calim Equity Partners LCC	Yellowknife	NWT	gold	C
ONTARIO					
Adams Mine	Dofasco	Kirkland Lake	ON	iron ore	C
Agrium Phosphate Mine	Agrium Products Inc.	Kapaskasing	ON	phosphate	O
Algoma Ore Division	Algoma Steel Inc.	Wawa	ON	iron	C
Aquarius Project	Echo Bay Mines Ltd	Timmins	ON	gold	AE
Campbell Mine	Placer Dome Inc.	Balmerton	ON	gold	O
Cheminis	Northfield Minerals Inc	Larder Lake	ON	gold	C
David Bell Mine	Teck Corp, Homestake Canada Inc.	Marathon	ON	gold	O
Detour Lake Mine	Placer Dome Inc.	Cochrane	ON	gold	C
Dome Mine	Placer Dome Inc.	South Porcupine	ON	gold	O
Eagle River Mine	River Gold Mines Ltd.	Wawa	ON	gold	O
Edwards Mine	River Gold Mines Ltd.	Wawa	ON	gold	O
Geco Mine	Noranda Minerals Inc	Manitowadge	ON	copper-zinc	C
Glimmer Mine	Exall Resources Ltd	Matheson	ON	gold	C
Golden Giant Mine	Battle Mountain Gold Company	Marathon	ON	gold	O
Golden Patricia	Barrick Gold	Pickle Lake	ON	gold	C
Hislop Mine	St Andrews Goldfields Ltd	Matheson	ON	gold	C
Holloway Mine	Battle Mountain Canada Ltd	Kirkland Lake	ON	gold	C
Holt-McDermott Mine	Barrick Gold Corp.	Kirkland Lake	ON	gold	O
Hoyle Pond	Kinross Gold Corporation	Schumacher	ON	gold	O
Kasabonika Diamond Exploration	De Beers	Pickle Lake	ON	diamonds	AE
Kerr Mine	A.J. Perron	Virginiatown	ON	gold	C
Kidd Creek Mettalurgical Site	Falconbridge Ltd.	Timmins	ON	zinc-copper-silver-lead-ca	S
Kidd Creek Mine	Falconbridge Ltd.	Timmins	ON	zinc-copper-silver-lead-ca	O
Lac des Iles Mine	North American Palladium Ltd	Thunder Bay	ON	platinum grp metals-gold-	O
Macassa Mine	Kinross Gold Corporation	Kirkland Lake	ON	gold	C
Madsen Mine	Claude Resources Inc.	Red Lake	ON	gold	C
Magino Mine	Golden Goose Resources	Wawa	ON	gold	C
Marathon Project	Polymet	Marathon	ON	palladium	AE
Matachewan Gold Mine	Royal Oak Mines	Matachewan	ON	gold	AE
Mishi Pit	River Gold Mines Ltd	Wawa	ON	gold	AE

Montcalm Project	Falconbridge	Timmins	ON	nickel-copper	AE
Moss Lake Gold Mines Ltd	River Gold	Shebandowan	ON	gold	AE
Musselwhite Mine	Placer Dome Inc, TVX Normandy	Pickle Lake	ON	gold	O
Nighthawk Lake	Kinross Mines	Timmins	ON	gold	C
Pamour Mine	Kinross	Timmins	ON	gold-silver	C
Red Lake Mine	Goldcorp Inc	Balmerton	ON	gold	O
Renabie	Barrick / Homestake	Missinabie	ON	gold	C
Shebandowan Mine	Inco Limited	Shebandowan	ON	nickel-copper-cobalt-plati	C
South Africa Minerals	Southern Africa Minerals Corporation	Foleyet	ON	Anorthosite	AE
Spider Resources	Spider Resources	Wawa	ON	diamonds	AE
Stock Mine	St Andrew Goldfields Ltd	Stock twp	ON	gold	C
Werner Lake Project	Canmine Resources Corporation	Werner Lake	ON	cobalt	AE
Williams Mine	Teck Corp, Homestake Canada Inc.	Marathon	ON	gold	O
Wilroy Mine	Noranda Minerals	Manitowadge	ON	copper-zinc	C
Winston Lake Division	Inmet Mining Corporation	Schreiber	ON	zinc-copper	C
QUEBEC					
Alma Smelter	Alcan	Alma	QC	aluminum	S
Arvida Smelter	Alcan	Jonquière	QC	aluminum	S
B.C. (British Canadian) Operations	Asbestos Corporation Limited	Chicoutimi	QC	asbestos	C
Beaufor Mine	Louvem Mines Inc. & Aurizon Mines Ltd.	Val d'Or	QC	gold	C
Bell Allard Mine	Noranda Inc.	Matagami	QC	zinc-copper	O
Bouchard-Hebert	Cambior Inc.	Quebec	QC	zinc-copper-gold-silver	O
Bousquet #2	Barrick Gold Corporation	Preissac	QC	gold-copper	O
Casa Berardi Mine	Aurizon Mines Ltd	La Sarre	QC	gold	C
Copper Rand Mine	MSV Resources Inc.	Chibougamau	QC	copper-gold	C
Donalda Mine	--	Rouyn-Noranda	QC	gold	C
Dore Lake	Osisko Exploration Ltee (?)	Chicoutimi	QC	vanadium	AE
Doyon Mine	Cambior Inc.	Rouyn-Noranda	QC	gold	O
East Amphi U/G Project	McWatters Mining Inc	Malartic	QC	gold	AE
Fonderie Gaspé Division	Noranda Mining and Exploration Inc.	Murdochville	QC	copper smelter	S
Francoeur	Richmont Mines Inc.	Rouyn-Noranda	QC	gold	O
Gallen Mine	Noranda Inc.	Rouyn-Noranda	QC	zinc-copper-gold-silver	C
Grande-Baie Smelter	Alcan	La Baie	QC	aluminum	S
Horne Smelter	Noranda Mining and Exploration Inc.	Rouyn-Noranda	QC	copper smelter, sulphuric	S
Joe Mann	Campbell Resources Inc.	Chibougamau	QC	gold-copper	C
Joubi	Western Quebec Mines Inc.	Val d'Or	QC	gold	C

Kiena Complex	McWatters Mining Inc.	Malartic	QC	gold	O
Lac Tio	Quit-Fer et Titane Inc.	Havre St-Pierre	QC	iron-titanium	O
Langlois Mine	Breakwater Resources Ltd	Val d'Or	QC	zinc-copper-gold-silver	O
LaRonde Mine	Agnico-Eagle Mines Ltd	Val d'Or	QC	gold-silver-copper-zinc	O
Laterrière Smelter	Alcan	Chicoutimi	QC	aluminum	S
Les Mines Selbaie	Biliton PLC	Rouyn-Noranda	QC	copper-zinc-gold-silver	O
Louvicourt	Novicourt Inc.	Val d'Or	QC	copper-zinc-silver-gold	O
Magnola Metallurgy	Noranda	Danville	QC	magnesium	O
Mines Gaspé Copper	Noranda Mining and Exploration Inc.	Murdochville	QC	copper	C
Mount-Wright	Quebec Cartier Mining Company	Mount Wright	QC	iron	O
Mouska Mine	Cambior Inc.	Destor	QC	gold	O
Niobec	Teck Corporation & Cambior Inc.	Chicoutimi	QC	niobium	O
Orleans Wollastonite Operation	Orleans Resources Inc.	Lac St-Jean	QC	wollastonite	O
QIT - Fer et Titan Smelter	Rio Tinto / QIT - Fer et Titane Inc.	Havre Saint-Pierre	QC	titanium dioxide	S
Sigma-Lamaque Complex	McWatters Mining Inc	Val d'Or	QC	gold	C
Sleeping Giant Mine	Aurizon Mines Ltd, Cambior Inc.	Amos	QC	gold	O
Troilus Mine	Inmet Mining Corporation	Chibougamau	QC	gold-copper	O
SASKATCHEWAN					
Amisk Lake Joint Venture	Cameco Corp	Denare Beach	SK	gold	AE
Cigar Lake Project	Cameco Corp, Cogema Resources Inc,	Cigar Lake	SK	uranium	AE
Cluff Lake	Cogema Resources Inc.	Saskatoon	SK	uranium	O
Contact Lake Mine	Cameco Corporation	La Ronge	SK	gold	C
Goldfields Project	Greater Lenora Resources Corporation	Uranium City	SK	gold	AE
Key Lake	Cameco Corporation	Pine House	SK	uranium	O
Komis Mine	Golden Rule Resources	La Ronge Belt	SK	gold	C
Konuto Lake Mine	Hudson Bay Mining and Smelting Co. Ltd	Denare Beach	SK	copper	O
McArthur River Mine	Cameco Corp, Cogema Resources Inc.	Key Lake	SK	uranium	O
McClean Lake Mine	Cogema Resources Inc, Denison Mines	Wollaston Lake	SK	uranium	O
McIlvenna Bay Deposit	Foran Mining Co	Hanson Lake	SK	base metals	AE
Mid West Joint Venture	Cogema Res.,Uranerz Ltd,Denison Mines	Wollaston Lake	SK	uranium	AE
Rabbit Lake	Cameco Corporation	Saskatoon	SK	uranium	O
Seabee	Claude Resources Inc.	La Ronge	SK	gold	O
YUKON TERRITORY					
Brewery Creek Mine	Viceroy Resource Corporation	Dawson City	YK	gold	O
Faro Mine	Anvil Range Mining Corp	Faro	YK	lead-zinc	C
Finlayson Project	Expatriate Resource	Pelly River	YK	lead-zinc	AE

Carmacks Project	Western Copper Holdings	Whitehorse Division	YT	copper	AE
Clear Creek	Redstar Resources	Dawson District	YT	gold	AE
Division Mountain	Cash Resources	Whitehorse Division	YT	coal	AE
Dublin Gulch Project	New Millennium Mining Ltd	Mayo	YT	gold	AE
Elsa Properties	United Keno Hill Mines Limited	Mayo	YT	silver-lead-zinc	C
Fyre Lake	Pacific Ridge Exploration	Finlayson Lake	YT	copper- cobalt-gold	AE
Keno Hill	BLM Mines	Mayo District	YT	lead-zinc-silver	AE
Ketza River	YGC Resources Ltd.	Ross River	YT	gold-silver	AE
Minto Project	Minto Exploration Ltd	Dawson City	YT	copper-gold-silver	AE
Mount Nansen Mine	B.Y.G. Natural Resources Inc.	Carmacks	YT	gold-silver	C
Mount Skukum Mine	Tagish Lake Gold Corp	Wheaton River	YT	gold-silver	C
Sa Dena Hes Mine	Teck Cominco Ltd, Korea Zinc Co. Ltd	Watson Lake	YT	zinc-lead	C
Schleelite Dome	Copper Ridge	Mayo District	YT	gold	AE
Skukum Creek	Omni Resources	Wheaton	YT	gold-silver-lead-zinc	AE
Wellgreen Property	Northern Platinum Ltd.	Haines Junction	YT	platinum-palladium-coppe	AE
Whiskey Lake	Noranda Mines		YT	coal	C

Appendix D

List of Mines in the Boreal Forest Region

Sorted by Status (Exploration, Closed, Operating, Abandoned Acid Generating or Smelter), Province & Mine

December, 2001

LIST OF MINES, SORTED BY STATUS (EXPLORATION, OPERATING, CLOSED, SMELTER), PROVINCE, AND MINE NAME					
MINE NAME	**COMPANY**	**LOCATION**	**PROV**	**METAL(S)**	**STATUS**
Buffalo Head Craton	Ashton Mining / Pure Gold Minerals Inc.	Buffalo Hills	AB	diamonds	AE
Cheviot Mine Project	Luscar Ltd, Consold of Canada Inc	Hinton	AB	coal	AE
Legend / Jazz Properties	Montella	Buffalo Hills	AB	diamonds	AE
Pembina/Gleichen Properties	DRC Resources Corp	Evansburg	AB	diamonds	AE
Seal / Whitefish Tower	New Claymore	Lubicon Lake	AB	diamonds	AE
Polaris Taku	Rembrandt Gold	Tulsequa Chief	BC	gold	AE
Red Chris	American Bullion Minerals	Stikine District	BC	metal	AE
Silvertip Project	Imperal Metals	Watson	BC	sliver-lead-zinc	AE
Taurus Project	International Taurus Resources	Watson Lake	BC	gold	AE
Tulsequah Chief Project	Redfern Resources Ltd	Atlin	BC	copper-lead-zinc-gold-silv	AE
Willow Creek	Global Tex / Dire Valley Coal	Chetwynd	BC	coal	AE
777 Project	Hudson Bay Mining & Smelting Co. Ltd.	Flin Flon	MB	copper-zinc-gold-silver	AE
BHP Expl Permit 161	BHP Diamonds	Hudson Bay Lowlands	MB	diamonds	AE
Canmine Expl Permit 99-16	Canmine Resources	S. Churchill	MB	nickel-copper	AE
Cominco Expl Permit 180-181	Cominco	Baldock Lake	MB	nickel-copper	AE
De Beers Expl Permit 184-205	De Beers Exploration Cda Ltd	Gods Lake	MB	diamonds	AE
Debeers 167-170	Debeers Exploration	Hayes R. Upland	MB	diamonds	AE
Falconbridge Expl Perm 2001-07	Falconbridge	Gillam	MB	nickel-copper	AE
Hudson Bay Expl Permit 215	Hudson Bay Mining & Smelting Co. Ltd.	Pelletier Lake	MB	copper-zinc	AE
Indicator Expl Permit 2001-13	Indicator Explorations Ltd	Karloske River	MB	diamonds	AE
Iriana	Iriana Resources	S Hayes River	MB	diamonds	AE
Kennecott Expl Permit 2000-04	Kennecott Cda Explorations	Bear Head Lake	MB	diamonds	AE
Maskwa Mill Project	Canmine Resources	Nopiming Provincial Park	MB	cobalt-copper	AE
Oasis 2001-05	Oasis Diamonds	Ilford	MB	diamonds	AE
Duck Pond	Queenston Mining	Buchans	NFLD	copper-zinc-lead	AE
Hammerdown Mine	Richmont Mines	King's Point	NFLD	gold	AE
Pine Cove Gold Mine	Nova Gold / Pine Cover Resources	Harbour Grace	NFLD	gold	AE
Voisey's Bay Deposit	Inco	Nain	NFLD	nickel	AE
CanTung Mine	North American Tungsten Corp. Ltd	Tungsten	NWT	tungsten	AE
Pine Point Mine	Kent-Ross Group (prev. Cominco Ltd)	Pine Point	NWT	lead-zinc	AE
Prairie Creek	Canadian Zinc Corporation	Nahanni	NWT	zinc	AE
Aquarius Project	Echo Bay Mines Ltd	Timmins	ON	gold	AE
Kasabonika Diamond Exploration	De Beers	Pickle Lake	ON	diamonds	AE

Marathon Project	Polymet	Marathon	ON	palladium	AE
Matachewan Gold Mine	Royal Oak Mines	Matachewan	ON	gold	AE
Mishi Pit	River Gold Mines Ltd	Wawa	ON	gold	AE
Montcalm Project	Falconbridge	Timmins	ON	nickel-copper	AE
Moss Lake Gold Mines Ltd	River Gold	Shebandowan	ON	gold	AE
South Africa Minerals	Southern Africa Minerals Corporation	Foleyet	ON	Anorthosite	AE
Spider Resources	Spider Resources	Wawa	ON	diamonds	AE
Werner Lake Project	Canmine Resources Corporation	Werner Lake	ON	cobalt	AE
Dore Lake	Osisko Exploration Ltee (?)	Chicoutimi	QC	vanadium	AE
East Amphi U/G Project	McWatters Mining Inc	Malartic	QC	gold	AE
Amisk Lake Joint Venture	Cameco Corp	Denare Beach	SK	gold	AE
Cigar Lake Project	Cameco Corp, Cogema Resources Inc,	Cigar Lake	SK	uranium	AE
Goldfields Project	Greater Lenora Resources Corporation	Uranium City	SK	gold	AE
McIlvenna Bay Deposit	Foran Mining Co	Hanson Lake	SK	base metals	AE
Mid West Joint Venture	Cogema Res.,Uranerz Ltd,Denison Mines	Wollaston Lake	SK	uranium	AE
Finlayson Project	Expatriate Resource	Pelly River	YK	lead-zinc	AE
Carmacks Project	Western Copper Holdings	Whitehorse Division	YT	copper	AE
Clear Creek	Redstar Resources	Dawson District	YT	gold	AE
Division Mountain	Cash Resources	Whitehorse Division	YT	coal	AE
Dublin Gulch Project	New Millennium Mining Ltd	Mayo	YT	gold	AE
Fyre Lake	Pacific Ridge Exploration	Finlayson Lake	YT	copper- cobalt-gold	AE
Keno Hill	BLM Mines	Mayo District	YT	lead-zinc-silver	AE
Ketza River	YGC Resources Ltd.	Ross River	YT	gold-silver	AE
Minto Project	Minto Exploration Ltd	Dawson City	YT	copper-gold-silver	AE
Schleelite Dome	Copper Ridge	Mayo District	YT	gold	AE
Skukum Creek	Omni Resources	Wheaton	YT	gold-silver-lead-zinc	AE
Wellgreen Property	Northern Platinum Ltd.	Haines Junction	YT	platinum-palladium-copp	AE
Gregg River Mine	Luscar Ltd.	Hinton	AB	coal	C
Golden Bear Mine	North American Metals Corp	Dease Lake	BC	gold	C
Quintette	Teck Corp	Chetwynd	BC	coal	C
Table Mountain Mine	Cusac Gold Mines Ltd	Watson Lake	BC	gold	C
Bissett Mine	Harmony Gold Mining Company Ltd.	Bissett	MB	gold	C
Keystone	Black Hawk Mining Inc.	Lynn Lake	MB	gold	C
Photo Lake	Hudson Bay Mining & Smelting Co. Ltd.	Snow Lake	MB	copper-zinc-gold-silver	C
Puffy Lake Mine	Pioneer Metals Corporation	Flin Flon	MB	gold	C
Beaver Brook	Roycefield Resources	Glenwood	NFLD	antimony	C
Hope Brook Gold Mine	Royal Oak	Couteau Bay	NFLD	gold	C

Rambler Mine	Ming Minerals Inc.	Baie Verte	NFLD	copper-gold	C
Ptarmigan Mine	Calim Equity Partners LCC	Yellowknife	NWT	gold	C
Tom Mine	Calim Equity Partners LCC	Yellowknife	NWT	gold	C
Adams Mine	Dofasco	Kirkland Lake	ON	iron ore	C
Algoma Ore Division	Algoma Steel Inc.	Wawa	ON	iron	C
Cheminis	Northfield Minerals Inc	Larder Lake	ON	gold	C
Detour Lake Mine	Placer Dome Inc.	Cochrane	ON	gold	C
Geco Mine	Noranda Minerals Inc	Manitowadge	ON	copper-zinc	C
Glimmer Mine	Exall Resources Ltd	Matheson	ON	gold	C
Golden Patricia	Barrick Gold	Pickle Lake	ON	gold	C
Hislop Mine	St Andrews Goldfields Ltd	Matheson	ON	gold	C
Holloway Mine	Battle Mountain Canada Ltd	Kirkland Lake	ON	gold	C
Kerr	A.J. Perron	Virginiatown	ON	gold	C
Macassa Mine	Kinross Gold Corporation	Kirkland Lake	ON	gold	C
Madsen Mine	Claude Resources Inc.	Red Lake	ON	gold	C
Magino Mine	Golden Goose Resources	Wawa	ON	gold	C
Nighthawk Lake	Kinross Mines	Timmins	ON	gold	C
Pamour Mine	Kinross	Timmins	ON	gold-silver	C
Renabie	Barrick / Homestake	Missinabie	ON	gold	C
Shebandowan Mine	Inco Limited	Shebandowan	ON	nickel-copper-cobalt-plati	C
Stock Mine	St Andrew Goldfields Ltd	Stock twp	ON	gold	C
Wilroy Mine	Noranda Minerals	Manitowadge	ON	copper-zinc	C
Winston Lake Division	Inmet Mining Corporation	Schreiber	ON	zinc-copper	C
B.C. (British Canadian) Operations	Asbestos Corporation Limited	Chicoutimi	QC	asbestos	C
Beaufor Mine	Louvem Mines Inc. & Aurizon Mines Ltd.	Val d'Or	QC	gold	C
Casa Berardi Mine	Aurizon Mines Ltd	La Sarre	QC	gold	C
Copper Rand Mine	MSV Resources Inc.	Chibougamau	QC	copper-gold	C
Donalda Mine	--	Rouyn-Noranda	QC	gold	C
Gallen Mine	Noranda Inc.	Rouyn-Noranda	QC	zinc-copper-gold-silver	C
Joe Mann	Campbell Resources Inc.	Chibougamau	QC	gold-copper	C
Joubi	Western Quebec Mines Inc.	Val d'Or	QC	gold	C
Mines Gaspé Copper	Noranda Mining and Exploration Inc.	Murdochville	QC	copper	C
Sigma-Lamaque Complex	McWatters Mining Inc	Val d'Or	QC	gold	C
Contact Lake Mine	Cameco Corporation	La Ronge	SK	gold	C
Komis Mine	Golden Rule Resources	La Ronge Belt	SK	gold	C
Faro Mine	Anvil Range Mining Corp	Faro	YK	lead-zinc	C
Elsa Properties	United Keno Hill Mines Limited	Mayo	YT	silver-lead-zinc	C

Mount Nansen Mine	B.Y.G. Natural Resources Inc.	Carmacks	YT	gold-silver	C
Mount Skukum Mine	Tagish Lake Gold Corp	Wheaton River	YT	gold-silver	C
Sa Dena Hes Mine	Teck Cominco Ltd, Korea Zinc Co. Ltd	Watson Lake	YT	zinc-lead	C
Whiskey Lake	Noranda Mines		YT	coal	C
Coal Valley Mine	Luscar Ltd.	Edson	AB	coal	O
Genessee Operations	Fording Coal Limited	Warburg	AB	coal	O
Highvale Mine	TransAlta Utilities Corp.	Seba Beach	AB	coal	O
Luscar Mine	Luscar Ltd, Consol of Canada Inc.	Hinton	AB	coal	O
Obed Mountain Mine	Luscar Ltd	Hinton	AB	coal	O
Whitewood Operations	TransAlta Utilities Corp	Wabamun	AB	coal	O
Bullmoose	Teck Corp	Chetwynd	BC	coal	O
Bernic Lake	Cabot Corporation	Lac du Bonnet	MB	lithium-cesium-rubidium	O
Birchtree	INCO	Thompson	MB	nickel-copper	O
Bucko Lake Nickel Mine	Nuinsco Resources/Falconbridge	Wabawden	MB	nickel	O
Callinan Mine	Hudson Bay Mining & Smelting Co. Ltd.	Flin Flon	MB	copper-zinc-gold-silver	O
Chisel North Mine	Hudson Bay Mining & Smelting Co. Ltd.	Snow Lake	MB	zinc	O
Flin Flon Mine and Mill	Hudson Bay Mining & Smelting Co. Ltd.	Flin Flon	MB	copper-lead-zinc	O
New Britannia Mine	TVX Normandy Americas, High River Gold I	Snow Lake	MB	gold	O
Ruttan	Hudson Bay Mining & Smelting Co. Ltd.	Leaf Rapids	MB	copper-zinc	O
Thompson Mine (T-1 & T-2)	Inco Limited	Thompson	MB	nickel-copper	O
Trout Lake Mine	Hudson Bay Mining & Smelting Co. Ltd.	Flin Flon	MB	copper-zinc-gold-silver	O
Iron Ore Company of Canada	Iron Ore Company of Canada	Labrador City	NFLD	iron	O
Nugget Pond	Richmont Mines Inc.	Baie Verte	NFLD	gold	O
Wabush Mine	Stelco Inc.	Labrador City	NFLD	iron	O
Con Mine	Miramar Mining Corporation	Yellowknife	NWT	gold	O
Giant	Royal Oak Mines Inc.	Yellowknife	NWT	gold	O
Agrium Phosphate Mine	Agrium Products Inc.	Kapaskasing	ON	phosphate	O
Campbell Mine	Placer Dome Inc.	Balmerton	ON	gold	O
David Bell Mine	Teck Corp, Homestake Canada Inc.	Marathon	ON	gold	O
Dome Mine	Placer Dome Inc.	South Porcupine	ON	gold	O
Eagle River Mine	River Gold Mines Ltd.	Wawa	ON	gold	O
Edwards Mine	River Gold Mines Ltd.	Wawa	ON	gold	O
Golden Giant Mine	Battle Mountain Gold Company	Marathon	ON	gold	O
Holt-McDermott Mine	Barrick Gold Corp.	Kirkland Lake	ON	gold	O
Hoyle Pond	Kinross Gold Corporation	Schumacher	ON	gold	O
Kidd Creek Mine	Falconbridge Ltd.	Timmins	ON	zinc-copper-silver-lead-ca	O
Lac des Iles Mine	North American Palladium Ltd	Thunder Bay	ON	platinum grp metals-gold-	O

Musselwhite Mine	Placer Dome Inc, TVX Normandy	Pickle Lake	ON	gold	O
Red Lake Mine	Goldcorp Inc	Balmerton	ON	gold	O
Williams Mine	Teck Corp, Homestake Canada Inc.	Marathon	ON	gold	O
Bell Allard Mine	Noranda Inc.	Matagami	QC	zinc-copper	O
Bouchard-Hebert	Cambior Inc.	Quebec	QC	zinc-copper-gold-silver	O
Bousquet #2	Barrick Gold Corporation	Preissac	QC	gold-copper	O
Doyon Mine	Cambior Inc.	Rouyn-Noranda	QC	gold	O
Francoeur	Richmont Mines Inc.	Rouyn-Noranda	QC	gold	O
Kiena Complex	McWatters Mining Inc.	Malartic	QC	gold	O
Lac Tio	Quit-Fer et Titane Inc.	Havre St-Pierre	QC	iron-titanium	O
Lac Tio Mine	Rio Tinto / QIT - Fer et Titane Inc.	Havre Saint-Pierre	QC	ilmenite & titanium	O
Langlois Mine	Breakwater Resources Ltd	Val d'Or	QC	zinc-copper-gold-silver	O
LaRonde Mine	Agnico-Eagle Mines Ltd	Val d'Or	QC	gold-silver-copper-zinc	O
Les Mines Selbaie	Biliton PLC	Rouyn-Noranda	QC	copper-zinc-gold-silver	O
Louvicourt	Novicourt Inc.	Val d'Or	QC	copper-zinc-silver-gold	O
Magnola Metallurgy	Noranda	Danville	QC	magnesium	O
Mount-Wright	Quebec Cartier Mining Company	Mount Wright	QC	iron	O
Mouska Mine	Cambior Inc.	Destor	QC	gold	O
Niobec	Teck Corporation & Cambior Inc.	Chicoutimi	QC	niobium	O
Orleans Wollastonite Operation	Orleans Resources Inc.	Lac St-Jean	QC	wollastonite	O
Sleeping Giant Mine	Aurizon Mines Ltd, Cambior Inc.	Amos	QC	gold	O
Troilus Mine	Inmet Mining Corporation	Chibougamau	QC	gold-copper	O
Cluff Lake	Cogema Resources Inc.	Saskatoon	SK	uranium	O
Key Lake	Cameco Corporation	Pine House	SK	uranium	O
Konuto Lake Mine	Hudson Bay Mining and Smelting Co. Ltd	Denare Beach	SK	copper	O
McArthur River Mine	Cameco Corp, Cogema Resources Inc.	Key Lake	SK	uranium	O
McClean Lake Mine	Cogema Resources Inc, Denison Mines	Wollaston Lake	SK	uranium	O
Rabbit Lake	Cameco Corporation	Saskatoon	SK	uranium	O
Seabee	Claude Resources Inc.	La Ronge	SK	gold	O
Brewery Creek Mine	Viceroy Resource Corporation	Dawson City	YK	gold	O
Flin Flon Smelter	Hudson Bay Mining & Smelting Co. Ltd.	Flin Flon	MB	copper smelter, zinc refin	S
Thompson Mine Smelter	Inco Limited	Thompson	MB	nickel-copper	S
Kidd Creek Mettalurgical Site	Falconbridge Ltd.	Timmins	ON	zinc-copper-silver-lead-ca	S
Alma Smelter	Alcan	Alma	QC	aluminum	S
Arvida Smelter	Alcan	Jonquière	QC	aluminum	S
Fonderie Gaspé Division	Noranda Mining and Exploration Inc.	Murdochville	QC	copper smelter	S
Grande-Baie Smelter	Alcan	La Baie	QC	aluminum	S

Horne Smelter	Noranda Mining and Exploration Inc.	Rouyn-Noranda	QC	copper smelter, sulphuric	S
Laterrière Smelter	Alcan	Chicoutimi	QC	aluminum	S
QIT - Fer et Titan Smelter	Rio Tinto / QIT - Fer et Titane Inc.	Havre Saint-Pierre	QC	titanium dioxide	S
Mine Name	Company	Location	Provin	Metal (s)	Status

Appendix E

List of Acid-Generating Abandoned Mines in the Boreal Forest Region

December, 2001

	ACID GENERATING ABANDONED MINES		
ID#	MINE NAME	PROVINCE	METAL(S)
400	Aldermac	Quebec	-Copper-
402	Anderson/Snow Lake*	Manitoba	-Copper-Zinc-
403	Baker	BC	AU, AG, CU, ZN, PB
404	Bankfield	Ontario	-Gold-Silver-
405	Barvue	Quebec	-Zinc-Silver-
406	Berens River (Golsil)	Ontario	-Gold-Silver-Lead-Zinc-
407	Big Bull	BC	CU, ZN, PB, AG, AU
408	Buchans	Newfoundland	-Lead-Zinc-Silver-Gold-
409	Canadian Malartic-AB	Québec	-Gold-Nickel-
410	Candego	Quebec	-Lead-Zinc-
411	Central Patricia No. 1	Ontario	-Gold-Silver-
412	Centre Hill Mine (Munro Mine)	Ontario	-Copper-Zinc-Silver-Nickel-Gold-
413	Cochenour Wilans	Ontario	-Gold-Silver-
414	Coniagas	Quebec	-Zinc-
415	Consolidated Louana	Ontario	-Gold-
416	Cook Iron Mine	Newfoundland	-Iron-
417	Creighton	Saskatchewan	-Copper-Zinc-
418	Crescent Lake	Newfoundland	-Columbium-Lead-Zinc-
419	East Sullivan	Quebec	-Copper-Zinc-
420	Falconbridge	Ontario	
421	Fox	Manitoba	-Copper-Zinc-
424	Goose Cove Mine	Newfoundland	-Copper-Zinc-Arsenic-
425	Granada	Quebec	-Gold-Silver-
426	Green-Meehan	Ontario	-Silver-Cobalt-Copper-Nickel-Lead-
427	Grum and Vangorda (Faro)	Yukon Territory	-Zinc-Calcium-Silver-
428	Gullbridge	Newfoundland	-Columbium-Lead-Zinc
429	Gunnar	Saskatchewan	-Uranium-
430	Jamieson	Ontario	-Copper-Zinc-Gold-Silver-
431	Kam Kotia	Ontario	-Copper-Zinc-
434	Lac Renzy	Quebec	
435	Lake Shore	Ontario	
436	Langmuir	Ontario	-Nickel-Copper-Gold-Sliver-
437	Lemoine	Québec	-Copper-
438	Little Bay	Newfoundland	-Copper-
439	Lorado	Saskatchewan	-Uranium-
440	Lorraine	Québec	-Nickel-Copper-
441	Lynn Lake Mine	Manitoba	-Copper-Zinc-
442	Manitou-Barvue	Québec	-Copper-Zinc-
444	Mattabi	Ontario	-Copper-Zinc-Silver-Lead-Gold-
445	New Jason	Ontario	-Gold-Silver-Lead-Zinc-Copper-
446	North Coldstream	Ontario	-Copper-Gold-Silver-
449	Poirier	Québec	-Copper-Zinc-
451	Ryan Lake Mine	Ontario	-Copper-Molybdenum-Gold-Silver-
453	Sherridan	Manitoba	-Copper-Zinc-
455	South Bay	Ontario	-Zinc-Copper-Gold-Lead-
456	St. Anthony	Ontario	-Silver-Gold-
457	Sturgeon Lake Deposit	Ontario	-Copper-Gold-Lead-Zinc-Silver-
458	Sturgeon River	Ontario	-Gold-Silver-Copper-Lead-

459	Tashota-Nipigon	Ontario	-Gold-Silver-Copper-Lead-Zinc-
460	Texmont	Ontario	-Nickel-Copper-
461	Thierry Mine	Ontario	-Copper-Nickel-Gold-Silver-
462	Tilt Cove	Newfoundland	-Copper-Gold-Zinc-
464	United Keno Hill Mines	Yukon Territory	-W
465	Waite-Amulet	Québec	-Copper-Zinc-
466	Whalesback	Newfoundland	-Copper-Lead-Zinc-
467	Windy Craggy	BC	CU, CO, AU, AG, ZN
468	Zenmac No. 1 and 2	Ontario	-Copper-Zinc-

APPENDIX F

Methodology for Mapping Component

December, 2001

APPENDIX "F"

Methodology for Mapping Component

The map of mining activity in Canada's Boreal Forest was prepared by Laurentian University's Elliot Lake Research Field Station, using data provided primarily by Northwatch. Mine data was drawn from various inventories and data sets, all of which were variously outdated or incomplete for the purpose of assembling the boreal mines inventory.

Sources included industry and government listings, news reports, and various data bases. Both government and industry listings contained inaccurate location descriptions, and mine sites frequently appeared on different lists, often with different names, owners and identified by different status (operating, suspended, etc.). Given the changing face of mining in Canada, several mines were listed as operating in Year 2000 data bases which were used initially, but had closed by the release of the 2001 data base in the fall of this year. Other mines closed in the final quarter of 2001; this required verification on a mine-by-mine basis. In several cases, mines which had previously been listed as closed or abandoned are now subject to exploration. .

Given these factors, each mine site had to be individually researched to establish the current name, ower, status and exact location.

Map Layer Sources

The boreal forest region map layer was provided by Ian Gillespie, Geomatics Unit Coordinator, with permission from the Canadian Wildlife Service, Environment Canada. This map layer delineates the boreal forest region as determined by Stanley Rowe (1972).

Other base map layers were downloaded off the World Wide Web from http://res.agr.ca/PUB/CANSIS/NSDB/ECOSTRAT

These layers correspond to the NTS 1:1,000,000 scale and included the following:

- Roads
- Lakes & rivers
- Provincial & international boundaries
- Cities & towns
- Canada and the Alaskan U.S. peninsula

It must be noted that the roads represented on the map of Mining Activity in Canada's Boreal Forest Region (December 2001) are provincial and national highways only. Secondary and tertiary roads (and other mine-related infrastructure such as dams, hydro lines, and railways) are a major source of environmental disturbance, but are not represented in these map products. The data was available for some jurisdictions, but the inclusion of all of the relevant infrastructure crowded the maps excessively and restricted the clarity of other pertinent information – namely the location and status of mines – when mapping on a national scale.

Glossary of Selected Mining Terms

Acidic precipitation / Acid Rain - Snow and rain that have a low pH, caused by sulphur dioxide and nitric oxide gases from industrial activity released into the atmosphere.

Acid mine drainage - Acidic run-off water from mine waste dumps and mill tailings ponds containing sulphide minerals. Also refers to ground water pumped to surface from mines.

Adit - An opening driven horizontally into the side of a mountain or hill for providing access to a mineral deposit.

Aeromagnetic survey - A geophysical survey using a magnetometer aboard, or towed behind, an aircraft.

Airborne survey - A survey made from an aircraft to obtain photographs, or measure magnetic properties, radioactivity, etc.

ANFO - Acronym for ammonium nitrate and fuel oil, a mixture used as a blasting agent in many mines.

Annual report - The formal financial statements and report on operations issued by a corporation to its shareholders after its fiscal year-end.

Anode - A rectangular plate of metal cast in a shape suitable for refining by the electrolytic process.

Anomaly - Any departure from the norm which may indicate the presence of mineralization in the underlying bedrock.

Anthracite - A hard, black coal containing a high percentage of fixed carbon and a low percentage of volatile matter.

Assay - A chemical test performed on a sample of ores or minerals to determine the amount of valuable metals contained.

Assay map - Plan view of an area indicating assay values and locations of all samples taken on the property.

Assessment work - The amount of work, specified by mining law, that must be performed each year in order to retain legal control of mining claims.

Autogenous grinding - The process of grinding ore in a rotating cylinder using large pieces of the ore instead of conventional steel balls or rods.B

Backfill - Waste material used to fill the void created by mining an orebody.

Background - Minor amounts of radioactivity due not to abnormal amounts of radioactive minerals nearby, but to cosmic rays and minor residual radioactivity in the vicinity.

Ball mill - A steel cylinder filled with steel balls into which crushed ore is fed. The ball mill is rotated, causing the balls to cascade and grind the ore.

Basal till - Unsorted glacial debris at the base of the soil column where it comes into contact with the bedrock below.

Base camp - Centre of operations from which exploration activity is conducted.

Base metal - Any non-precious metal (eg. copper, lead, zinc, nickel, etc.).

Batholith - A large mass of igneous rock extending to great depth with its upper portion dome-like in shape. Similar, smaller masses of igneous rocks are known as bosses or plugs.

Bauxite - A rock made up of hydrous aluminum oxides; the most common aluminum ore.

Bear market - Term used to describe market conditions when share prices are declining.

Bedding - The arrangement of sedimentary rocks in layers.

Beneficiate - To concentrate or enrich; often applied to the preparation of iron ore for smelting.

Bentonite - A clay with great ability to absorb water and which swells accordingly.

Bessemer - An iron ore with a very low phosphorus content.

Bio-leaching - A process for recovering metals from low-grade ores by dissolving them in solution, the dissolution being aided by bacterial action.

Blast furnace - A reaction vessel in which mixed charges of oxide ores, fluxes and fuels are blown with a continuous blast of hot air and oxygen-enriched air for the chemical reduction of metals to their metallic state.

Blasthole - A drill hole in a mine that is filled with explosives in order to blast loose a quantity of rock.

Blister copper - A crude form of copper (assaying about 99%) produced in a smelter, which requires further refining before being used for industrial purposes.

Bulk mining - Any large-scale, mechanized method of mining involving many thousands of tonnes of ore being brought to surface per day.

Bulk sample - A large sample of mineralized rock, frequently hundreds of tonnes, selected in such a manner as to be representative of the potential orebody being sampled. Used to determine metallurgical characteristics.

Bull market - Term used to describe financial market conditions when share prices are going up.

Byproduct - A secondary metal or mineral product recovered in the milling process.C

Cable bolt - A steel cable, capable of withstanding tens of tonnes, cemented into a drillhole to lend support in blocky ground.

Cage - The conveyance used to transport miners and equipment between the surface and the mine levels.

Calcine - Name given to concentrate that is ready for smelting (i.e. the sulphur has been driven off by oxidation).

Carbon-in-pulp - A method of recovering gold and silver from pregnant cyanide solutions by adsorbing the precious metals to granules of activated carbon, which are typically ground up coconut shells.

Cathode - A rectangular plate of metal, produced by electrolytic refining, which is melted into commercial shapes such as wirebars, billets, ingots, etc.

Circulating load - Over-sized chunks of ore returned to the head of a closed grinding circuit before going on to the next stage of treatment.

Claim - A portion of land held either by a prospector or a mining company. In Canada, the common size is 1,320 ft. (about 400 m) square, or 40 acres (about 16 ha).

Clarification - Process of clearing dirty water by removing suspended material.

Classifier - A mineral-processing machine which separates minerals according to size and density.

Closed circuit - A loop in the milling process wherein a selected portion of the product of a machine is returned to the head of the machine for finishing to required specification.

Coal - A carbonaceous rock mined for use as a fuel.

Coalification - The metamorphic processes of forming coal.

Collar - The term applied to the timbering or concrete around the mouth of a shaft; also used to describe the top of a mill hole.

Column flotation - A milling process, carried out in a tall cylindrical column, whereby valuable minerals are separated from gangue minerals based on their wetability properties.

Common stock - Shares in a company which have full voting rights which the holders use to control the company in common with each other. There is no fixed or assured dividend as with preferred shares, which have first claim on the distribution of a company's earnings or assets.

Complex ore - An ore containing a number of minerals of economic value. The term often implies that there are metallurgical difficulties in liberating and separating the valuable metals.

Cone crusher - A machine which crushes ore between a gyrating cone or crushing head and an inverted, truncated cone known as a bowl.

Concentrate - A fine, powdery product of the milling process containing a high percentage of valuable metal.

Concentrator - A milling plant that produces a concentrate of the valuable minerals or metals. Further treatment is required to recover the pure metal.

Converter - In copper smelting, a furnace used to separate copper metal from matte.

Core - The long cylindrical piece of rock, about an inch in diameter, brought to surface by diamond drilling.

Cordillera - The continuous chain of mountain ranges on the western margin of North and South America.

Custom smelter - A smelter which processes concentrates from independent mines. Concentrates may be purchased or the smelter may be contracted to do the processing for the independent company.

Cut-and-fill - A method of stoping in which ore is removed in slices, or lifts, and then the excavation is filled with rock or other waste material (backfill), before the subsequent slice is extracted.

Cyanidation - A method of extracting exposed gold or silver grains from crushed or ground ore by dissolving it in a weak cyanide solution. May be carried out in tanks inside a mill or in heaps of ore out of doors.

Cyanide - A chemical species containing carbon and nitrogen used to dissolve gold and silver from

ore.

Depletion - An accounting device, used primarily in tax computations. It recognizes the consumption of an ore deposit, a mine's principal asset.

Development - Underground work carried out for the purpose of opening up a mineral deposit. Includes shaft sinking, crosscutting, drifting and raising.

Development drilling - drilling to establish accurate estimates of mineral reserves.

Diamond - The hardest known mineral, composed of pure carbon; low-quality diamonds are used to make bits for diamond drilling in rock.

Diamond drill - A rotary type of rock drill that cuts a core of rock that is recovered in long cylindrical sections, two cm or more in diameter.

Dilution (mining) - Rock that is , by necessity, removed along with the ore in the mining process, subsequently lowering the grade of the ore.

Drill-indicated reserves - The size and quality of a potential orebody as suggested by widely spaced drillholes; more work is required before reserves can be classified as probable or proven.

Due diligence - The degree of care and caution required before making a decision; loosely, a financial and technical investigation to determine whether an investment is sound.

Dump - A pile of broken rock or ore on surface.

Electrolysis - An electric current is passed through a solution containing dissolved metals, causing the metals to be deposited onto a cathode.

Electrolytic refining - The process of purifying metal ingots that are suspended as anodes in an electrolytic bath, alternated with refined sheets of the same metal which act as starters or cathodes.

EM survey - A geophysical survey method which measures the electromagnetic properties of rocks.

Environmental impact study - A written report, compiled prior to a production decision, that examines the effects proposed mining activities will have on the natural surroundings.

Erosion - The breaking down and subsequent removal of either rock or surface material by wind, rain, wave action, freezing and thawing and other processes.

Exploration - Prospecting, sampling, mapping, diamond drilling and other work involved in searching for ore.

Ferrous - Containing iron.

Flotation - A milling process in which valuable mineral particles are induced to become attached to bubbles and float as others sink.

Flowsheet - An illustration showing the sequence of operations, step by step, by which ore is treated in a milling, concentration or smelting process.

Flow-through shares - Shares in an exploration company that allow the tax deduction or credits for mineral exploration to be passed to the investor.

Flux - A chemical substance that reacts with gangue minerals to form slags, which are liquid at furnace temperature and low enough in density to float on the molten bath of metal or matte.

Free milling - Ores of gold or silver from which the precious metals can be recovered by concentrating methods without resorting to pressure leaching or other chemical

Geochemistry - The study of the chemical properties of rocks.

Geology - The science concerned with the study of the rocks which compose the Earth.

Geophysics - The study of the physical properties of rocks and minerals.

Geophysical survey - A scientific method of prospecting that measures the physical properties of rock formations. Common properties investigated include magnetism, specific gravity, electrical conductivity and radioactivity.

Glory hole - An open pit from which ore is extracted, especially where broken ore is passed to underground workings before being hoisted.

Grab sample - A sample from a rock outcrop that is assayed to determine if valuable elements are contained in the rock. A grab sample is not intended to be representative of the deposit, and usually the best-looking material is selected

Greenstone belt - An area underlain by metamorphosed volcanic and sedimentary rocks, usually in a continental shield.

Heap leaching - A process whereby valuable metals, usually gold and silver, are leached from a heap, or pad, of crushed ore by leaching solutions percolating down through the heap and collected from a sloping, impermeable liner below the pad.

Hedging - Taking a buy or sell position in a futures

market opposite to a position held in the cash market to minimize the risk of financial loss from an adverse price change.

High grade - Rich ore. As a verb, it refers to selective mining of the best ore in a deposit.

High-grader - One who steals rich ore, especially gold, from a mine.

Host rock - The rock surrounding an ore deposit.

Hydrometallurgy - The treatment of ore by wet processes, such as leaching, resulting in the solution of a metal and its subsequent recovery.

Induced polarization - A method of ground geophysical surveying employing an electrical current to determine indications of mineralization.

Industrial minerals - Non-metallic, non-fuel minerals used in the chemical and manufacturing industries. Examples are asbestos, gypsum, salt, graphite, mica, gravel, building stone and talc.

Ion exchange - An exchange of ions in a crystal with irons in a solution. Used as a method for recovering valuable metals, such as uranium, from solution.

Jig - A piece of milling equipment used to concentrate ore on a screen submerged in water, either by the reciprocating motion of the screen or by the pulsation of water through it.

Kimberlite - A variety of peridotite; the most common host rock of diamonds.

Laterite - A residual soil, ususally found in tropical countries, out of which the silica has been leached. May form orebodies of iron, nickel, bauxite and manganese.

Leaching - A chemical process for the extraction of valuable minerals from ore; also, a natural process by which ground waters dissolve minerals, thus leaving the rock with a smaller proportion of some of the minerals than it contained originally.

Level - The horizontal openings on a working horizon in a mine; it is customary to work mines from a shaft, establishing levels at regular intervals, generally about 50 metres or more apart.

Limestone - A bedded, sedimentary deposit consisting chiefly of calcium carbonate.

Line cutting - Straight clearings through the bush to permit sightings for geophysical and other surveys.

Lode - A mineral deposit in solid rock.

Magnetic gradient survey - A geophysical survey using a pair of magnetometers a fixed distance apart, to measure the difference in the magnetic field with height above the ground.

Magnetic separation - A process in which a magnetically susceptible mineral is separated from gangue minerals by applying a strong magnetic field; ores of iron are commonly treated in this way.

Magnetic survey - A geophysical survey that measures the intensity of the Earth's magnetic field.

Map-staking - A form of claim-staking practised in some jurisdictions whereby claims are staked by drawing lines around the claim on claim maps at a government office.

Marginal deposit - An orebody of minimal profitability.

Metallurgical coal - Coal used to make steel.

Metallurgy - The study of extracting metals from their ores.

Mill - A plant in which ore is treated and metals are recovered or prepared for smelting; also a revolving drum used for the grinding of ores in preparation for treatment.

Milling ore - Ore that contains sufficient valuable mineral to be treated by milling process.

Minable reserves - Ore reserves that are known to be extractable using a given mining plan.

Mineral - A naturally occurring homogeneous substance having definite physical properties and chemical composition and, if formed under favorable conditions, a definite crystal form.

Nugget - A small mass of precious metal, found free in nature.

Open pit - A mine that is entirely on surface. Also referred to as open-cut or open-cast mine.

Ore - A mixture of ore minerals and gangue from which at least one of the metals can be extracted at a profit.

Orebody - A natural concentration of valuable material that can be extracted and sold at a profit.

Ore Reserves - The calculated tonnage and grade of mineralization which can be extracted profitably; classified as possible, probable and proven according to the level of confidence that can be placed in the data.

Outcrop - An exposure of rock or mineral deposit that can be seen on surface, that is, not covered by soil or water.

Oxidation - A chemical reaction caused by exposure to oxygen that results in a change in the chemical composition of a mineral.

Pan - To wash gravel, sand or crushed rock samples in order to isolate gold or other valuable metals by their higher density.

Patent - The ultimate stage of holding a mineral claim, after which no more assessment work is necessary because all mineral rights have been earned.

Pellet - A marble-sized ball of iron ore fused with clay for transportation and use in steelmaking.

Pillar - A block of solid ore or other rock left in place to structurally support the shaft, walls or roof of a mine.

Pitchblende - An important uranium ore mineral. It is black in color, possesses a characteristic greasy lustre and is highly radioactive.

Placer - A deposit of sand and gravel containing valuable metals such as gold, tin or diamonds.

Plant - A building or group of buildings in which a process or function is carried out; at a mine site it will include warehouses, hoisting equipment, compressors, maintenance shops, offices and the mill or concentrator.

Polishing pond - The last in a series of settling ponds through which mill effluent flows before being discharged into the natural environment.

Possible reserves - Valuable mineralization not sampled enough to accurately estimate its tonnage and grade, or even verify its existence. Also called "inferred reserves."

Potash - Potassium compounds mined for fertilizer and for use in the chemical industry.

Precambrian Shield - The oldest, most stable regions of the earth's crust, the largest of which is the Canadian Shield.

Primary deposits - Valuable minerals deposited during the original period or periods of mineralization, as opposed to those deposited as a result of alteration or weathering.

Probable reserves - Valuable mineralization not sampled enough to accurately estimate the terms of tonnage and grade. Also called "indicated reserves."

Prospect - A mining property, the value of which has not been determined by exploration.

Proven reserves - Reserves that have been sampled extensively by closely spaced diamond drill holes and developed by underground workings in sufficient detail to render an accurate estimation of grade and tonnage. Also called "measured reserves."

Pyrrhotite - A bronze-colored, magnetic iron sulphide mineral.

Rare earth elements - Relatively scarce minerals such as niobium and yttrium.

Reclamation - The restoration of a site after mining or exploration activity is completed.

Reconnaissance - A preliminary survey of ground.

Recovery - The percentage of valuable metal in the ore that is recovered by metallurgical treatment.

Refractory ore - Ore that resists the action of chemical reagents in the normal treatment processes and which may require pressure leaching or other means to effect the full recovery of the valuable minerals.

Replacement ore - Ore formed by a process during which certain minerals have passed into solution and have been carried away, while valuable minerals from the solution have been deposited in the place of those removed.

Resource - The calculated amount of material in a mineral deposit, based on limited drill information.

Reverberatory furnace - A long, flat furnace used to slag gangue minerals and produce a matte.

Rockburst - A violent release of energy resulting in the sudden failure of walls or pillars in a mine, caused by the weight or pressure of the surrounding rocks.

Rock mechanics - The study of the mechanical properties of rocks, which includes stress conditions around mine openings and the ability of rocks and underground structures to withstand these stresses.

Rod mill - A rotating steel cylinder that uses steel rods as a means of grinding ore.

Room-and-pillar mining - A method of mining flat-lying ore deposits in which the mined-out area, or rooms, are separated by pillars of approximately the same size.

Salting - The act of introducing metals or minerals into a deposit or samples, resulting in false assays. Done either by accident or with the intent of defrauding the public.

Sample - A small portion of rock or a mineral deposit taken so that the metal content can be determined by assaying.

Seismic prospecting - A geophysical method of prospecting, utilizing knowledge of the speed of reflected sound waves in rock.

Shaft - A vertical or inclined excavation in rock for the purpose of providing access to an orebody. Usually equipped with a hoist at the top, which lowers and raises a conveyance for handling workers and materials.

Siderite - Iron carbonate, which when pure, contains 48.2% iron; must be roasted to drive off carbon dioxide before it can be used in a blast furnace. Roasted product is called sinter.

Sinter - Fine particles of iron ore that have been treated by heat to produce blast furnace feed.

Slag - The vitreous mass separated from the fused metals in the smelting process.

Sodium cyanide - A chemical used in the milling of gold ores to dissolve gold and silver.

Solvent extraction-electrowinning (SX-EW) - A metallurgical technique, so far applied only to copper ores, in which metal is dissolved from the rock by organic solvents and recovered from solution by electrolysis.

Stope - An excavation in a mine from which ore is, or has been, extracted.

Strike - The direction, or bearing from true north, of a vein or rock formation measureon a horizontal surface.

Strip - To remove the overburden or waste rock overlying an orebody in preparation for mining by open pit methods.

Stripping ratio - The ratio of tonnes removed as waste relative to the number of tonnes of ore removed from an open-pit mine.

Strip mine - An open-pit mine, usually a coal mine, operated by removing overburden, excavating the coal seam, then returning the overburden.

Sub-bituminous - A black coal, intermediate between lignite and bituminous.

Subsidiary company - A company in which the majority of shares (a controlling position) is held by another company.

Sulphide - A compound of sulphur and some other element.

Sulphide dust explosions - An underground mining hazard involving the spontaneous combustion of airborne dust containing sulphide minerals.

Sulphur dioxide - A gas liberated during the smelting of most sulphide ores; either converted into sulphuric acid or released into the atmosphere in the form of a gas.

Sump - An underground excavation where water accumulates before being pumped to surface.

Tailings - Material rejected from a mill after most of the recoverable valuable minerals have been extracted.

Tailings pond - A low-lying depression used to confine tailings, the prime function of which is to allow enough time for heavy metals to settle out or for cyanide to be destroyed before water is discharged into the local watershed.

Thermal coal - Coal burned to generate the steam that drives turbines to generate electricity.

Thickener - A large, round tank used in milling operations to separate solids from liquids; clear fluid overflows from the tank and rock particles sink to the bottom.

Trench - A long, narrow excavation dug through overburden, or blasted out of rock, to expose a vein or ore structure.

Trend - The direction, in the horizontal plane, of a linear geological feature, such as an ore zone, measured from true north.

Tube mill - An apparatus consisting of a revolving cylinder about half-filled with steel rods or balls and into which crushed ore is fed for fine grinding.

Witness post - A claim post placed on a claim line when it cannot be placed in the corner of a claim because of water or difficult terrain.

Zone - An area of distinct mineralization.

Zone of oxidation - The upper portion of an orebody that has been oxidized.

Selected Readings on Mining, the Environment and Community

Assembly of First Nations & MiningWatch Canada. *After the Mine: Healing Our Lands and Nations - a workshop on abandoned mines*. Sudbury: Assembly of First Nations & MiningWatch Canada, 2001.

Findings of a workshop examining abandoned mines and related environmental and social concerns, particularly as they affect First Nations communities.

BC Wild & Environmental Mining Council of BC. *Acid Mine Drainage Mining & Water Pollution Issues in BC*. BC Wild & Environmental Mining Council of BC, Undated.

A primer on acid mine drainage and related environmental impacts.

CCSG Associates, MiningWatch Canada. *Financial Options for the Remediation of Mine Sites: A preliminary study.* Ottawa: MiningWatch Canada, 2001.

A report on abandoned mines, what causes them and how various Canadian jurisdictions are responding to the problem. Includes a summary of funding mechanisms for abandoned mine remediation and relevant mining regulations for 5 Canadian jurisdictions, and some international examples.

Chambers, C. & Winfield, M. *Mining's Many Faces Environmental Mining Law and Policy in Canada.* Toronto: The Canadian Institute for Environmental Law and Policy, 2000.

An introductory overview of current environmental laws and policies applicable to the metal mining sector, major policy trends, and the politics of mineral development in Canada.

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