REPORT OF RESULT OF A WORKSHOP ON MINE RECLAMATION TORONTO, ONTARIO, MARCH 10-11, 1994

MEND REPORT 5.8e

Workshop Hosted by the
IGWG-Industry Task Force on Mine Reclamation

August 1994

Report of Results of a Workshop

on Mine Reclamation

Toronto, Ontario, March 10-11, 1994

Workshop Hosted by the
IGWG-Industry Task Force on Mine Reclamation

Report by
G. Feasby, CANMET
and
R. K. Jones, Mining Sector
Natural Resources Canada

August 1994

TABLE OF CONTENTS

1.0 Summary and Recommendations

Representatives from the mining industry and provincial and federal mining ministries held a two-day workshop on mine reclamation in Toronto on March 10-l 1, 1994

Many policy issues were discussed by the participants, and perspectives from the industry, the provinces, territories and from the federal government were presented. There remains a great deal of work to do and information to be obtained to arrive at a clear consensus on the many issues concerned with mine reclamation.

Among the many issues discussed, two central issues were raised at the workshop; the extent of the liability for mine reclamation and how the cost of this reclamation might be met.

CANMET and MEND (Mine Environment Neutral Drainage program) have assembled a databank from information on the liability associated with acid mine drainage (AMD), the most important mine environmental issue. It was estimated that the AMD liability ranges from $2 to $5 billion, depending on the sophistication of treatment and control technology being put in place. The most economical strategy to meet environmental objectives may be to collect water and treat it for a very long time, but such a practice raises concerns about treatment product disposal and sustainability of the process. New technologies that will reduce or eliminate AMD are being developed by industry and governments under the MEND program.

A total of about 7 billion tonnes (41,000 hectares) of metal-mine and industrial mineral tailings are estimated to exist in Canada. In addition, about 6 billion tonnes of waste rock are estimated to exist on surface. Insufficient information is available to make an estimate of the cost of rehabilitation of non-acid generating mine waste sites, but the cost of reclaiming these sites to meet current standards is expected to be over $1 billion. Less than 10% of the total $3 to $6 billion liability is attributable to sites that have reverted to the crown.

A review of the financial performance of the mining industry over the past 21 years shows that on balance the industry has had a net after tax and after dividend surplus of $11.3 billion (in constant $1993). However, considerable writedowns ($18.2 billion) occurred and the retained earnings position deteriorated from $9.6 billion to $2.7 billion. The after-tax real rate of return on investment was only 3.6%.

Two examples of extensive mine reclamation were presented at the workshop -- Equity Silver in British Columbia and Denison Mines in Ontario. Both cases are examples of the application of the best and least-costly technologies to achieve minimum long-term environmental impact. Tax treatment of reclamation financial assurance and increasingly-stringent standards were issues raised by the two companies.

A more comprehensive national database is needed to get a more precise measure of the nature, extent and needs of mine reclamation across Canada. Expertise and practical skills in mine rehabilitation are being developed in across Canada, and this should be made more available by the documenting and reporting of many more examples. Canada is a world leader in many aspects of mine reclamation.

2.0 **The Workshop**

2.1 Background and Purpose of the Workshop

In September 1993, at the Mines Minister's Conference in Fredericton, it was agreed that the Intergovernmental Working Group on the Mineral Industry (IGWG) and mining industry would set up a task force to assess the nature, extent and expected financial impact of reclaiming active, inactive and orphaned. mine sites across Canada.

A task force was established in November 1993 to examine the financial and technical issues and to develop an approach to mine-site reclamation. Dr. Irwin Itzkovitch of Natural Resources Canada and Mr. Patrick Reid of the Ontario Mining Association agreed to co-chair the task force.

Participants at the January 25, 1994 meeting of the Industry/IGWG Task Force on Mine Reclamation discussed the many technical, financial and jurisdictional issues facing the mining industry, governments and the public. Although some clarification of these issues was accomplished during the meeting, it was agreed that a wider discussion was needed and that more precision was required within the data on those mine sites requiring reclamation and on the financial implications of this reclamation on the industry and governments.

2.2 Description of the Toronto Workshop

Fifty representatives from the mining industry and from provincial and federal government ministries responsible for mineral resources were invited to Toronto by the Task Force co-chairs to attend a 2-day workshop entitled "Mine Reclamation and Financial Assurance". Subjects presented and discussed at this workshop were as follows:

TOPIC	CHAMPION	SUMMARY
Mine Site Definitions	Manitoba	Definitions vary nationally. Consensus and harmonization are difficult.
Acid Mine Drainage Liability	NRCan - CANMET	Liability between $2 and $5 billion. Data base needs improving. Report to be prepared for Mines Minister's meeting in Victoria in September, 1994.
Recent Financial Performance of Mining Industry	NRCan - Mining Sector	Retained earnings of the mining industry have declined significantly. Reworking of financial data and clarification of current debt load is needed.

TOPIC	CHAMPION	SUMMARY
Case Studies:		
Equity Silver	British Columbia, Placer Dome	First Canadian case of financial bonding for mine closure. Financial assurance was reduced by consultation process.
Denison Mines	Denison	Multi-technology approach to closure of mine tailings areas. Concern that FEAR0 could delay process and impose unachievable standards.
Timing and Transition	Mining Association of Canada	Universally applied standards and criteria for closure needed .
Forms of Financial Assurance	Mining Association of Canada	Industry wants many options available.
Marginal Operators	Ontario	Unresolved whether marginal operators would be treated same as established operators.
Standards	Ontario Mining Association	Agreed that standards should be harmonized and site specific factors need to be considered.
Funding for Cleaning up Orphaned Sites	Canadian Council of Ministers of Environment	Mining properties are not a large proportion of industrial waste high priority sites. Concern that other industrial waste sites are categorized like mine waste sites, but may be much more environmentally hazardous.
Post Closure Security	British Columbia	Experience and policy in British Columbia outlined.
Exit Ticket	Ontario	Industry wants clearly defined exit ticket, and to not be paying for ever. End-of-mine closure costs easy to define, but estimates of long term maintenance costs imprecise.

Also, the workshop participants agreed that:

- Environmental effects as opposed to universal analytical criteria should be used to determine closure standards for mine sites.
- Financial assurance requirements should be as flexible and efficient as possible.
- Public input to the decision-making process is essential.
- Closure requirements should be science-based and be site specific.
- Ministries responsible for mining should have better linkages with environment ministries.

3.0 Database on Liabilities Associated with Acid Mine Drainage

3.1 What is Acidic Drainage?

Acidic drainage is the largest single environmental problem facing the world's metal mining industry. Technologies to prevent, or substantially reduce, acidic drainage from occurring in waste rock piles, in tailings sites and in mine walls are being developed and demonstrated in Canada under the Mine Environment Neutral Drainage (MEND) program. These new technologies will substantially reduce the operating and closure costs at existing mine sites and of rehabilitation of abandoned mine sites. New mines can now be opened without the concern about extensive future liabilities from acid mine drainage (AMD).

Acid generation is a **natural process** consisting essentially of oxidation of sulphides, particularly those of pyrite and pyrrhotite, on exposure to oxygen and water, that produces oxidation products, sulphuric acid and metal sulphates; surface waters become acidic if sufficient acid-neutralizing minerals such as calcite are not present. The acidic water from metal and many coal mines frequently carries with it elevated concentrations of heavy metals such as zinc, copper and nickel and high levels of dissolved aluminium and sulphates. If acidic drainage is left uncollected and untreated, the local aquatic environment can be seriously effected and the natural restoration process is inhibited.

At active mine sites as well as many inactive mine sites, mining companies operate comprehensive systems to collect and treat effluents and seepage from all sources. These facilities, when well operated and maintained, are sufficient to prevent downstream environmental impact. However, **acid generation may persist for hundreds of years following mine closure;** mine waste from metal mining in Europe 500 years ago is still producing acidic drainage. The operation of treatment plants for many decades or even hundreds of years is undesirable and costly, but in many cases, may be necessary. These treatment plants produce sludges that can contain a very low percentage by weight of solids. In some severe cases, in a few decades, the volume of sludge will exceed the volume of mine wastes producing the acidic drainage, and there may be no place to put the sludges. Also, concern has been raised about the metal content of treatment sludges and their long term stability.

Acidic drainage is not the only concern in the closure and rehabilitation of mine sites, but where occurring, it can be the most costly component. In Table 1, the estimated costs of rehabilitation at a small base-metal mine which has produced 1 million tonnes of acid-producing tailings and produced 250,000 tonnes of acid-generating waste rock are shown. Of the total cost, 72% or $2.5 million at $250,000 per hectare is attributable to AMD. The cost of rehabilitating the same amount of non acid-producing mine waste would be about $250,000. Measures needed to stabilize underground openings are not included in these estimates.

Table 1

Estimated Closure Costs for a Small Canadian Mine

	$ 000's	%
Sealing Openings	50	1
Surface Structures	500	14
Surface Cleanup and Rehabilitation	300	9
Machinery Disposal	100	3
Waste Management		
Environmental. Studies	250	7
Tailings - Cover and Treat	2,000	58
Waste Rock - Cover and Treat	250	7
	3,450	100

3.2 Inventory of Acid-generating Mine Wastes in Canada

CANMET and MEND have conducted surveys of acid-generating mine wastes in Canada. The results of these surveys (as of August 19, 1994) are summarized in Table 2. The provinces and mining companies have been very helpful in providing available information for these surveys. It is emphasized that a complete national database on mine wastes has not been completed, although several provinces and territories have made considerable progress in defining their own mine waste inventories and freely provided access to the information.

Table 2 contains reasonable estimates of acid-producing and potentially acid-producing mine tailings and waste rock. The estimates include wastes at mine sites that have been fully rehabilitated or at sites where the wastes have been deposited under water. Where estimates of either tonnes or hectares were not available, it is assumed that there are 150,000 tonnes of tailings per hectare and 400,000 tonnes of waste rock per hectare.

Table 2

Estimates of Acid-producing and Potentially Acid-producing Mine Wastes In Canada

	Tailings		**Waste Rock**	
	Million Tonnes	Hectares	Million Tonnes	Hectares
Newfoundland & Labrador	29.5	170	0.5	
Nova Scotia	11.3	90	35.9	
New Brunswick	76.5	564	25.7	
Quebec	254	2390	70.0	180
Ontario	984	6481	80.1	
Manitoba	200	1780	68.8	
Saskatchewan	66.4	273	19.9	
British Columbia	192	571	421.0	
Territories	64	243	17.0	
Canada	1,877.7	12,562	738.9	

Details of the information that are summarized in Table 2 are shown in Appendix A.

3.3 Mine Waste-Reclamation Technologies

Mine waste reclamation in Canada has evolved over the past 20 years from revegetation to more complex technologies that ensure long-term stability and minimization of environmental impact.

3.3.1 Conventional Technologies

Twenty years ago, acid generation from mine tailings and waste rock was not widely recognized as a significant environmental issue for the mining industry. The general approach to mine waste rehabilitation was essentially contouring for stability and erosion control, and the establishing a stable vegetation cover.

The uranium mining industry was at the forefront of developing technology for mine waste rehabilitation and the general concern was the prevention of the release of radioactivity into the environment. At Elliot Lake, Ontario, it was soon realized that, although revegetated sites looked nice and erosion was controlled, the most significant problem, acidification and the resultant water contamination, was not significantly reduced. It was realized that a better understanding and better methods to control acidic drainage needed to be developed. In 1988, IGWG and the mining industry and the governments put together the Reactive Acid Tailings Stabilization (RATS) program, which later became the Mine Environment Neutral Drainage (MEND) program to coordinate research and development and to supplement the work initiated by mining companies and research organizations.

3.3.2 MEND - Developed Technologies

MEND has made a significant contribution to technology development for acid mine drainage control in the last 5 years. The major options to achieve the objectives of minimizing the long term care and maintenance, and minimizing deleterious environmental impact are as follows:

TECHNOLOGIES	DESCRIPTION
Prediction Technologies	
• Static and kinetic test procedures	• Determine acid potential and rate
• Predictive mathematical models	• Predict future impact
Prevention Techniques	
• Underwater disposal	• Exclude air
• Separation and segregation	• Separate sulphides
• Elevated water table	• Keep wet, exclude air
Control Technologies	
• Dry soil and composite covers	• Prevent water, air inflow
• Alkalinity addition	• Neutralize acid *in situ*
• Porous envelope	• Isolate wastes below grade
Treatment	
• Metals removal	• Remove toxic metals before lime treatment
• Passive treatment systems	• Enhance natural biological systems

One of the significant findings of MEND and of others dealing with acidic drainage at mine sites is that once acidification has started, it is practically impossible to stop. Treatment plants will need to be operated for an extended time. Long term collection and treatment of contaminated water is therefore a major part of the cost of many mine reclamation programs.

A more significant finding is that prevention of acid generation can be accomplished by disposing of wastes under water. At some of the older mine sites in Canada, tests on submerged mine wastes have confirmed predictions and scientific tests that an engineered water cover is the best option for new mine sites. However, even for water covers, some long term monitoring and maintenance of control structures will be required.

For many existing mine tailings sites, water covers are impractical or undesirable because of stored oxidation products. For waste rock, flooding is only possible if the rock is returned to the mine openings (as backfill in underground mines) or into open pits.

3.4 Estimation of Acid Mine Drainage Liability

Using cost evaluation spreadsheets developed by Noranda Technology Centre (NTC 1992) and Steffen, Robertson and Kirsten (SRK, 1994) reclamation and maintenance costs were developed for the following options for acid-generating mine wastes:

Tailings Option	**Method**	**Assumptions**
1.	Collect seepage and treat	100 or more years of water treatment
2.	Water cover	10 years of water treatment, perpetual embankment maintenance
3.	Establish complex dry cover	50 years of water treatment
Waste Rock		**Assumptions**
1.	Collect and treat seepage	100 or more years of water treatment
2.	Move to pit, add alkalinity and cover with soil	5 years of water treatment
3.	Recontour slopes, add complex earth cover	100 years of water treatment

The above options are shown schematically in Appendix B. Every operating and inactive mine waste site is different and a combination of the above options or other options may be determined to be the most environmentally and economically attractive. Also, several mining companies are now actively examining what can be done to minimize sulphide oxidation by removing the sulphides in the milling process.

The discount rate selected for calculation of net present value (NPV) of future costs is 3% for all options examined, and an annual cost maintaining a presence or "being there" of $120,000 is assumed for each 100 hectares of tailings and each 25 million tonnes of waste rock site. Water treatment is assumed to be by conventional low density sludge lime treatment technology.

A summary of the estimated existing liabilities for acid-producing mine wastes is shown in Table 3. Wastes with acid-production potential that have been completely disposed of underwater in natural lakes and in oceans do not represent any present or future liability and are excluded from these estimates. However, exposed beaches are often present at many "underwater" disposal sites, and acid-generating materials have sometimes been used to construct embankments and roadways. This practice leads to surface contamination, and these sites are included in the estimates.

Table 3

Estimates of Acid-Producing Mine Waste Liability in Canada
($ Billions)

Option	Up-Front costs	Maintenance Costs		Total Costs
		Annual	Net Present Value	
Tailings - 1 Pump & treat	0.10	0.045	1.42	1.52
Tailings -2 Water cover	1.08	0.052	0.45	1.53
Tailings -3 Dry Cover	2.07	0.044	1.10	3.18
Waste Rock -1 Pump and treat	0.02	0.012	0.38	0.40
Waste Rock -2 Return to pit	2.04	0.007	0.03	2.07
Waste Rock -3 Dry Cover	0.37	0.009	0.28	0.65
Least costly technology: Collect and treat water - $1.92 billion				
Most costly technology: Dry soil covers for tailings and return rock to pit - $5.25 billion				

Although precise information on mine property stewardship and ownership is not widely available, an estimate of the proportion of the crown liability and the possible time of incurrence of future company liability from currently-active mines is important in the determination of the financial impact of mine-site reclamation. For acid-generating sites, an estimate is shown in Table 4. Abandoned or inactive sites that are believed to have an owner of record are included in those sites to be rehabilitated in the next 10 years.

Table 4

Estimates of Liability Distribution of Acid Mine Drainage

Incidence of Liability and timing	Tailings		Waste Rock		Total	
	$M	%	$M	%	$M	%
Crown (Provinces & Canada) - now	270	8.5	170	8.1	440	8.4
Companies - 0 to 10 years from now	1,200	37.7	1,270	61.3	2,470	47.0
Companies - 10 to 20 Years from now	750	23.6	630	30.6	1,380	26.3
Companies more than 20 years from now	960	30.2	-	-	960	18.3
Total	3,180	100.0	2,070	100.0	5,250	100.0

4.0 Estimates of Other Mine Reclamation Costs

Table 5 provides an estimate of the inventory of other mine wastes in Canada. This listing is known to be incomplete, and major inventories of mine wastes such as in the case of surface coal mining in Saskatchewan and Alberta and the mining of oil sands mining are not included.

Table 5

Estimates of Neutral and Basic Mine Wastes In Canada

	Tailings		Waste Rock	
	Million Tonnes	Hectares	Million Tonnes	Hectares
Newfoundland & Labrador	578	3,860	604	
Nova Scotia	7.4	100	9.7	
New Brunswick	1.5	50	1.0	
Quebec	1,630	6,015	2,634	2545
Ontario	693	5,406	48.3	
Manitoba	8.5	620	33.0	
Saskatchewan	325	1,830	34.2	
British Columbia	1540	10,000	2,150	
Territories	149	1,000	10.1	
Canada	**4,932.4**	28,881	**5,524.3**	

The estimated liability for neutral or alkaline mine wastes is even more dependent on site-specific factors than in the case of acid-generating wastes. Environmental concerns range from dissolved residual metal complexes, as is often found in gold mine wastes, to the contaminating of ground water by salt from potash tailings. With respect to many tailings and waste rock areas, the long term concern is structural stability of piles, stacks and embankments. However, with a significant proportion of abandoned or orphaned sites, little significant environmental concern can be identified.

At $2,000 per hectare for neutral or alkaline tailings, the estimated liability is calculated to be $0.57 billion; and for waste rock at $0.10 per tonne, $ 0.55 billion.

These estimates are, of course, very inexact because a very large number of abandoned mine sites have yet to be surveyed by provincial and territorial authorities to assess the environmental and safety risks. Several provinces are in the process of conducting abandoned mines surveys. Natural Resources Canada (CANMET) is cooperating with Nova Scotia, Ontario and British Columbia in the generation of more precise data on abandoned mines.

The current environmental liability from non-acid generating mine waste sites using simple criteria for water quality and personal safety is estimated to be at least $1 billion. This estimate is expected to increase with the availability of site-specific data. Also, the provinces are requesting new and currently-operating mines to develop closure and rehabilitation plans. This information will assist provincial authorities in assessing the existing liability, determine the extent of the public liability for orphaned sites, and may ultimately lower the cost of rehabilitation at many mine sites.

5.0 **Historical Financial Performance of the Mining Canadian Industry**

5.1 Background

This section attempts to provide a perspective, over the 21-year period 1972 to 1992, of the Canadian metal mining and processing industry's financial performance.

The analysis is based on Statistics Canada's Industrial Corporations Financial Statistics from Catalogues 61-207 and 61-008. Metal mining, smelting and refining, including the mining and refining of iron ore and uranium, are included in the two series. Catalogue 61-207 contains annual statistics derived from income tax returns for the years 1972 to 1987, while catalogue 61-008 contains quarterly financial statistics gathered by Statistics Canada surveys over the period 1988 to 1992. The data from the two sources are significantly different since the former is based on individual corporate financial information while the latter is based on consolidated financial statements for groups or families of corporations under common ownership and control. The weakness in using two different data sets is recognized and any future research should be based on a common balance sheet and income statement approach.

A further drawback in using these aggregate data for financial analysis of the industry is that some companies disappear over time as a result of bankruptcies or mergers and acquisitions. Moreover, new companies come into the picture. Finally, companies can be included or excluded from the industry through industrial reclassification by Statistics Canada, meaning that each year's set of data excludes those of companies that have disappeared. Thus, a precise accounting cannot be performed for the 21-year period as data are not completely reconcilable from year to year. For example, companies that went bankrupt, or otherwise left the industry, would be dropped from the series at some point and their losses, which otherwise would be charged against retained earnings, would not be included later in the series. This would also be true in considering the industry's rate of return on equity. In short, the financial data for each year reflects a snapshot of the industry and some caution has to be used in discerning trends.

Notwithstanding the foregoing, these catalogues provided a rough framework for the Task Force to assess various scenarios of aggregate reclamation financial requirements with aggregate industry cash flows, income, and other financial parameters.

The Task Force will have to consider the relevance of historical corporate performance when it comes to assessing the future. This is because there are bound to be significant changes: new supplies of mineral commodities coming on to western world markets as a result of the break-up of the former Soviet Union; new opportunities for growth in demand as other lesser developed countries advance (e.g. China, India); and, the replacing of labour with capital and other modemizing initiatives to increase productivity. Such events will significantly affect the future of the industry. The industry must also continue to cope with the cyclicality of its markets which will have an unpredictable effect on future financial performance.

5.2 Financial Overview

5.2.1 Change in Equity

Over the 1972-92 period there was an increase in equity of only $2.78 billion in constant 1993 dollars (Table 1 Appendix C). Equity for total metal mining over the period averaged $17.16 billion (Figure 1 Appendix C). It should be noted that neither Catalogue, 61-207 nor 61-008, publish data in constant dollars. NRCan has converted the original Statistics Canada data to constant dollars using the GDP Implicit Price Index.

The change in share capital (both common and preferred), contributed surplus, other surplus and retained earnings (Figure 2) indicates that retained earnings started to decline sharply after 1980, from a level of about $11.4 billion to a low of only $2.7 billion by 1992. Over the entire 21-year period retained earnings fell by $6.9 billion.

Over the same period a tremendous amount of new equity was issued: in 1972, there was some $3 billion in common and preferred stock outstanding; however, by the end of 1992, the outstanding share capital had reached $14 billion, representing a $11 billion increase or almost 1.5 times the amount of loss in retained earnings. By the end of 1992, share capital had largely replaced retained earnings as the predominant method of financing industry requirements for equity capital.

The preferred share portion of equity capital increased fifty-fold from $47 million in 1972 to $2.4 billion in 1978 (Figure 3). Although the annual levels of preferred share varied, they averaged slightly more than $2 billion. The increase in preferred share financing did not replace debt financing in any significant way. Also, the amount of dividends paid on this level of preferred share financing would not have been very large compared to the amount of dividends paid out with respect to common shares.

5.2.2 Change in Debt Capital

There was virtually no change in debt (in constant 1993 dollars) over the 1972-1992 period (Figure 4). The amount outstanding was $8.697 billion in 1972 and $8.719 billion at the end of 1992 (see also Table 1). The average annual debt outstanding over the period was $8.81 billion.

5.2.3 Rate of Return on Equity

The average accounting rate of return on equity, before taxes (Table 1) was 10.86% and the after-tax rate was 7.86%. This was based on an aggregate of $39.66 billion in pre-tax operating income and $28 .55 billion in after-tax income. The after-tax income of the total metal mining industry, fluctuated significantly over the 21-year period averaging $1.36 billion per year (Figure 5).

However, although these averages are mathematically correct, they can be misleading from an aggregate industry point of view for the reasons explained below.

The after-tax return was calculated after deducting accounting income and mining taxes which included $2.7 billion of deferred taxes. The "cash" after-tax return would include the $2.7 billion of deferred taxes.

The industry's performance over the 21-year period, in terms of profits and -dividends is summarized below in order to estimate what might have been "available" cash and the real aggregate rate of return of the industry.

	$ billions
Operating Profit Before Taxes	$39.660
Add: Net Positive Extraordinary Items	4.936
Less: Income and Mining Taxes **"Paid"**	13.346
After Tax Profits Available for Dividends	$31.250
Dividends Paid	19.924
Balance	$11.326

If the industry did indeed have surplus earnings of $11.3 billion after payment of dividends, then one would have expected retained earnings to have grown from $9.6 billion at the beginning of 1972 to a level of some $20.9 billion rather than $2.7 billion at the end of 1992. The $18.2 billion difference is attributable to industry write-offs.

Thus, the **real** return over the 21-year period would, in fact, only have been some $13.05 billion ($31.25 billion minus $18.20 billion) for an adjusted after-tax real rate of return of 3.6 percent.

5.2.4 Debt to Equity Ratio and Interest Coverage

Debt to equity ratios over the period tended to fluctuate around what was considered to be a reasonable industry target of 35/65 (Figure 6). In fact, the average was very close to the target for the period.

The interest coverage over the period averaged 4.0 times interest which is a fairly conservative level for the industry (Figure 7). Of course, this ratio fluctuated considerably around the average, and was affected by economic cycles.

5.2.5 Dividend Pattern

Total dividends paid by the industry over the period (both preferred and common) amounted to $19.9 billion, or an average of $948 million per year (Figure 8).

5.2.6 Capital Expenditures

Capital expenditures were calculated as the difference, year-over-year, in gross capital assets. In 1988 there was a break in the series from Catalogue 61-207 to Catalogue 61-008. Average capital spending of the industry, in 1993 dollars, was slightly in excess of $1 .O billion per year (Figure 9). Even with this amount of capital spending, the total net fixed assets employed in the industry, were virtually unchanged from the beginning to the end of the period assessed (i.e. $15.484 billion in 1972 and $15.446 billion in 1992)

5.2.7 Cash Flow from Operations

The cash flow generated from operations, which fluctuated significantly reflecting the highly cyclical nature of the industry, averaged $3.8 billion per year over the period (Figure 10).

5.2.8 Selected Operating Costs

Figure 11 shows industry operating costs for labour, energy and materials and supplies over the period. Fuels and electricity costs more than doubled between 1972 and 1981 from $646 million to $1329 million and, thereafter, remained more or less constant. Labour costs were more or less equal at the beginning and end of the period, $3.3 billion in 1972 and $3.7 billion in 1991, but they did escalate to some $4.3 billion in 1981. The cost of materials and supplies rose over the last two decades, in real terms -- and fluctuated depending on metal price cycles and related production levels -- from $4.6 billion in 1972 to some $6.3 billion in 1991.

5.3 summary

The industry might have taken on moderately higher levels of debt and issued more share capital, but over the period the target debt/equity level and interest coverage were, in our view, quite reasonable, so any additional capital would have lowered the rate of return on equity. The actual after-tax rate of return to equity does not appear to be excessive at 3.6 % in real terms. No attempt was made in this study to calculate the effects on the rate of return on equity of differing levels of debt and equity.

In summary, until metal prices improve, it is possible that the industry in aggregate will either have to curtail some common dividends to generate extra funding for mine reclamation or be prepared to accept a lower rate of return on equity by raising additional outside debt or equity capital. Individual companies will be faced with different situations.

6.0 Case Studies

Two mine reclamation programs were presented at the workshop.

6.1 Equity Silver, Houston, British Columbia

Equity Silver was mined for silver, copper and gold from 3 open pits from 1980 to 1992. Shortly after mine development, it was discovered that pit waste rock was acid generating, even though the sulphide content was only 2 to 3 %. A total of 85 million tonnes of waste rock, of which 77 million are acid-producing were stockpiled on surface, and a tailings area of 109 hectares was developed. The tailings are potentially acid-producing but are prevented from “generating acid” by the presence of an engineered water cover (minimum 1.5 metres) and the presence of sufficient alkalinity in the tailings, part of which was added in the milling process.

In the decommissioning process, the acid production from waste rock dumps and the incidental use of waste rock for construction were determined to be the major liabilities. Early estimates of the total property liability that could have been converted into a security bond was $60 million, only slightly less than the cost of mine development.

Two important factors were instrumental in the reduction of the large bond that was meant to pay for one-time site reclamation and ongoing treatment and monitoring costs. First, the company did an extensive review of the available technology to reduce acid production and to get estimates as precise-as-possible of future liabilities. A compacted clay cover was placed on recontoured waste rock; as a result, water infiltration was expected to be reduced from 40% of precipitation to 10 % .

Secondly, a technical committee representing the provincial government, the company and the public reviewed extensively all historical, testing and modelling data to arrive at a set of recommendations. The final agreed-to financial assurance bond was $32 million.

Monitoring of results to date have shown that acid production is slightly lower than predicted. Equity Silver continues to fund research on the performance of the soil covering the rock piles.

The tax treatment of the financial assurance bond remains a concern of the company and of the mining industry.

6.2 Denison Mines - Elliot Lake Ontario

Denison operated a large uranium mine at Elliot Lake from 1957 until 1992. Over 100 million tonnes of tailings were deposited in 3 areas. All mining was underground, and except for a bacterially assisted underground in-situ leach, uranium was recovered from the ore by leaching in strong sulphuric acid, and the tailings residues were stored behind engineered embankments.

Shortly after the mining started, natural acidification was observed in both underground stopes and in tailings areas. Although the public and regulatory focus has been on the control of radionuclides, the most significant environmental problem was and continues to **be acid** generation in the tailings.

Denison is decommissioning the facility by taking the following actions:

- Demolition of surface buildings and disposal in tailings and underground;
- Replacing dams and covering some old tailings;
- Cleaning up small tailings sites, backfilling underground and consolidation to the **main** tailings site;
- Upgrading collection and treatment plants; and
- Levelling and flooding the main tailings areas.

The levelling and flooding of the main (Long Lake) tailings area has been achieved by a rapid and economical method - dredging. Water quality is expected to improve in a few years and this will allow the shut down of the main treatment plant. The total costs for decommissioning are estimated to be less than $1.00 per tonne. An older and smaller stacked tailings area is expected to cost about $5 per tonne.

Denison pointed out in the workshop that decommissioning is proceeding according to today's accepted standards. Public (FEARO) hearings, set for late 1994, could result in more stringent requirements and escalating costs.

7.0 Recommendations for Further Studies

Since every mine site is different and varies in complexity, a more comprehensive national database is needed to get a more precise measure of the nature and extent and mine reclamation needs across Canada. Unfortunately, currently more mines are being closed and sites rehabilitated than there are new mines opening. However, a great deal of expertise and practical skills are being developed in mine rehabilitation, and this expertise will be very valuable to mine owners and operators in Canada and internationally. The mistakes of the past will not be repeated if this expertise and experience becomes widely available. New mines can now be opened, operated and closed without concerns for costly long-term maintenance and water treatment.

Appendix A

Summary of Canadian Mine Waste Data

NEWFOUNDLAND & LABRADOR

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Baie Vert	Asb	1		1		37,000			2					
Bell Island Mines	Fe		1			25,000			2					
Buchans	Pb, Zn, Ag, Au	1			1	13,200			1	2				
Collier Pt.	Barite		1		1	5			2	2				
Cook Iron Mine	Fe		1		1	1			1	2				
Cresent Lake	Cb, Pb, Zn		1		1	2					2		1	2
Daniels Harbour	Pb, Zn		1		1	5,600			2	2				
Fluorspar Mines	Fluorite	1			1	1,800			2	2				
Goose Cove Mine	Cu, Zn, As		1		1	2			1	2	2		1	
Gullbridge	Cb, Pb, Zn		1		1	2,500			1	2				
Hope Brook	Au	1		1		2,000			1	1	500		1	1
IOC	Fe	1		1		330,000		underwater	2	1				
Little Bay	Cu		1		1	2,400			1	2				
Manuels	Pyrophylite	1		1							600		2	2
Rambler	Cu, Pb, Zn	1			1	1,500			1	2				
Tilt Cove	Cu, Au, Zn		1		1	5,700		Ocean/underwater	1	2				
Wabush	Fe	1		1		180,000		underwater	2	2				
Whalesback	Cu, Pb, Zn	?			1	2,200			1	2				
TOTALS		8	9	5	12	608,910					1,104			

* Y=1, N=2

NOVA SCOTIA

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
CBDC Broughton	Coal	1			1									
CBDC Colonial	Coal	1			1									
CBDC Franklin	Coal	1			1									
CBDC Gardiner	Coal	1			1									
CBDC Lingan	Coal	1			1						17,000		1	1
CBDC New Waterford	Coal	1		1							700	5.3	1	2
CBDC Prince	Coal	1		1							800		2	2
CBDC Princess	Coal	1			1						3,000	55	1	1
CBDC Pt. Aconi	Coal	1		1							204	5.7	1	1
CBDC Summit Dump	Coal	1			1						2,000		1	1
CBDC Victoria Junctio	Coal	1		1							7,000	80	1	1
Gays River	Zn	1			1									
Rio Kemptville	Sn, Cu	1			1	11,290	90	stacked	1	1	8,883		2	2
						7,410		water cover	2	1	3,963		1	1
Springhill	Coal		1		1						2,000		1	2
TOTALS		13	1	4	10	18,700	90				45,550	146		

* Y=1, N=2

NEW BRUNSWICK

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Brunswick #12	Cu, Pb, Zn	1		1		70,000	350	stacked	1	1				
Brunswick #6	Cu, Pb, Zn	1			1	200	2	covered	1	1	5,400	21.6	1	1
East West Caribou	Cu, Pb, Zn	1			1	300	10	underwater	1	1				
Heath Steele	Cu, Pb, Zn	1			1	6,000	202	underwater	1	1	2,300		1	1
NB Coal Fire Rd.	Coal	1			1	0					18,000		1	1
Mount Pleasant	W, Zn	1			1	1,000	25	water cover	2	2	1,000		2	2
Potocan	KCl	1		1		500	25	stacked	2	1				
TOTALS		7	0	2	5	78,000	614				26,700	21.6		

* Y=1, N=2

QUÉBEC

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Acid or Potential Acid Producers														
Barvue	Zn, Ag	1			1		38		1	2		22	1	2
Agnico Eagle	Au, Ag	1			1		171		1	1				
Albert	Cu, PY	1			1		6		1					
Aldermac	Cu	1			1		130		1					
Anacon Lead	Zn	1			1		7		1					
Canadian Malartic-AB	Au, Ni		1		1		78		1					
Candego	Pb, Zn		1		1		3		1					
Canbec (Harvey Hill)	Cu	1			1		10		1					
Capel	Cu	1			1		2		1					
Clinton	Cu	1			1				1			1.5	1	
Coniagas	Zn	1			1		9		1					
Copper Rand 4	Cu, Au	1		1			60		1					
Doyon (Parc Original)	Au, Ag	1			1		100		1					
Doyon (Parc 1992)	Au, Ag	1		1			50	valley		2				
Doyon (Parc 1994)	Au, Ag	1			1		120		1	2				
Doyon (Halde Nord)	Au, Ag	1			1						20,000	47	1	1
Doyon (Halde Sud)	Au, Ag	1			1						20,000	46	1	1
Dumagami	Au, Ag	1		1			78							
Eastern Metal	Ni	1			1							5	1	
East Sullivan	Cu, Zn		1		1		175	stacked	1	2	1,000			
East Sullivan	Cu, Zn		1		1				1	2		5	1	
Eusits	Cu	1			1		11							
Eustis	Cu	1			1							2	1	
Gallen (West McDonald)	Zn	1			1				1			5	1	
Granada	Au, Ag	1			1		9		1			1	1	
Howard	Zn, Cu	1			1				1			1	1	
Lac Memphremgog	Cu	1			1				1			1	1	

* Y=1, N=2

QUÉBEC

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Lac Renzy	Ni, Cu	1			1		7	underwater	1					
Lac Watson (Mattagami)	Zn, Cu	1		1			202		1					
Lemoine	Cu	1			1		5		1					
Lorraine	Ni, Cu		1		1		15		1					
Louvicourt (Cellule Est)	Cu, Zn	1			1		90							
Manitou-Barvue	Cu, Zn	1		1			127		1					
Mobrun	Cu, Zn	1			1		72							
Montauban Sud	Pb, Ag	1			1		5							
Moulton Hill (Ascot)	Cu, Zn	1			1		6							
New Calumet	Zn, Pb	1			1		4	beach		2				
Noranda-1 (Horne)	Cu	1			1		7	stacked	1					
Noranda-2 (Horne)	Cu	1			1		9	stacked	1	1				
Noranda-3 (Horne)	Cu	1			1		50	stacked	1	1				
Noranda-4 (Horne)	Cu	1			1		37	stacked	1	1				
Noranda-5 (Horne)	Cu	1			1		50	stacked	1					
Norbec A	Cu, Zn	1			1		16							
Norbec B	Cu, Zn	1			1		19							
Normetal	Cu, Zn	1			1		72							
Old Waite (Montgomery)	Cu	1			1							4	1	
Orchan	Zn, Cu	1			1							6	1	
Pandora	Au	1			1		5							
Poirier	Cu, Zn	1			1		65	stacked	1	2				
Principale (Camchib 1)	Cu	1			1		10							
Quebec Copper	Cu	1			1		4							
Quemont-1	Cu	1			1		49							
Quemont-2	Cu	1		1			75		1					
Rainville	Cu	1			1		8							
Selbaie 1	Cu, Zn	1			1		5							

* Y=1, N=2

QUÉBEC

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Selbaie 2	Cu, Zn	1		1			145	beach	1	1	10,000	25	1	1
Selbaie	Cu, Zn	1		1								6	2	1
Solbec-Cupra	Cu, Zn	1			1		65	stacked	1	2			1	2
Somex (Lac Edouard)*	Ni, Cu		1		1		5							
Suffield	Cu, Zn	1			1							2	1	
Tetreault	Zn, Pb	1			1		7							
Thompson Cadillac	Au	1			1		0.2							
Vauze	Cu, Zn	1			1		15							
Waite-Amulet	Cu, Zn	1			1		54	stacked	1	1				
Weedon	Cu, Zn	1			1		11							
Wood Cadillac*	Au		1		1		15							
Sub-total 1						**254,000**	**2388.2**				**70,000**	**179.5**		
Neutral Sites														
Anglo American	Mo	1			1		35							
Ansil	Cu, Zn	1			1							1		
Arntfield	Au	1			1		5							
Beattie (Eldorado)	Au, Ag	1			1		140							
Belleterre	Au, Ag	1			1		51							
Bevcon	Au	1			1		60							
Bousquet 1, 2	Au	1		1		4,000						?		
Burnt Crek	Fe	1			1							91		
Canadian Malartic-C	Au	1			1		36							
Camflo-1	Au	1			1		80							
Camflo-2,3	Au	1		1			60							
Camflo	Au	1			1							?		
Casa Berardi	Au	1			1	1,900	10		2	1				
Certac	Au	1			1		2							

* Y=1, N=2

QUÉBEC

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Chesbar	Fe	1			1		50							
Copper Cliff	Cu	1			1							0.2		
Copper Rand-1,3	Cu, Au	1			1		38							
Copper Rand	Cu, Au	1			1							3		
Corbet	Cu, Zn	1			1							3		
Cournor (Courvan)	Au	1			1		10							
Darius (O'Brien)	Au	1			1		7							
Donalda	Au	1			1		7							
D'Or Val	Au	1			1		40							
Dumont	Au	1		1								0.6		
Eagle West	Au	1			1	1,000	5					1		
East Malartic	Au	1		1			350							
Eastmaque	Au	1			1							0.5		
Ferderber	Au	1		1		3,000	71.5							
Ferderber	Au	1		1								0.9		
Ferriman	Fe	1			1							109		
Francoeur (Wasamac 2)	Au	1			1		6							
French	Fe	1			1							47		
Gagnon	Fe	1			1							128		
Geant Dormant	Au	1		1			90							
Gold. Pnd (Casa Berardi)	Au	1		1			16							
Granada	Au, Ag	1			1		9							
Granada	Au, Ag	1			1							1		
Grandroy	Cu, Au	1			1							3		
Graphex (Ashbury)	Graphite	1			1		6							
Graphicor	Graphite	1			1		10							
Green Stabell (Jacola)	Au	1			1		5							
Hilton	Fe	1			1		60							

* Y=1, N=2

QUÉBEC

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Hilton	Fe	1			1							137		
Icon Sullivan	Cu	1			1							25		
IOC (Sept-Iles)	Fe	1			1		?							
Isle-Dieu	Zn, Cu	1		1								1		
Jaculet	Cu	1			1							1		
Joe Mann (Chibex)	Au, Cu	1			1		12							
Joe Mann (Chibex)	Au, Cu	1		1								2		
Joubi	Au	1		1								1		
Kiena	Au	1		1			80					2		
Lac aux Dores	Cu, Au	1			1							1.5		
Lac Bachelor	Au	1			1		66							
Lac Fire	Fe	1			1							?		
Lac Jeannine	Fe	1			1		310							
Lac Jeannine	Fe	1			1							147		
Lac Rose	Au	1			1		3							
Lac Shortt	Au	1			1		78							
Lac Shortt	Su	1			1							1		
Lac Tio	Fe, Ti	1		1								73		
Lamaque	Au	1			1		280							
Lapa (West Cadillac)	Au	1			1		15							
Lucien Beliveau	Au	1			1		37							
McWatters	Au	1			1		9							
Molybdenite Corp	Mo	1			1		25							
Molybdenite Corp	Mo	1			1							1		
Mont Wright	Fe	1		1			1,180							
Mont Wright	Fe	1		1								250		
Muscocho (Montauban N)	Au	1			1		2							
Norbeau	Au	1			1		4							

* Y=1, N=2

QUÉBEC

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Norita	Cu, Zn	1		1								1		
Perron	Au	1			1		36							
Portage	Cu, Au	1		1								2		
Powell Rouyn	Au	1			1		9							
Pierre Beauchemin	Au	1			1							1.2		
Preissac Molybdene	Mo	1			1		12							
Preissac Molybdene	Mo		1		1		22							
Principale (Camchib 2)	Cu, Au	1			1		60							
Principale (Camchib 3)	Cu, Au	1		1			40							
QCM (Port Cartier)	Fe	1		1			10							
Quebec Lithium	Li	1			1		11							
Quesabe	Au	1			1		1							
Quyon Moly (MOSS)	Mo	1			1		8							
Rand Malartic	Au	1			1							0.5		
Retty	Fe	1			1							37		
Selbaie	Cu, Zn, Au	1		1		25,000	135		1	1		33	1	1
Senator	Au	1			1		16							
Shawkey	Au	1			1		5							
Sigma-1,2,3	Au	1			1		27							
Sigma-4,5,6,7,8,9	Au	1			1		90							
Sigma B	Au	1		1			41							
Sigma (Parc d'Urgence)	Au	1		1			12							
Sigma-2	Au	1		1								7		
Simkar (Louv. Goldfields)	Au	1			1		4							
Simkar (Louv. Goldfields)	Au	1			1							0.5		
Siscoe	Au	1			1		25							
Springer (Opemiska)	Cu	1			1		111							
Springer (Opemiska)	Cu	1			1							15		

* Y=1, N=2

QUÉBEC

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Stadacona	Au		1		1		28							
Stratmin	Graphite	1		1			5							
Sullivan	Au		1		1		50							
Terrains Auriferes-A*	Au		1		1		46							
Terrains Auriferes-B	Au	1		1			97							
Wasamac 1	Au	1			1		40							
West Malartic	Au	1			1		15							
Wrightbar	Au	1			1							1		
Y. Vezina (Aiguebelle)	Au	1		1			71							
Sub-total 2						**750,000**	**4387.5**				**625,000**	**1129.9**		
Alkaline Sites														
American Chrome	Cr	1			1							2		
Asbestos Hill-1	Asb	1			1							25		
Asbestos Hill-2	Asb	1			1		10							
Baker Talc	Talc	1		1			1					1		
Bell-1	Asb	1		1			92							
Bell-2	Asb	1		1								17		
Boston	Asb	1			1							27		
British Canadian 1	Asb	1		1			66							
British Canadian 2	Asb	1		1			59							
Broughton	Talc	1		1								4		
Cary Canadian 1	Asb	1			1		23							
Cary Canadian 2	Asb	1			1		20							
Cary Canadian 3	Asb	1			1							32		
Cary Canadian 4	Asb	1			1							5		
Cary Canadian 5	Asb	1			1							30		
Cary Canadian 6	Asb	1			1							12		

* Y=1, N=2

QUÉBEC

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Cary Canadian 7	Asb	1			1							67		
Chrysotile	Asb	1			1		1							
Continental	Asb	1			1		1							
Continental	Asb	1			1							2		
East Broughton-1	Asb	1			1		11							
East Broughton-2	Asb	1			1		5							
East Broughton-3	Asb	1			1							4		
East Broughton-4	Asb	1			1							10		
East Broughton-5	Asb	1			1							7		
Federal	Asb	1			1		4							
Flintkote-1	Asb	1			1		13							
Flinkote-2	Asb	1			1							26		
Gaspe	Cu	1		1			500					300		
Jacob	Asb	1			1		7							
Jeffrey	Asb	1			1		496					289		
Johnson	Asb	1		1			22							
King-Beaver	Asb	1		1			52							
Kitchener	Talc	1			1							2		
Lac D'Amiante-1,2,3,4,5,6,	Asb	1		1			67					383		
Luzenac	Talc	1			1							1		
Madelaine	Cu		1		1		25							
Montreal	Cr		1		1							4		
Nationale-1,2,3,4	Asb	1			1		24					26		
Nicolet Asbestos	Asb	1			1		13					4		
Niobec	Nb2O5	1			1		66							
Niobec	Nb2O5	1		1			80							
Normandie-1,2,3	Asb	1			1		60					103		
Quebec Asbestos-1,2,3	Asb	1			1		16					12		

* Y=1, N=2

QUÉBEC

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Reed-Belanger	Cr	1			1		4							
Sterrett	Cr	1			1		1							
St-Lawrence Columbium	Nb2O5	1			1		18					17		
Vimy Ridge	Asb	1			1		7							
Wolfe	Asb	1			1		1							
Sub-total 3						880,000	1,765				2,010,000	1,412		
TOTAL		209	13	45	177	1,918,900	8540.7				2705000	2721.4		

* Y=1, N=2

ONTARIO

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Adams	Fe						511	contained						
Algoma	Fe	1		1		25,000			2	2				
Ankerite Mine	Au (Ag)	?			1	5,200	27	2 raised stacks	2	2			2	2
Aquarius	Au					100	10	2 contained						
Ardeen/Kerry/Moss	Au, Ag	?			1	143	3	cross valley	2			0.5		
Ashley	Au, Ag, Cu, Pb, Zn	?			1	150	2	uncontained beach	2	2				
Atico/Sapawe	Ag, Au, Cu, Pb, Zn	?			1	33	2	uncontained beach	2					
Aunor	Au (Ag)	1			1	8,500	19	2 raised stacks	?	2				
Bankfield	Au, Ag		?		1	200	10	uncontained beach	1	2				
Barry Hollinger	Au, Ag		?		1	250	12	uncontained beach	2					
Beaver Mine	Au, Co		?		1	100	100	uncontained beach	?	2				
Bell Creek	Au					400	30	valley						
Belore	Au,Ag,(Cu,Pb,Zn)		?		1	143		?	?					
Berens River	Au, Ag, Pb, Zn		?		1	550	3	stacked	1	2				
Bicroft	U	1			1	2	12.5	beach	2	2				
Bidgood Kirkland	Au, Ag	?			1	600	5	cross valley	2					
Big Mama Creek	Zn,Cu					8,600								
Big Master	Ag, Au		?		1	45	1	uncontained beach	2					
Black Donald Graphite	Graphite				1	85	1	deep water	2					
Bousquet	Au (Ag, Cu)	?			1	17	1	uncontained beach	2					
Broulan	Au (Ag)	1			1	4,500	20	raised stack	2	2				
Bruce Mines	Cu (Au, Ag)		1		1	460	45	uncontained beach	1					
Cal Graphite	C	1		1		1,100	6		2					
Campbell	Au					12,000	60		2	1				
Canadaka Mine	Ag, Co	1			1	350	5	cross valley	2					
Cart Lake	Ag, Co	?			1	1,300	18	uncontained beach	?					
Casey Summit (Jason)	Au,Ag					270								
Castle Mine	Co, Ag	1			1	400	15	uncontained beach	?					
Cathroy Larder	Au (Ag, Cu, Zn)	?			1	22	2	cross valley	2					
Cedar Island Mine	Au					17		underwater	2	2				
Central Patricia No.1	Au, Ag		?		1	500	20	raised stack - 3 areas	1	2				

* Y=1, N=2

ONTARIO

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Centre Hill Mine	Cu, Zn, Ag (Ni, Au)		?		1	300	2	cross valley	1	2				
Chambers Ferland	Ag, Co, Ni	?			1	200	25	uncontained beach	?					
Cline Mine	Au, Ag	?			1	300	2	uncontained beach	2					
Cobalt Lake	Ag, Co	?			1	500	15	deep water	2					
Cochenor Wilans	Au, Ag	1			1	2,300	110	cross valley	1					
Coldstream	Cu, Au, Ag	1			1	2,700			2					
Coniaurum	Au (Ag, Cu)	?			1	4,500	35	raised stack/cross valley	2					
Consolidated Luanna	Au	1			1	70	8	raised stack	1					
Con. Can. Faraday	Cu, Ni (Au, Ag)	?			1	1,250	18	underwater/stack	1					
Cordova (Lasir) Gold	Au, Ag				1	120	1	uncontained beach	1					
Corrnucopia	Au, Ag					17								
Coppercorp	Cu	1			1	1,000	20	cross valley	1					
Crosswise Lake	Ag, Co	?			1	1,500	50	uncontained beach	?					
Crown Mine	Au (Ag)	?			1	200		uncontained beach	2					
Darwin Mine	Au, Ag					6	0.2	underwater						
David Bell	Au	1		1		2,300	50	water cover	1	1				
Delnite	Au (Ag)	?			1	3,800	24	raised stack	2					
Denison	U	1			1	70,000	280	water cover	1	1				
DeSantis	Au, Ag (Pb, Zn, Cu)		1		1	200	12	uncontained beach	2					
Detour Lake	Cu, Au	1			1	9,900	100	water covers	2	1	3,500		1	1
Dik Dik	Au, Ag					4								
Dome	Au	1		1		46,000	420	stacked	2	1				
Dona Lake		1			1	770	5		2	1				
Eastmaque	Au	1			1	7,000	50	beach	2	2				
Elora	Ag, Au				1	90			2					
Empress	Au					1								
ERG	Au		1		1	6,250	500	raised stack	2					
Evenlode Mine	Mo,Au					5								
Falcon Onaping	Ni	1		1		45,600	194	beach	1	1	3,000	12	1	1
Falconbridge Sud.	Ni	1		1		17,600	120	various	1	1	10,000		1	1
Faymar	Au (Ag)		?		1	160	6	uncontained beach	2					

* Y=1, N=2

ONTARIO

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Fecunis		1			1	11,300	54		1	1				
Gateford	Au (Ag)		1		1	100	2	uncontained beach	2					
Geco		1		1		33,000	200	stacked	1	1	1,500			1
Genex	Cu				1	15	2	cross valley	1					
Gillies Lake	Au (Ag)		1		1	55	4	uncontained beach	2					
Glen Lake	Ag, Co (Ni)	1			1	1,500	10	cross valley	?					
Gold Eagle	Au, Ag		1		1	180	10	valley	2					
Golden Star	Au (Ag)				1	20		uncontained beach	2					
Goldlund	Au, Ag (Zn, Cu)	?			1	50	1	valley	2		10		?	2
Gordon Lake	Cu, Ni, Au, Ag	1				125			2					
Green-Meehan	Ag, Co (Cu, Ni, Pb)	?			1	25	4	uncontained beach	1					
Griffith	Fe	1			1	60,000	400	underwater/raised stack	2					
Hammond Reef	Au (Ag, Cu, Pb)					1								
Hardrock	Ag, Au, Cu, Pb	1			1	1,500	22	uncontained beach	2	2	100		?	2
Hallnor	Au (Ag)				1	4,200	50	raised stacks	2					
Hasaga	Au, Ag	?			1	1,500	15	uncontained beach	2					
Hollinger	Au, Ag	1			1	58,000	190	raised stack	2					
Holt McDermott	Au	1		1		3,150	16		2	1				
Howey	Au, Ag		1		1	4,500	35	beach/stack	2					
Hudson Patricia	Au, Ag (Pb, An, Cu)				1	11		underwater	2					
Hoyle	Au, Ag	1		1		450	10	uncontained beach	1					
Inco Sudbury	Ni, Cu	1		1		500,000	2250	stacked	1	1	31,000		1	1
Jackson-Manion	Au, Ag	?			1	100	1.5	uncontained beach	2					
Jamieson	Cu, Zn (Au, Ag)	?			1	430	15	cross valley	1					
Jardun	Pb, Zn	1			1	130	3	uncontained beach	1					
Jerome	Au (Ag)	?			1	335		deep water	2					
Jubilee	Au (Ag)					45								
Kam Kotia	Cu, Zn		1		1	6,000	275	2 uncontained beaches	1	2	200		1	2
Kanichee	Cu, Ni	?			1	500	10	cross valley	1					
Keeley Frontier Mine	Ag, Co (Ni, Cu)	1			1	300	5	uncontained beach	2					
Kenrica	Au, Ag (Cu)				1	22		probably underwater	2					

* Y=1, N=2

ONTARIO

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Kenwest	Au, Ag					45								
Kerr Addison	Au					38,300	110	contained						
Kerry (Moss)	Au,Ag					143								
Kidd Copper	Ni, Cu (Co, Pt)	1			1	3,500	10	cross valley	1	1				
Kidd Cr.	Cu, Zn	1		1		91,000	1205	cone	1	1	25,000		2	2
Kingdon Mine	Pb, Zn				1	905	15	raised stack	2					
Kirkland Lake	Au, Ag	?			1	3,000	24	cross valley	2					
Lacnor	U	1			1	11,000	101	beached, cross valley	1	1				
Laguerre	Au					41	7	under park						
Lakeshore	Au, Ag	1			1	17,000	135	cross valley	2					
Langis	Ag, Co (Ni)		?		1	300	20	uncontained beach	?					
Langmuir	Ni (Cu, Au, Ag)	1			1	1,000	60	cross valley	1					
Laurentian	Ag, Au		1		1	45	2	valley	2					
Leitch Gold	Au, Ag	?			1	920	100	raised stack	2		10			
Little Long Lac Gold	Au, Ag	1			1	1,800	10	uncontained beach	2	1				
Long Lake Mine	Au, Ag (Cu)	?			1	220	10	uncontained beach	2					
Long Lake Mine	Pb, Zn, Ag				1	87	25	raised stack	2					
Lythmore #1	Gypsum				1	40 ?	1	raised stack	2					
Macassa	U, Ag	1			1	6,300	30		2					
MacKenzie Island	Au, Ag	?			1	2,000	8	uncontained beach	2					
MacLeod Cockshutt	Au, Ag (Pb, Zn)	1			1	10,000	60	stack/beach	2	?	1,000		?	?
Madawaska	U	1			1	4,000	35	stack/beach	2	2				
Madsen	Au, Ag	?			1	8,000	15	uncontained beach	2					
Magnet Consolidated	Au, Ag	?			1	350	10	uncontained beach	2	?				
Marmoraton Mine	Fe	1			1	30,000	100	raised stack	2		20,000		2	2
Matachewan Cons.	Au					3,500	22							
Mattabi	Cu, Zn, Ag, Pb, Au	1			1	12,500	100	water cover	1	1	11,400		1	1
Mayburn	Cu (Au, Zn)	1			1	125	4	cross valley	1					
McIntyre	Au					47,000	350	series of contained						
McKenzie	Au, Ag					2,000								
McMarmac	Au, Ag	?			1	150		uncontained beach	2					

* Y=1, N=2

ONTARIO

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
McMillan	Au, Ag	?			1	60	2	uncontained beach	2					
Mikado	Au, Ag, Cu, Pb		?		1	57	1	stack on shore of lake	2					
Milanda	Au, Ag, Cu, Pb		?			57			?					
Minto Mine	Au, Ag					28	1.2	underwater						
Moneta	Au, Ag	?			1	300	2	uncontained beach	2					
Morris Kirkland	Au (Ag, Cu)	?			1	130	11.5	uncontained beach	2					
Naybob	Au, Ag	?			1	300	12	uncontained beach	2					
New Jason	Au, Ag (Pb, Zn, Cu)	?			1	270	6	uncontained beach	1					
Nickel Rim	Ni, Cu	1		1		970	21		1					
Nippising Hill	Ag, Co				1	150	8	uncontained beach	?					
Nordic	U	1			1	14,000	101	stacked	1	1				
North Coldstream	Cu, Au, Ag	?			1	2,700	15	stack/beach	1					
Northern Concentrato	Au					3								
North Shores	Au,Ag					4								
Nova Scotia Mine	Ag, Co (Au, Cu, Pb)	?			1	275	6	uncontained beach	?					
Olive (Preston)	Ag, Au, Cu, Zn	1			1	7								
Olympia (Gold Coin)	Au,Ag					2								
Omega	Au (Ag)	?			1	1,600	8	raised stack	2					
Owl Creek	Au	1			1	1,700			2		3,300		2	2
Pamour	Au					34,000	215	3 contained						
Pan Empire	Au, Ag	?			1	425		side hill	2		40			
Panel	U	1			1	14,000	117	water cover	1	1				
Parkhill Mine	Au, Ag					10	0.4	overgrown						
Paymaster	Au (Ag, Pb, Zn, Cu)	?			1	5,600	35	raised stacks	2					
Penhorwood Talc	Talc						15	deposit in open pit						
Pickle Crow Gold	Ag, Au		?		1	3,500	50	2 valley's, 1 partial stack	2	2	100		?	2
Porcupine Lake	Au (Ag)				1	11		deep water	2					
Porcupine Peninsular	Au, Ag	?			1	100		deep water	2					
Preston	Au					6,300	52	2 contained						
Pronto	U	1			1	5,000	50	beach	1	1				
Quirke	U	1			1	46,000	192	water cover	1	1	4		1	1

* Y=1, N=2

ONTARIO

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Redeemer	Au					2								
Red Lake Gold Shore	Au,Ag					86								
Regina Mine	Au					36								
Ronda	Au, Ag	?			1	25	1	uncontained beach	2					
Ross	Au (Cu)	1			1	6,500	32	raised stack	2					
Ryan Lake Mine	Cu, Mo (Au, Ag)	1			1	185	5	beach	1					
Sachigo River	Au, Ag (Cu, Zn, Fe)	?			1	46	0.2	uncontained beach	2					
Sand River/Undersill	Au, Ag	?			1	157	100	raised stack	2					
Sawbill	Au, Ag (Cu)					5								
Shebandowan	Ni, Cu	1			1	15,000	120	water cover	2					
Sherman	Fe	1			1	5,000	200	stacked	2	2	2,000			
Siscoe Tailings	Ag (Co, Ni, Cu, Fe, Pb)				1	1,000	8	uncontained beach	2					
South Bay	Zn, Cu, Au (Pb)	1			1	760	85	raised stack	1					
Spanish Am.	U	1			1	500	14	beach	1	1				
Stairs Mine	Au (Ag)				1	16	1	uncontained beach	2					
Stanleigh	U	1		1		14,000	200	water cover	1	1				
Stanrock	U	1			1	6,000	32	stacked	1	1				
Starratt-Olson	Au, Ag				1	1,000	16	high valley	2					
Steep Rock & Caland	Fe	1			1	93,000			2	2				
Strathcona	Ni, Cu	1		1		39,000	145	beach	1	1	5,000	10	1	1
Straw Lake Beach	Ag, Au, Cu		1		1	33		under water	1					
Sturgeon Lake	Cu, Au, Pb, Zn, Ag	1			1	2,200	25	raised stack	1		10,900		1	1
Sturgeon River	Au, Ag, Cu, Pb	1			1	145	6	uncontained beach	1	2	10		?	?
St. Anthony	Ag, Au		1		1	3,000	15	uncontained beach	1	2	300		?	2
Sultana	Au (Ag)				1	77		uncontained beach	2					
Sylvanite	Au, Ag	?			1	5,000	60	cross valley	2					
Tashhota-Nipigon	Au, Ag, Cu, (Pb,Zn)		1		1	51	2	uncontained beach	1					
Teck Hughes	Au, Ag	1			1	9,600	70	cross valley	2					
Temagami	Cu, Ag, Au, Ni, Co	1			1	670	5	uncontained beach	?					
Texmont	Ni, Cu	?			1	200	10	cross valley	1					
Theresa	Au, Ag	?			1	26	2	uncontained beach	2					

* Y=1, N=2

ONTARIO

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Thierry Mine	Cu (Ni, Au, Ag)	1			1	8,000	70	uncontained beach	1					
Toburn	Au, Ag	?			1	1,200	21	cross valley	2					
Tombill	Au, Ag	1			1	190	1	uncontained beach	2					
Tribag	Cu, Ag, Au	1			1	1,200	14	cross valley	1					
Twentieth Century	Au, Cu, Zn					9								
Tyranite	Au, Ag	?			1	225	10	uncontained beach	2					
Uchi	Au, Ag	?			1	750	10	uncontained beach	2					
Upper Canada	Au, Cu (Ag)	1			1	5,000	150	cross valley	2					
Vipond	Au (Ag)	?			1	1,500	24	side hill	2					
Wendigo Gold	Au (Cu, Ag)	1			1	200	2	uncontained beach	1					
White	Au	1		1		10,000	50		2	1				
Williams	Au	1		1		10,000	50	underwater	1	1				
Wilmar						760								
Winston Minnova	Zn, Cu	1			1	2,100	100	water covers	1	2				
Wright Hargreaves	Au, Ag	1			1	10,000	68	cross valley	2					
Young Davidson	Au, Ag	?			1	6,200	80	cross valley	2					
Zenmac	Cu, Zn	?			1	165	20	raised stack	1					
TOTAL - ONTARIO		73	12	16	150	1,676,832	11886.5				128,374	23		

* Y=1, N=2

MANITOBA

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Anderson/Snow Lk.	Cu, Zn	1		1		7,300	400	underwater	1	2	489		1	
Flin Flon	Cu, Zn	1			1	1,850	2	stacked	2	2	13,000		1	
Fox	Cu, Ni	1			1	8,000	250	water cover	1	1	1,000		1	
Inco	Cu, Ni	1				125,000	1,000	flooded	1	1	33,000		2	2
Lynn Lake	Cu, Ni	1			1	21,000	125	ponded	1	1	2,500		1	
Namew L	Cu, Zn	1			1	2,400	20	water cover	2	2				
Ruttan	Cu, Zn		1	1		37,200	359	underwater	1	2	51,800		1	1
Sherridan	Cu, Zn	1			1	8,200	45	stacked	1	1				
Tanco	Ta, Li	1		1		4,200	200	beach/stacked	2	2				
TOTAL		8	1	3	5	215,150	2,401				101,789			

* Y=1, N=2

SASKATCHEWAN

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Cluff Lake	U	1		1		3,000	50	stacked/underwater	2	1	19,500		2	1
Creighton	Cu, Zn	1		1		65,800	259	stacked	1	1				
Eldorado	U	1			1	6,000	100	underwater	2	2	4,000	50	2	2
Gunnar	U		1		1	5,500	110	beach	2	2	5,500		1	2
Key Lake	U	1		1		2,100	64	subareal	2	1	14,000	48	1	1
Lorado	U	1			1	600	14	beach	1	2				
Potash	KCl	1		1		300,000	1,700	stacked	2	2				
Rabbit B-Zone	U	1		1	1	2,500	20	pit	2	2	1,000		2	1
Rabbit	U	1		1		6,000	84	stacked/underwater	2	2	10,080	22	2	1
TOTAL		8	1	6	4	391,500	2,401				54,080	120		

* Y=1, N=2

BRITISH COLUMBIA

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Afton	Cu, Au	1			1	32,000	117	stack	2	2	135		2	2
Anyox		?						Adit making acid	1	2				
BC Nickel		?						beach			180			
Benson Lake Copper	Cu, Zn		?		1	5,000		underwater	1	2	20,000		2	2
Boss Mountain	Mo	1			1	8,800	70	stacked	2	2				
Bralore	Au	?			1						270		2	2
Brenda	Cu	1			1	30,000		stacked	2	2			2	2
Brittania	Cu		1			47,000		ocean	2	2	100		1	2
Caribou Gold	Au	?			1	22,400	35	water cover	1	2				
Cassiar	Asb	1			1				2	2			2	2
Duthie	Cu	1			1	100	2		1	2				
Elkview-Adit	Coal	1		1					2		45,000	50	2	2
Elkview-Baldy	Coal	1		1					2		70,000	65	2	2
Elkview-Balmer	Coal	1			1				2		80,000	44	2	2
Elkview-Erickson	Coal	1			1						70,000	38	2	2
Emory	Cu, Ni	?			1	1,800			2	2	180		2	2
Endako	Mo	1		1		200,000	?	valley	2	2	245,000	190	2	2
Equity Silver	Cu, Au	1			1	30,500	109	water cover	1	1	76,500	118	1	1
Fording	Coal	1		1							250,000	210	2	2
Gibraltar - Acid	Cu	1		1		265,000	533	valley, not acid	2	2	220,000		1	1
Gibraltar - Non-Acid		1		1					2	2	90,000		2	1
Golden Bear		1		1							3,010	19.5	2	2
Grandisle	Cu	1			1	52,000		stacked	2	1	75,000		1	1
Granduc	Cu	1			1								2	2
Highland Valley	Cu	1			1	635,000	2,200	valley	2	1	1,033,000		2	2
Island Copper	Cu	1		1		160,000		ocean	1	1	97,200	160	2	1
Island Mountain		?			1	200			2	2				
Johnny Mountain	Au	1			1	162		water cover	1	1	50		1	1

* Y=1,N=2

BRITISH COLUMBIA

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Kutcho Creek		1			1						50		1	2
Lenora		?												
M009		1									35,800		1	1
M040	Coal	1							2		21,365		2	1
M147		1				236	10		2				1	1
M184		1									590		2	1
Mount Sicker		?			1						47		1	2
Mount Washington	Cu		1		1				1	1	950		1	2
Pinchi Lake	Hg	1			1	2,500			2	2	180		2	2
Premier Gold	Au	1			1	300		stacked		2				
Quintette	Coal	1			1				2	1	57,900		2	1
Samatosum		1			1	450			2	2	6,480	12.5	1	2
Similco	Cu	1			1	154,400	1,000	water cover	2	2				
Sullivan	Pb, Zn	1		1		86,500	375	stacked	1	1	8,900		1	1
Tsable River	Coal	1			1				2	2	9		2	2
Tumbler	Coal	1		1					2	1	25,000	10	2	2
Westmin	Cu, Zn	1		1		2,310	50	subareal	1	1	6,243		1	1
TOTAL		**34**	**2**	**11**	**26**	**1,736,658**	**4,501**				**2,539,139**	**917**		

* Y=1,N=2

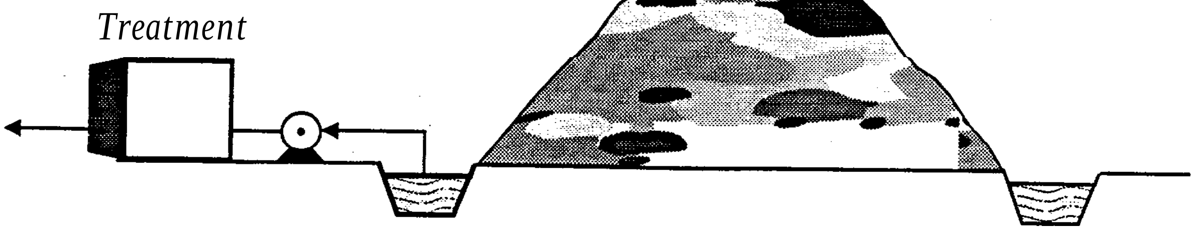
YUKON & NORTHWEST TERRITORIES

Site Name	Metals	Owner		Status		TAILINGS					WASTE ROCK			
		Co.	Crown	Active	Inactive	Tonnes (k)	Hectares	Method	Acid Y/N*	Treatment Y/N*	Tonnes (k)	Hectares	Acid Y/N*	Treatment Y/N*
Cantung	W, Cu	1			1	3,000	18.8	water cover	2	2				
Colomac	U	1			1	1,500					7,600		2	2
Con	Au	1		1		5,000		water cover	2	1				
Cullaton		1				500	20	water/till cover	1	2				
Discovery	Au	1	1			1,200	10							
Echo Bay Lupin	Au	1		1		5,800	100	underwater	1	2	1,000		2	2
Faro	Zn	1			1	61,000	192	valley/stacked	1	1	16,000		1	1
Giant	Au	1		1		6,000			2	1				
Ketza River	Cu, Au	1			1	300	8	water cover	1	2	300			
Nanisivik	Pb, Zn	1		1		12,600	100	underwater	1	2	420		2	2
Pine Point	Zn		1		1	90,000	700	stacked	2	1	10,000	50	2	2
Polaris	Pb, Zn	1		1		8,000		underwater	2	2				
Port Radium	U, Ag		1		1	1,000		beach/till cover	2	2				
Rankin	Ni		1		1	327	10	beach	1	1				
Sa Dena Hes	Zn, Pb	1			1	800	22	water cover	2	2			2	2
Salmita	Au	1			1	160	22	beach	2	2				
Terra	Ag	1			1	200		beach	2	2				
United Keno Hill	W	1			1	1,800	33	stacked	1	2	1,010		1	
Whitehorse Copper	Cu	1			1	13,700	75	stacked	2	1	380		2	2
TOTAL		16	4	5	12	212,887	1310.8				36,710	50		

* Y=1, N=2

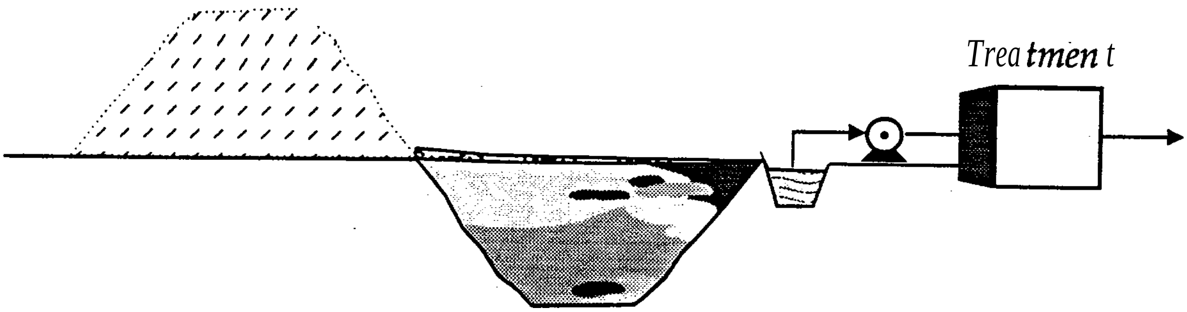
Appendix B

Schematic Representation of Options to Control Acid Mine Drainage



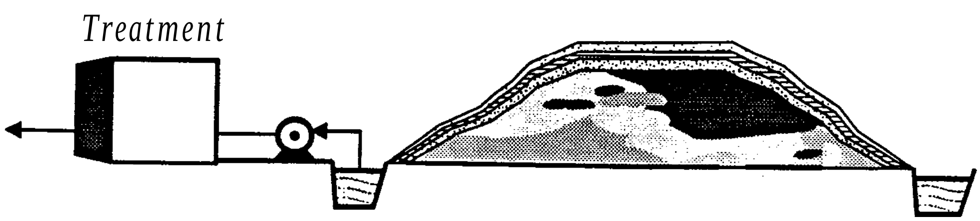
Rock Pile Base Case

Collect and Treat



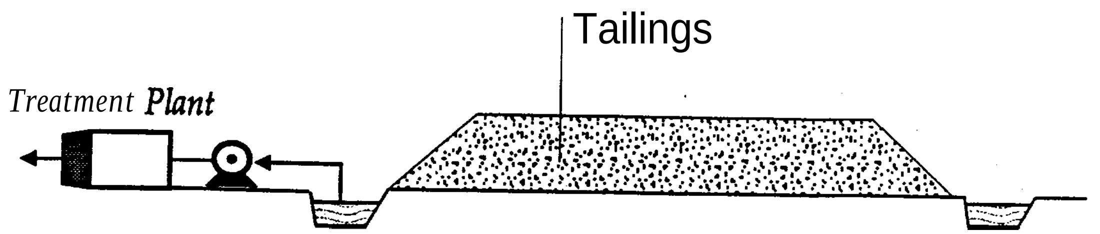
Rock Pile Case 2

Move to Pit, add Limestone,
Lime and Cover

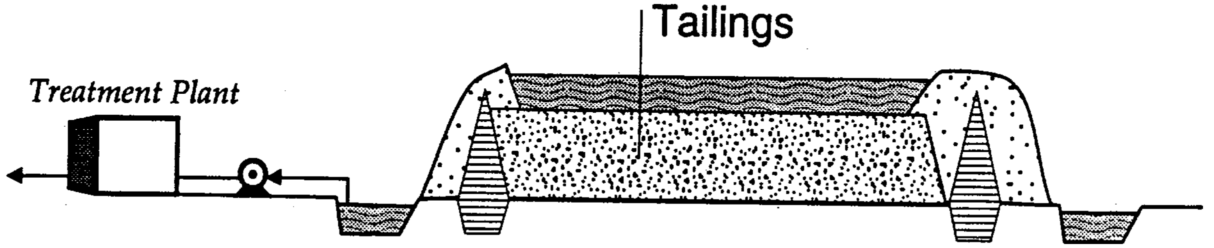


Rock Pile Case 3

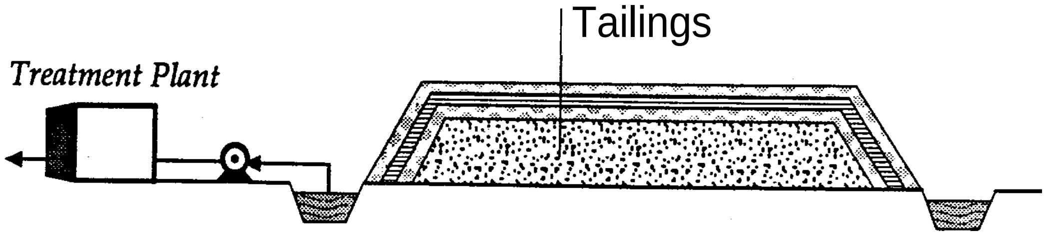
Recontour to a 3:1 Slope
Complex Cover, Collect and Treat



Tailings Base Case 1
Collect and Treat



Tailings Case 2
1m Water Cover, Collect and Treat



Tailings Case 3
3 Layer Earth Cover, Collect and Treat

Appendix C

Financial Performance of Canadian Mining Industry

Table 1. CORPORATION FINANCIAL STATISTICS - TOTAL METAL MINING 1972-1992
(Million dollars, except as noted)

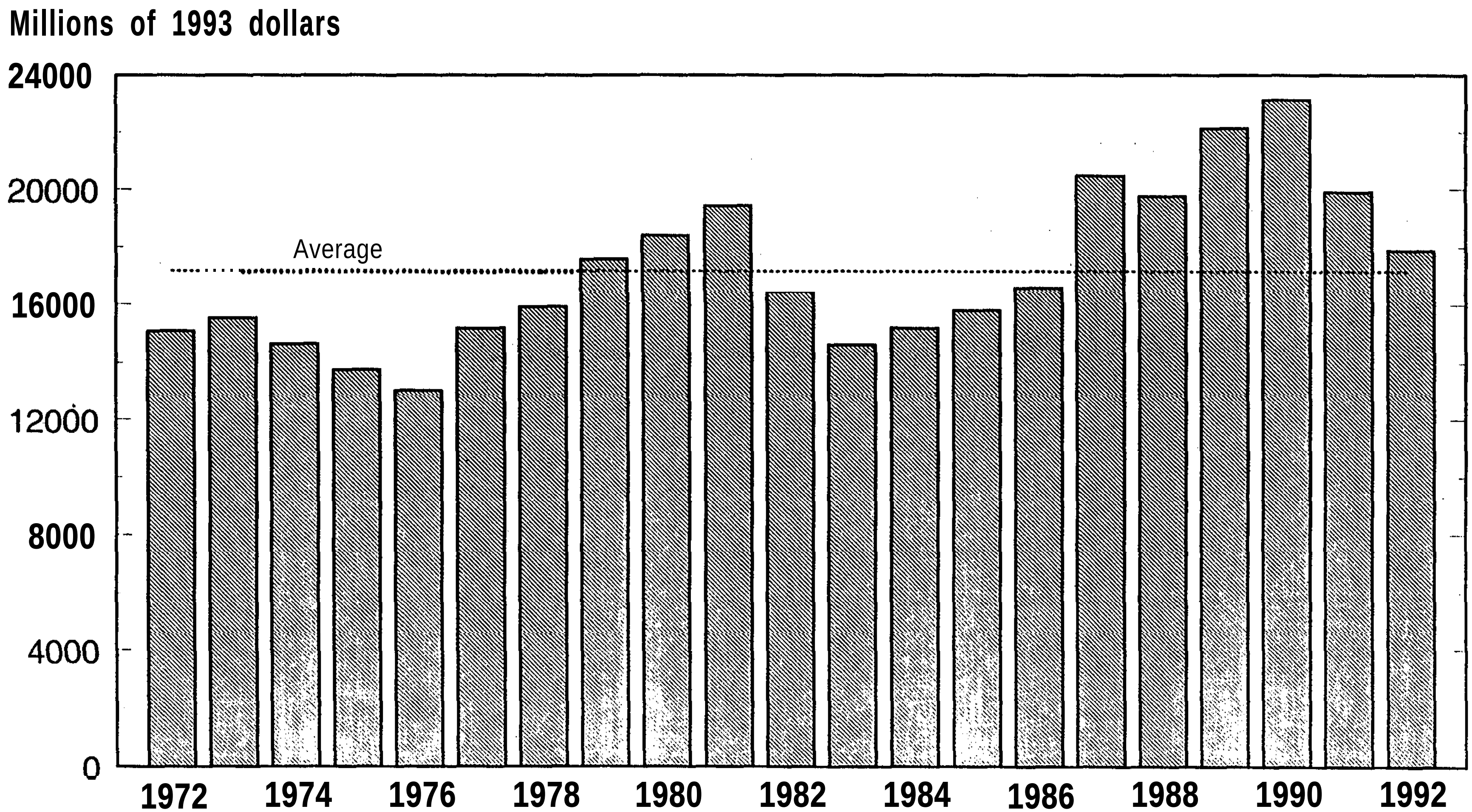
	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Current Ratio	2.26	1.98	1.77	1.65	1.47	1.61	1.93	2.06	1.81	1.75	1.67
Yearly cash flow from operations	735.0	1792.9	2096.7	1435.9	1435.2	1318.8	1999.7	3614.6	4092.2	2058.6	1249.1
in 1993 $	2543.3	5691.7	5824.2	3635.2	3337.7	2885.8	4131.6	6781.6	6947.7	3152.5	1761.8
Interest coverage	3.79	8.76	8.99	5.04	3.79	3.04	5.09	9.58	8.22	2.23	0.51
Interest expense	121.5	164.6	189.6	205.9	264.3	273.0	300.9	323.3	427.8	615.4	890.0
in 1993 $	420.4	522.5	526.7	521.3	614.7	597.4	621.7	606.6	726.3	942.4	1255.3
Capital expenditures	N/A	326.8	333.6	554.6	577.7	787.5	296.7	731.6	1205.6	1430.3	1125.6
in 1993 $	N/A	1037.5	926.7	1404.1	1343.5	1723.2	613.0	1372.6	2046.9	2190.4	1587.6
Dividends (cash) declared	242.6	375.5	452.2	391.3	351.6	304.8	392.2	669.9	967.5	1008.4	471.5
in 1993 $	839.4	1192.1	1256.1	990.6	817.7	667.0	810.3	1256.8	1642.6	1544.3	665.0
Rate of return on assets (percent)	5.56	15.48	16.57	9.27	8.23	6.10	10.55	18.01	17.66	5.57	1.80
Rate of return on equity before taxes (percent)	7.78	26.13	28.72	15.30	13.13	8.05	15.97	29.64	28.54	5.97	-3.78
Rate of return on equity after taxes (percent)	5.13	18.35	16.03	9.17	9.06	9.44	11.81	20.47	18.31	10.13	-1.17
Debt/Equity											
Debt	2513.4	2570.8	2647.7	3118.4	3625.9	3487.8	3678.3	3671.0	4135.9	6651.1	8338.1
in 1993 $	8696.9	8161.3	7354.7	7894.7	8432.3	7631.9	7599.8	6887.4	7021.9	10185.5	11760.4
Equity	4358.7	4887.8	5272.3	5433.0	5618.0	6933.2	7698.7	9359.0	10828.2	12680.0	11647.0
in 1993 $	15082.0	15516.8	14645.3	13754.4	13065.1	15171.1	15906.4	17559.1	18384.0	19418.1	16427.4
Share capital (in 1993 $)	3462.3	3075.6	2895.6	2617.2	2705.8	4218.6	4720.0	5346.9	5526.5	7268.0	6770.4
Retained earnings (in 1993 $)	9677.2	11057.5	10386.4	9822.5	9124.9	10187.1	10464.5	10621.8	11489.8	10630.2	7932.6
Contributed surplus and other (in 1993 $)	1942.9	1383.8	1363.6	1314.7	1234.4	1343.1	722.1	1590.4	1367.6	1519.9	1724.4
Debt plus equity	6872.1	7458.6	7920.0	8551.4	9243.9	10421.0	11377.0	13030.0	14964.1	19331.1	19985.1
Debt (as percent of debt plus equity)	37	34	33	36	39	33	32	28	28	34	42
Equity (as percent of debt plus equity)	63	66	67	64	61	67	68	72	72	66	58
GDP Implicit Price Index (1993=100)	28.9	31.5	36.0	39.5	43.0	45.7	48.4	53.3	58.9	65.3	70.9

Table 1. CORPORATION FINANCIAL STATISTICS - TOTAL METAL MINING 1972-1992
(Million dollars, except as noted)

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Avg.
Current Ratio	1.60	1.23	1.32	1.58	1.92	1.46	1.66	1.67	1.60	1.35	1.68
Yearly cash flow from operations	1704.9	1598.6	1660.7	2191.6	3383.3	5011.0	5136.0	3590.0	2046.0	2105.0	2393.1
in 1993 $	2288.5	2081.5	2104.8	2715.7	4003.9	5662.1	5540.5	3751.3	2085.6	2122.0	3764.2
Interest coverage	1.22	0.67	0.90	1.36	3.10	7.10	6.00	2.70	1.00	1.10	4.01
Interest expense	751.8	935.4	757.0	883.5	776.4	568.0	666.0	847.0	702.0	621.0	537.4
in 1993 $	1009.1	1218.0	959.4	1094.8	918.8	641.8	718.4	885.1	715.6	626.0	768.7
Capital expenditures	532.6	820.8	108.7	28.7	673.0	N/A	2262.0	1217.0	-681.0	156.0	657.3
in 1993 $	714.9	1068.7	137.8	35.6	796.4	N/A	2440.1	1271.7	-694.2	157.3	1061.8
Dividends (cash) declared	420.1	562.0	602.2	631.4	547.7	2504.0	1166.0	918.0	953.0	875.0	705.1
in 1993 $	563.9	731.8	763.2	782.4	648.2	2829.4	1257.8	959.2	971.5	882.1	1051.0
Rate of return on assets (percent)	3.76	2.41	2.54	4.19	7.62	12.40	12.10	6.50	2.00	2.00	8.11
Rate of return on equity before taxes (percent)	1.53	-2.68	-0.64	2.37	9.41	19.70	16.40	6.40	-0.10	0.30	10.86
Rate of return on equity after taxes (percent)	1.77	-3.43	-1.00	3.23	7.70	12.03	14.69	3.31	-0.06	0.11	7.86
Debt/Equity											
Debt	8611.7	8293.8	8476.6	10256.7	8244.7	6675.0	6025.0	6092.0	8546.0	8650.0	5919.5
in 1993 $	11559.3	10799.2	10743.5	12709.7	9757.0	7542.4	6499.5	6365.7	8711.5	8719.8	8811.2
Equity	10895.6	11671.0	12468.3	13399.5	17289.8	17482.0	20519.0	22127.0	19515.0	17722.0	11800.2
in 1993 $	14625.0	15196.6	15802.7	16604.1	20461.3	19753.7	22134.8	23121.2	19893.0	17864.9	17161.3
Share capital (in 1993 $)	7372.2	9070.3	9814.8	10951.7	13681.4	13223.0	12876.0	13580.0	14282.0	14482.0	7997.2
Retained earnings (in 1993 $)	5787.7	4585.2	4504.7	4241.6	5033.6	5118.0	6882.0	6757.0	4614.0	2743.0	7698.1
Contributed surplus and other (in 1993 $)	1465.1	1541.3	1483.0	1410.8	1746.3	1415.0	2375.0	2785.0	1000.0	1646.0	1541.6
Debt plus equity	19507.3	19964.8	20944.9	23656.2	25534.5	24157.0	26544.0	28219.0	28061.0	26372.0	17719.8
Debt (as percent of debt plus equity)	44	42	40	43	32	28	23	22	30	33	
Equity (as percent of debt plus equity)	56	58	60	57	68	72	77	78	70	67	
GDP Implicit Price Index (1993=100)	74.5	76.8	78.9	80.7	84.5	88.5	92.7	95.7	98.1	99.2	

Figure 1

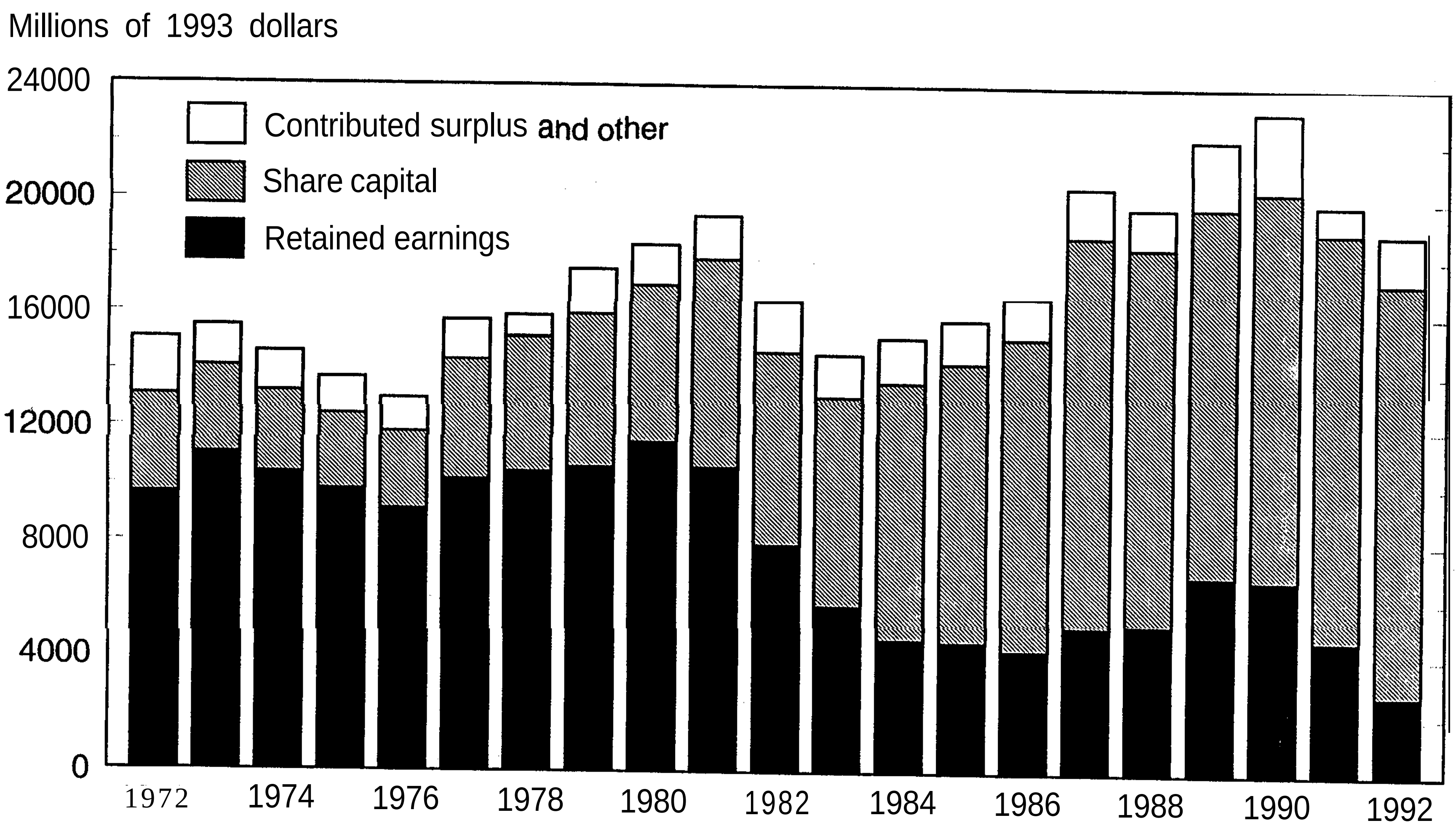
EQUITY - TOTAL METAL MINING
1972 - 1992



"Total Metal Mining" includes integrated operations.
Source: Statistics Canada, Industrial Organization and Finance Division.

Figure 2

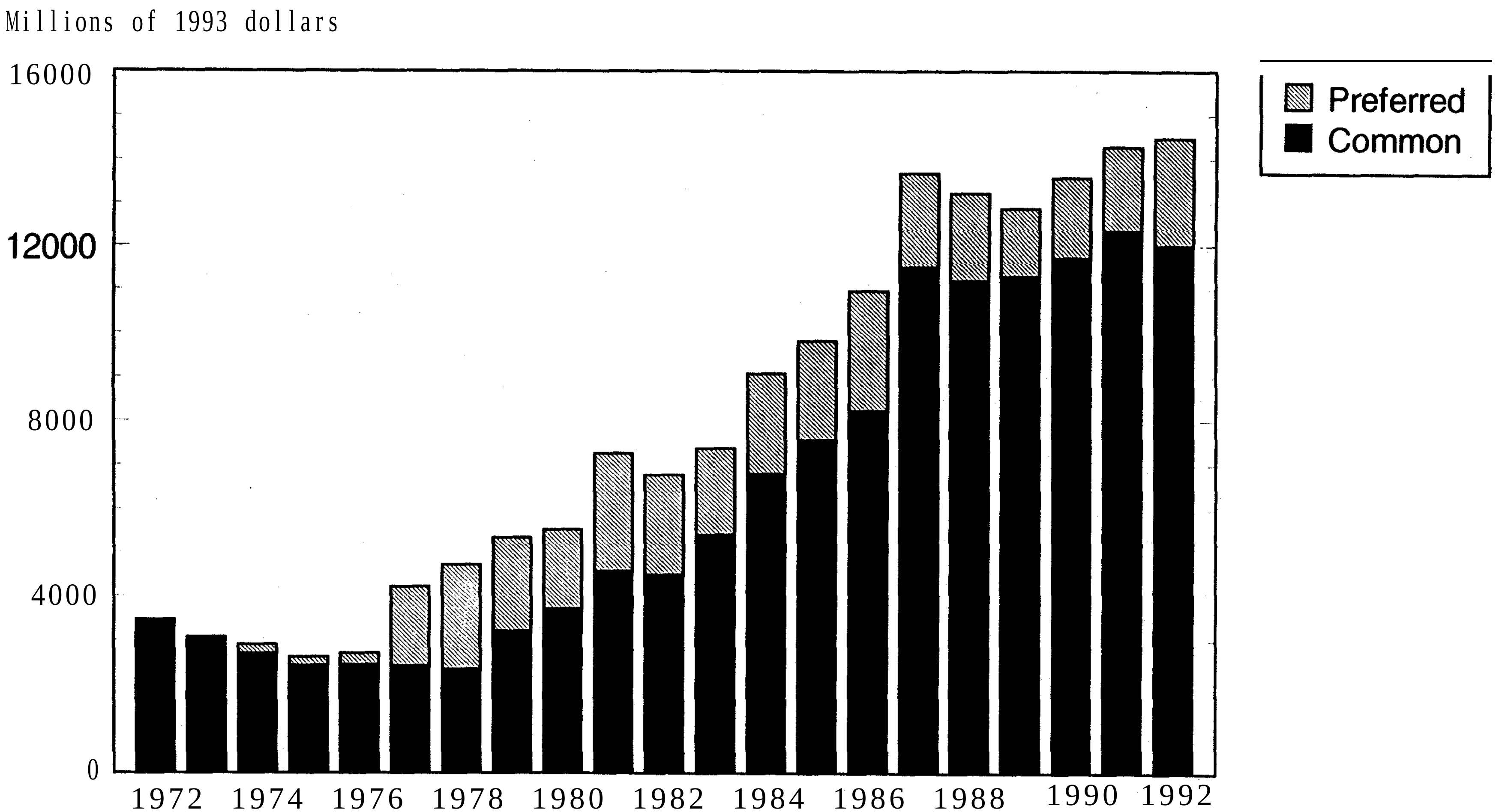
EQUITY COMPONENTS - TOTAL METAL MINING
1972 - 1992



"Total Metal Mining" includes integrated operations.
Source: Statistics Canada, Industrial Organization and Finance Division.

Figure 3

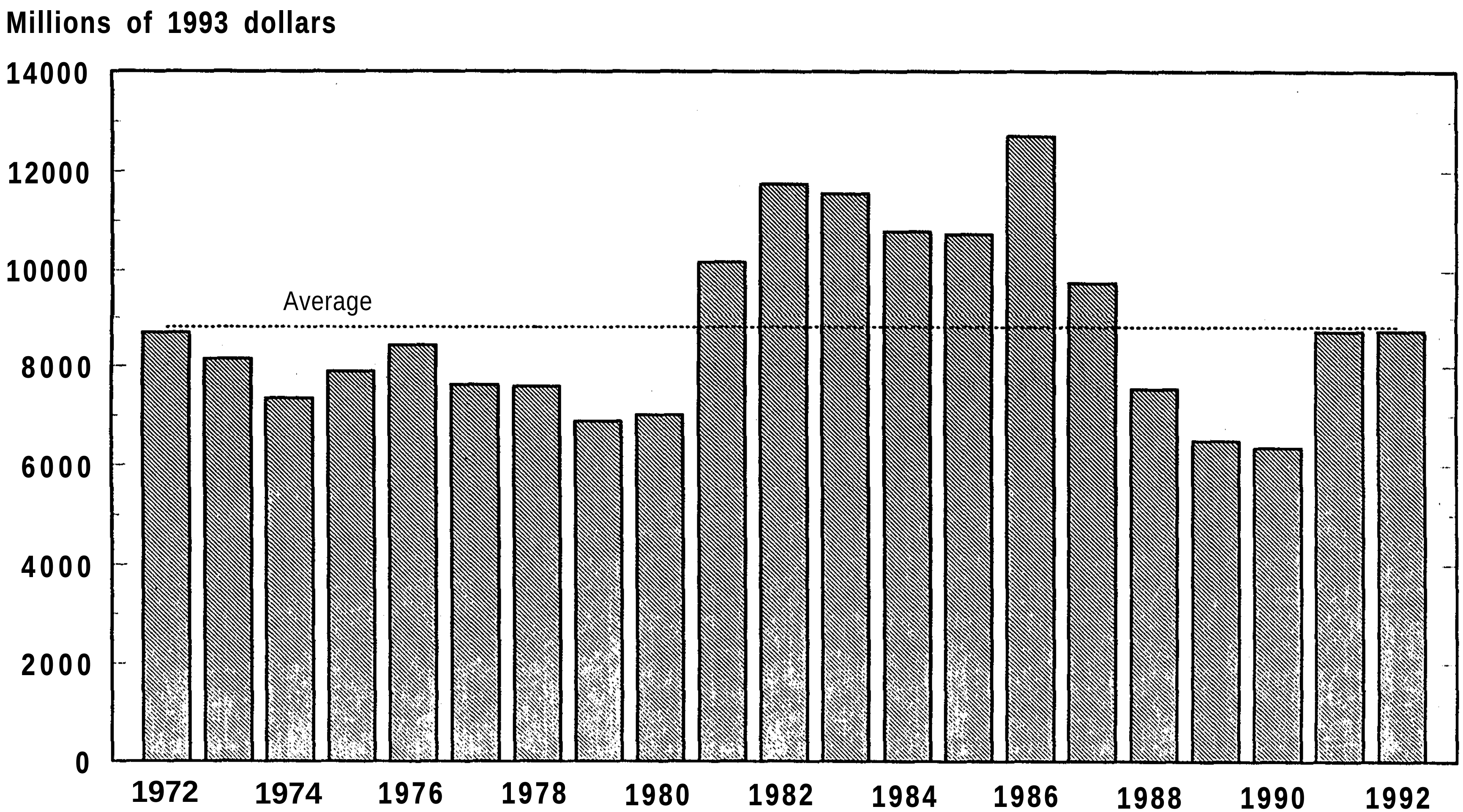
SHARE CAPITAL COMPONENTS - TOTAL METAL MINING
1972 - 1992



"Total Metal Mining" includes integrated operations.
Source: Statistics Canada, Industrial Organization and Finance Division.

Figure 4

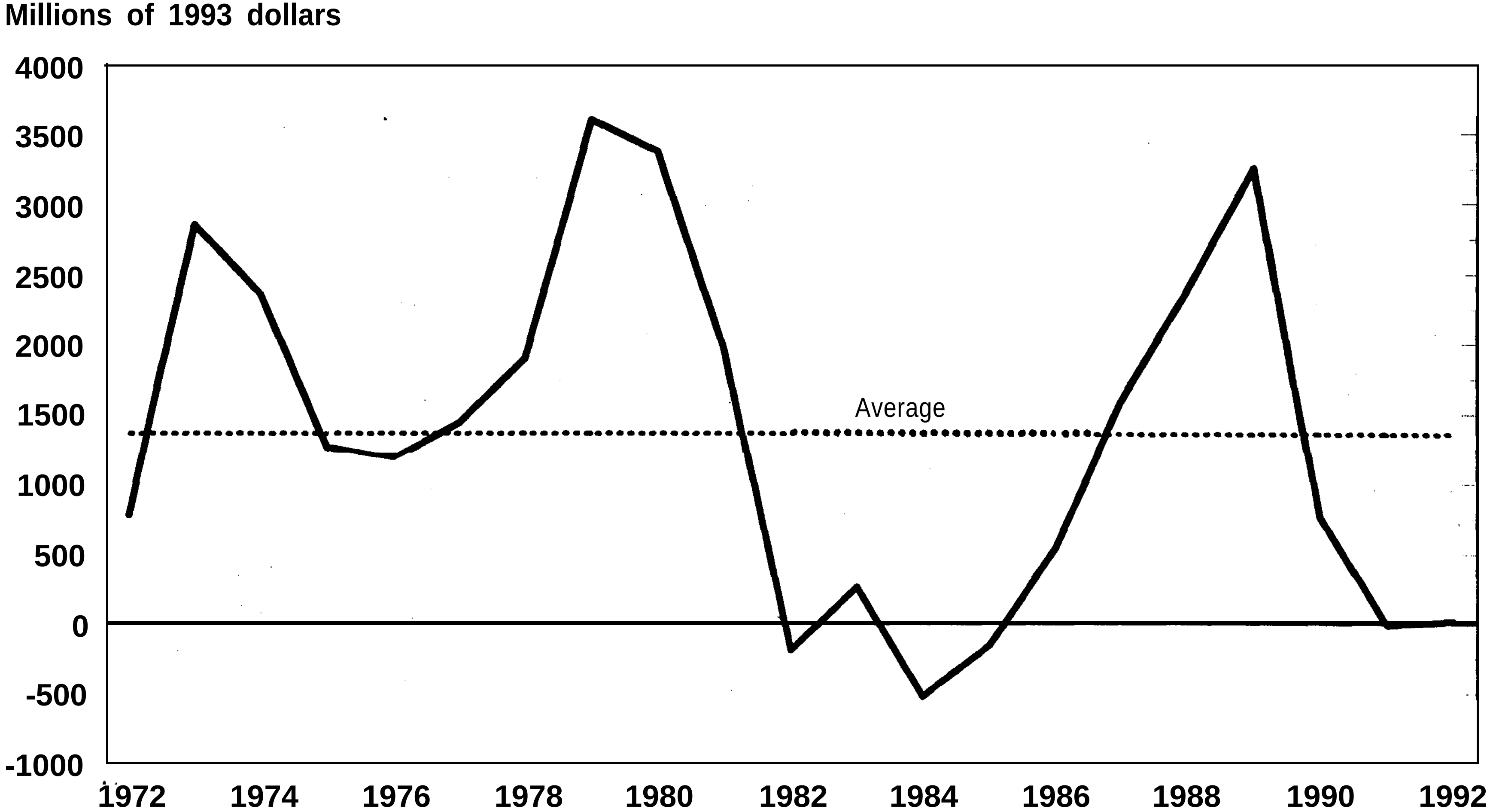
DEBT - TOTAL METAL MINING
1972 - 1992



"Total Metal Mining" includes integrated operations.
Source: Statistics Canada, Industrial Organization and Finance Division.

Figure 5

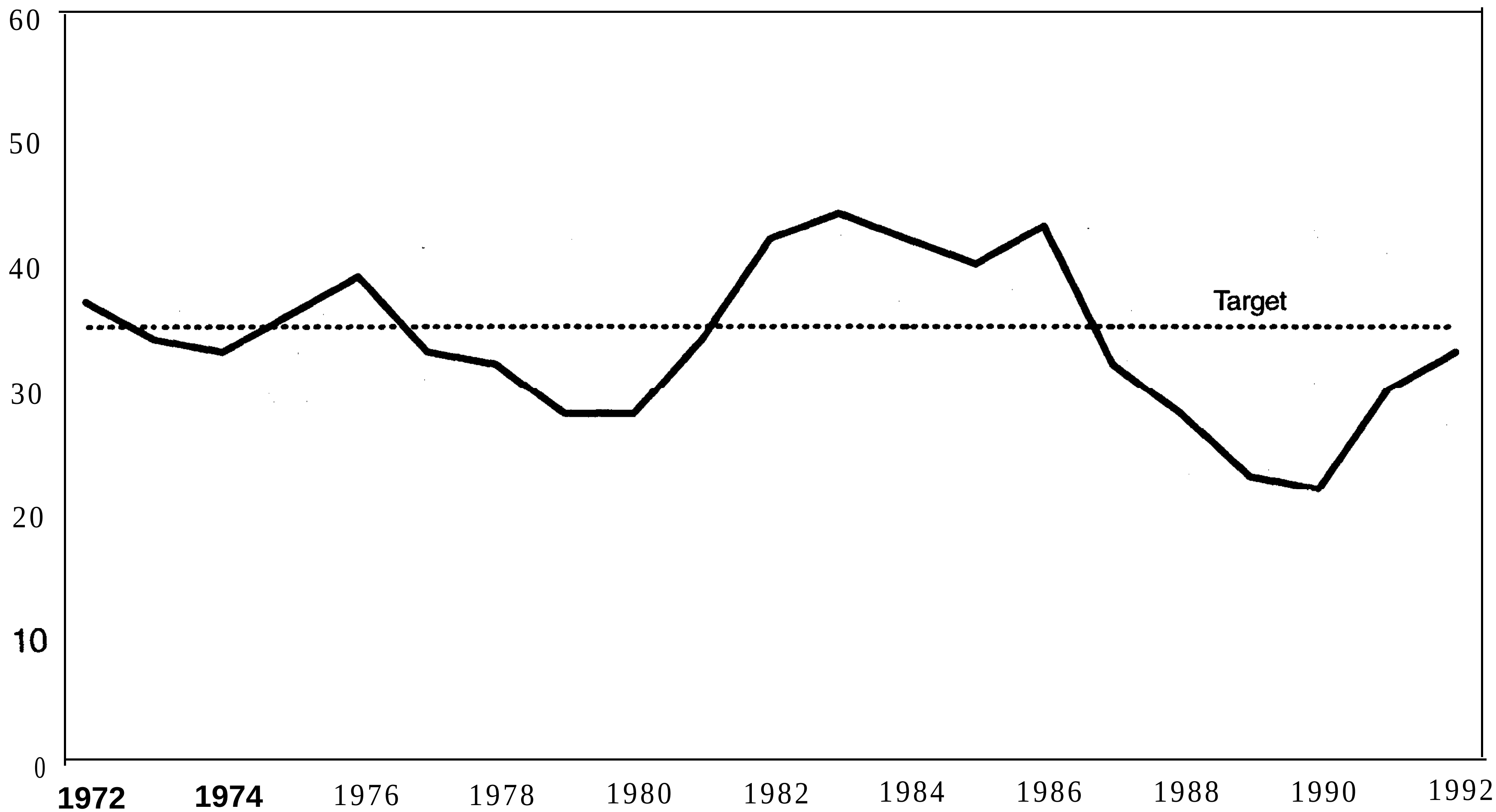
NET AFTER-TAX PROFIT - TOTAL METAL MINING 1972 - 1992



"Total Metal Mining" includes integrated operations.
Source: Statistics Canada, Industrial Organization and Finance Division.

Figure 6

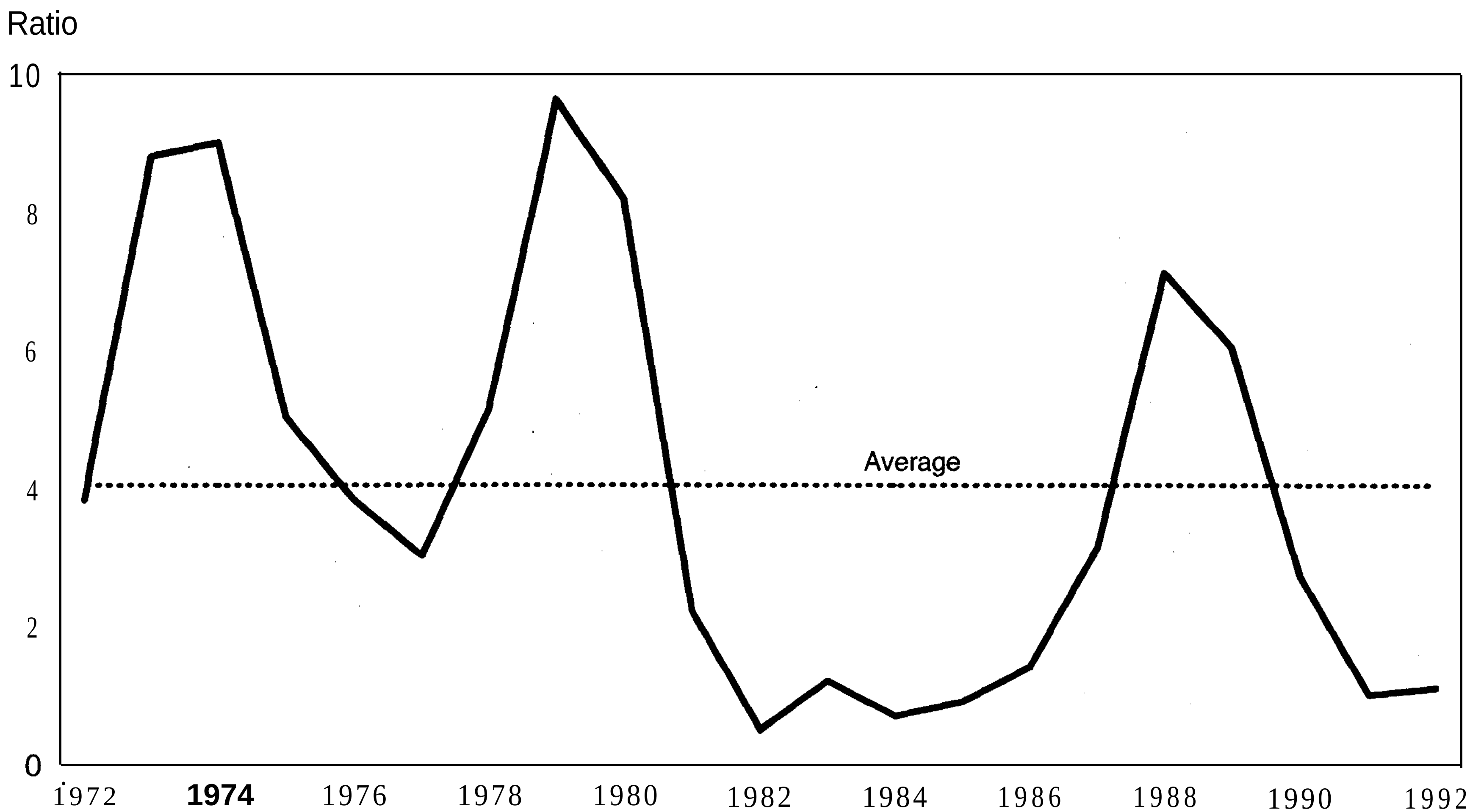
DEBT TO EQUITY RATIO - TOTAL METAL MINING
1972 - 1992



"Total Metal Mining" includes integrated operations.
Source: Statistics Canada, Industrial Organization and Finance Division.

Figure 7

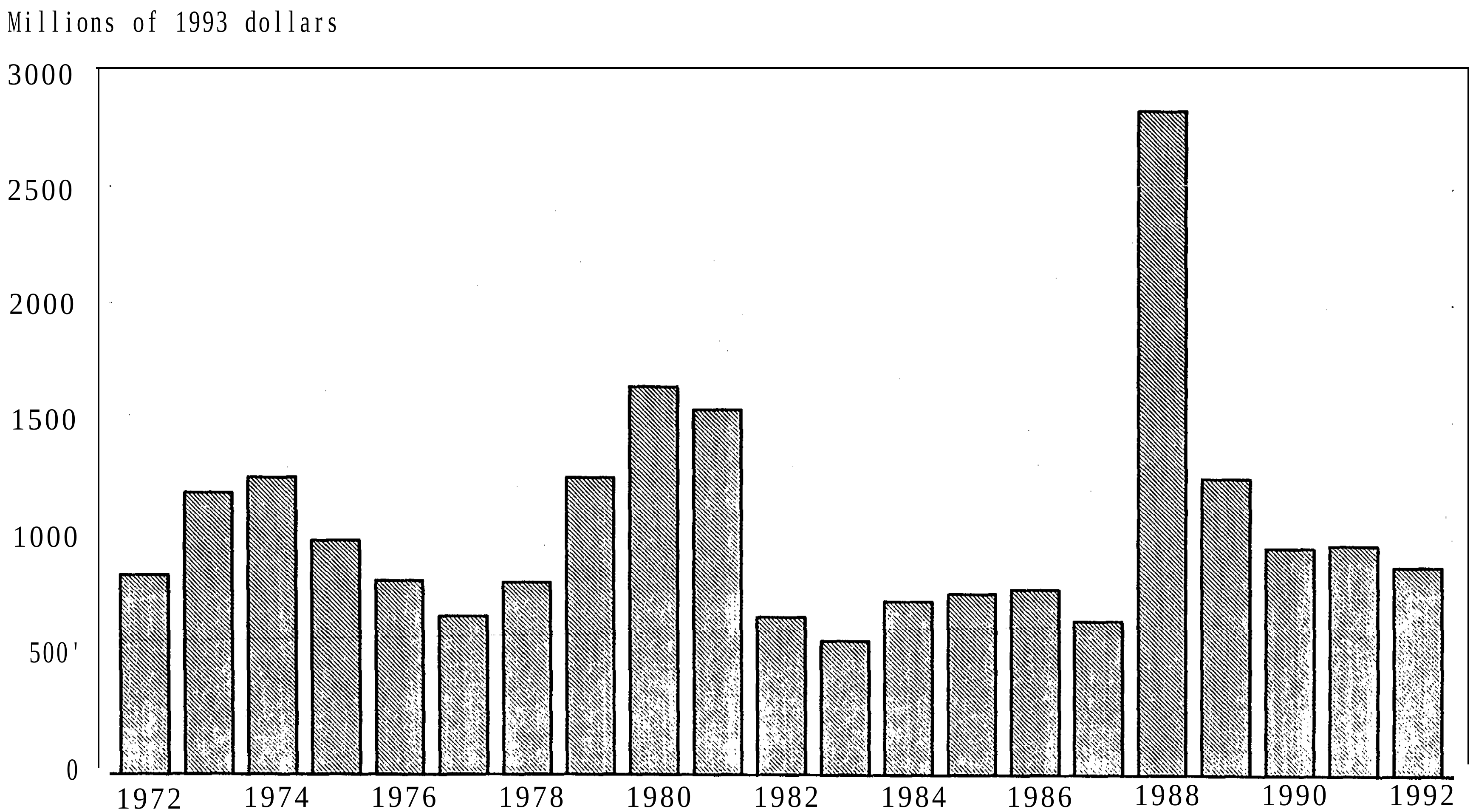
INTEREST COVERAGE RATIO - TOTAL METAL MINING 1972 - 1992



"Total Metal Mining" includes integrated operations.
Source: Statistics Canada, Industrial Organization and Finance Division.

Figure 8

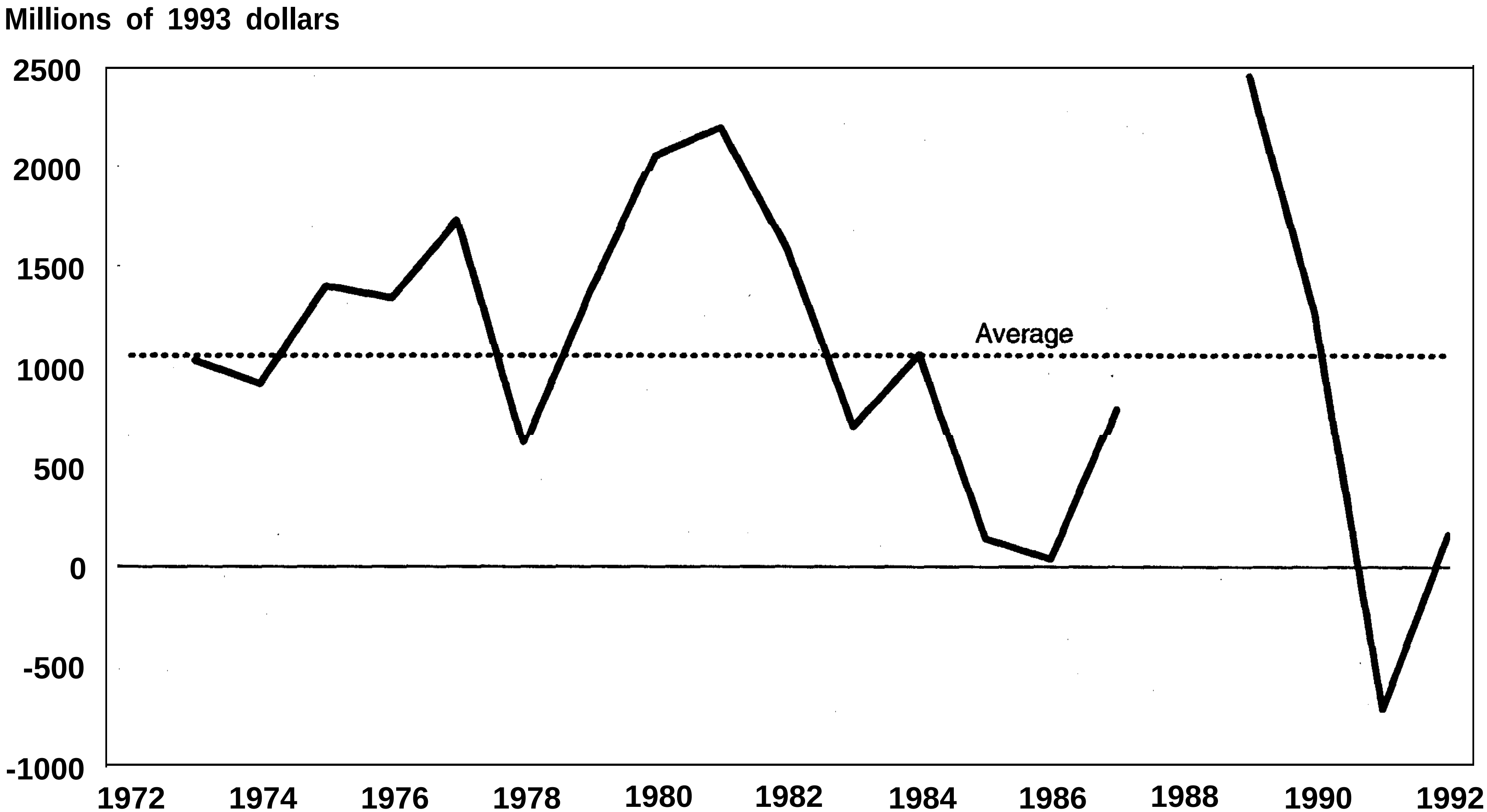
DIVIDENDS DECLARED - TOTAL METAL MINING 1972 - 1992



"Total Metal Mining" includes integrated operations.
Source: Statistics Canada, Industrial Organization and Finance Division.

Figure 9

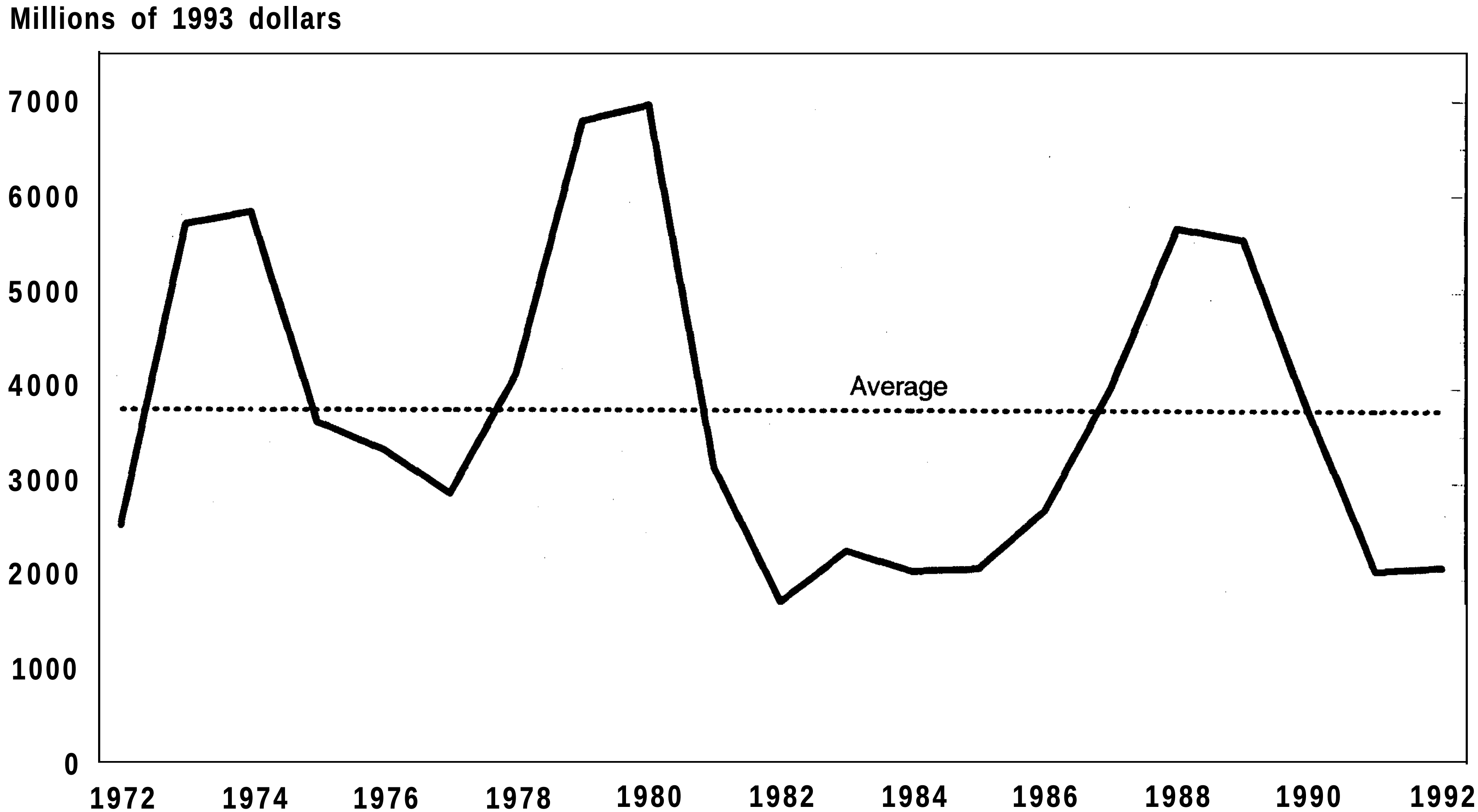
CAPITAL SPENDING - TOTAL METAL MINING
1972 - 1992



"Total Metal Mining" includes integrated operations.
Broken series - data not available for 1988.
Source: Statistics Canada, Industrial Organization and Finance Division.

Figure 10

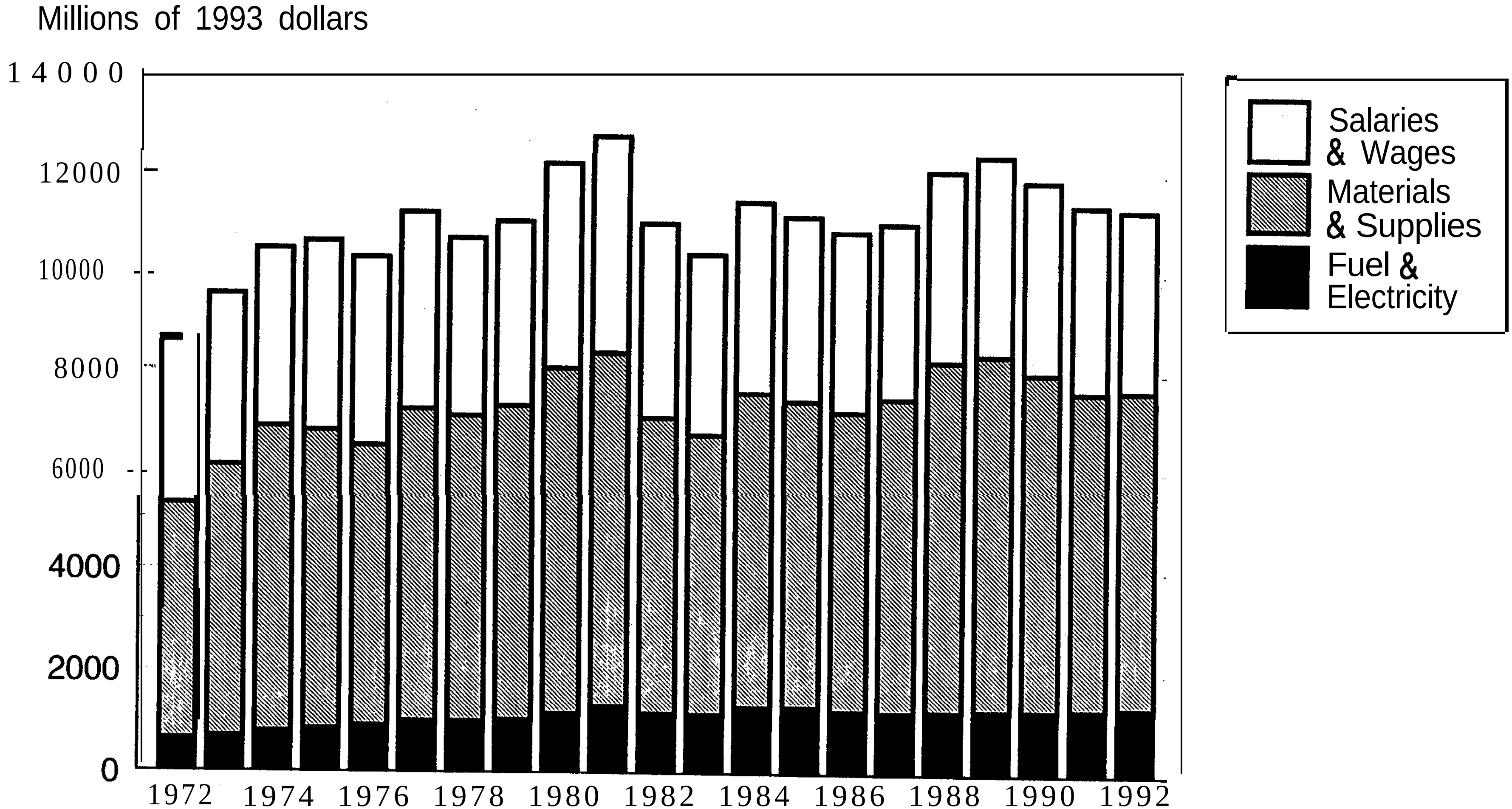
CASH FLOW FROM OPERATIONS
TOTAL METAL MINING
1972 - 1992



“Total Metal Mining” includes integrated operations.
Source: Statistics Canada, industrial Organization and Finance Division.

Figure 11

SELECTED PRODUCTION COSTS IN THE METAL MINE AND SMELTING AND REFINING INDUSTRIES 1972-92



Source: Statistics Canada, General Review of the Mineral Industry, Cat. no. 26-201; Industrial Organization and Finance Division.