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The Slave Geologic Province

Transportation and Economic Development: Scenario Development

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WHAT'S INSIDE

The purpose of this study is to assess the impact of investment in transportation infrastructure in the Slave Geologic Province.

The study is divided into four phases: Scenario Development; Benefit-Cost Analysis; Economic Impact Analysis; and Taxation Revenue and Fiscal Impact Analysis.

This phase of the study develops the transportation and economic impact scenarios to be used in the subsequent analyses.

There are a total of four scenarios: a base case and three development scenarios.

Each scenario comprises investments in transportation infrastructure and their impacts in terms of mineral and other economic developments.

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The research was conducted by Peter Lok, Senior Research Associate and Frédéric Clavet, Pascal Cormier, Gavin Hales, Research Associates under the direction of Pedro Antunes, Associate Director of the Economic Service Group and Luc Bussière, Director of the Economic Services Group.

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Executive Summary

- This study develops a base case and three additional transportation and economic impact scenarios for the Northwest Territories over a 20-year period.
- The Government of the Northwest Territories developed the base case and scenarios. While attempting to provide a realistic assessment of future activities in the Slave Geological Province, the uncertainty associated with this forecasting exercise is acknowledged. It is further noted that the scenarios were developed to bound the range of potential future activities in the Slave Geological Province and not to forecast actual future events.
- The base case and development scenarios will be used in a subsequent benefit-cost analysis. Studies will also be made on the economic impact and taxation revenue implications of the base case and development scenarios.
- The first step taken in producing the development scenarios was to define a range of possible transportation infrastructure investments. The transportation infrastructure is composed of possible investments in new roads and a deepwater port on the Arctic coast (see Exhibit 1).
- The next step was to determine what level of mineral and other economic activity would be generated by these investments in transportation infrastructure. New transportation infrastructure was assumed to have three main potential impacts on mining: it would increase the probability of making new mine discoveries, make some known deposits economic to mine; and extend the operational life of existing mines.
- The potential scale of mineral production and of the potential for new mineral discoveries in the Slave Geological Province were investigated using mine production models, developed by the Northwest Territories Department of Resources, Wildlife and Economic Development, and a Conference Board statistical analysis of mineral discoveries.
- Transportation infrastructure developments were also considered to have potential impacts beyond the mining sector. These included the effects on the tourism industry, renewable resource development, training and human resource development, municipal infrastructure development, the environment and social/cultural impacts.
- The potential mining and other economic impacts of the transportation infrastructure developments were used to develop the economic development components of the base case and other scenarios.
- The base case was developed to represent a “status quo’ scenario in which there is no new investment in transportation infrastructure. Despite this, some mineral development does go ahead.

Exhibit 1

Source: Northwest Territories Department of Transportation

- In Scenario 1 an all-weather road is built in the northern part of the Slave Geological Province in conjunction with the development of the Izok Lake base-metal deposit. The road runs from Contowyto Lake to a new deepwater port on the Arctic coast, with an extension to the diamond mines in the Lac de Gras region. This new transportation corridor is assumed to lead to the development of the Hackett River site and to the discovery and development of a new base-metal deposit.
- Scenario 2 adds to Scenario 1 with the gradual extension of the all-weather road to Yellowknife by 2012. This increased access to the region is assumed to lead to the discovery and development of a new diamond deposit.
- Scenario 3 represents a rapid development scenario in which the transportation corridor in Scenario 2 is built as soon and as quickly as possible (by the end of 2006). This results in earlier access to the region and is assumed to lead to the discovery and development of a new diamond deposit. Some other deposits are also developed earlier.

1 Introduction

Over the past 10 years, the Conference Board has undertaken a number of studies on transportation-related issues in the Northwest Territories. These studies examined various aspects of the transportation infrastructure and economic development in the Slave Geologic Province. A number of options have been examined to date as part of the government's overall transportation strategy. One option being assessed is a transportation corridor through the Slave Geologic Province and a port situated on the Arctic coast in the Nunavut Territory.

One potential impact of making improvements to existing transportation infrastructure or the construction of new transportation infrastructure is the stimulation economic development. However, the development of new or improving existing transportation infrastructure can also have significant social and environmental impacts. Thus, it is important to critically examine all of the impacts of proposed investments in transportation infrastructure before proceeding.

The current study is an assessment of transportation and economic development in the Slave Geologic Province. The study comprises four phases as follows:

1. Scenario Development;
2. Benefit Cost Analysis;
3. Economic Impact Analysis; and
4. Taxation Revenue and Fiscal Impact Analysis.

The first phase—Scenario Development—is the focus of this report. In general, the report describes the methodology and results of the scenario development exercise. The end product is a set of four scenario descriptions: a base case and three development scenarios. The base case and development scenarios will be used in the subsequent analyses.

1.1 Approach

Determining the possible future course of economic development in the Slave Geologic Province is a highly uncertain exercise. As a result, the scenarios were designed to describe a broad range of potential future outcomes. At the same time, however, it was important to produce scenarios that are as realistic as possible.

The first step taken in producing the economic development scenarios was to define a range of possible transportation infrastructure investments. The transportation infrastructure is composed of possible investments in new roads and a deepwater port on the Arctic coast. The Northwest Territories Department of Transportation developed the transportation infrastructure scenarios.

The investment in new transportation infrastructure is assumed to spur additional economic activity. First of all, there is the activity associated with construction and maintenance of the transportation infrastructure itself. In addition to this, the new transportation infrastructure can lead to an increase in mining activity and other economic spin-offs such as increased tourism.

Determining the likely increase in mining and other economic activity that could result from investment in new transportation infrastructure was the major challenge of the research under Phase I of the study. Thus, the essential question to be answered by the research was:

> *What mining and other economic activity is likely to take place if new investment in transportation infrastructure is made?*

To determine appropriate economic development scenarios, the research made use of a number of different models and techniques including macroeconomic forecasting, statistical analysis and mine production models supplied by the Northwest Territories Department of Resources, Wildlife and Economic Development. The results of the analysis are found in this report, along with a description of the models and techniques used. In some cases, technical discussions are found in the attached appendices.

1.2 Layout of the Report

The report is presented in four chapters. After this introduction, Chapter 2 discusses the composition of the transportation infrastructure scenarios, which were developed by the Northwest Territories Department of Transportation. These provide the starting point for the timing, scale and duration of all other impacts.

Chapter 3 investigates the relationship between land transportation corridors and economic development. The primary focus of the analysis is on how transportation corridors can promote the discovery of new mines. The chapter also discusses how transportation corridors can affect the viability of existing mines and other potential impacts of transportation infrastructure development. In addition, the chapter discusses the methodology underlying the development of the mineral and other economic development components of the scenarios. The data sources, models and modelling approaches are discussed along with results of the analyses and the approach taken in dealing with uncertainty.

Chapter 4 presents the scenarios in terms of transportation investment, economic development and other impacts.

2 Transportation Infrastructure

Transportation infrastructure scenarios serve as the starting point in the overall scenario development. These transportation infrastructure scenarios serve as the basis for the economic development and other impacts (see Chapter 3). The Northwest Territories Department of Transportation developed four transportation infrastructure scenarios. This chapter presents and discusses the various investments in transportation infrastructure that are being considered in each scenario.

2.1 Overview

2.1.1 Land Transportation Corridor

The base case and scenarios in this report consider a number of alternatives for the land transportation corridor. These alternatives range from no new investment in transportation to a permanent, gravel-surfaced, all-weather road over the entire route from Yellowknife to a proposed new port on the Arctic coast.

Exhibit 2

Transportation Corridor Options in the Slave Geological Province

Winter Road:

A winter road is constructed annually on ice over water bodies and/or compacted snow over frozen terrain and is commonly open to traffic from early January till late March.

All-Weather Road:

An all-weather road is constructed with a loose or stabilised gravel surface and is available to traffic throughout the year. All-weather roads require a greater initial capital cost as well as higher operations and maintenance costs relative to winter roads.

Source: The Northwest Territories Department of Transportation.

At present, there is a winter road from Yellowknife to the Lupin gold mine. The road from Yellowknife to Lupin is operated by Echo Bay Mines (the owners of the Lupin gold mine) and used to re-supply Lupin and the Ekati and Diavik Diamond mines with fuel and dry cargo. Other diamond companies also use this road in their exploration and sampling work.

2.2 Deepwater Port

The construction of a deepwater port on the Arctic Coast is common to all scenarios except the base case. The timing of this project, the investment expenditures required and the maintenance costs of the port are identical for all three scenarios. Construction will begin in 2003 (one year earlier in Scenario 3) and will be completed two years later when the port begins operations.

The port would be used to re-supply mines such as the Izok Lake base-metal mine and the Lupin gold mine. The port would also be used to ship base-metal concentrate from the Izok Lake and other mines to markets in Europe and the Pacific Rim. The port facility may also be used to supply nearby coastal communities.

2.3 Transportation Infrastructure Scenarios

The transportation infrastructure investments for the base case and three scenarios are described below (see Exhibit 3).

2.3.1 Base Case

The base case presents a scenario in which there is no new investment in transportation infrastructure. In this scenario, the existing winter road from Yellowknife to the Lupin gold mine is assumed to be sufficient to meet the needs of all existing and planned mineral development. No new transportation infrastructure is constructed and there are no major improvements to the existing infrastructure. As a result, the only transportation costs associated with the base case are the operations and maintenance (O&M) costs of the existing winter road.

2.3.2 Scenario 1

In this scenario an all-weather road between Contwoyto Lake and the Arctic coast with a deepwater seaport at its terminus is built in conjunction with the development of the Izok Lake base metal mine. In addition, the all-weather road is extended to the Lac de Gras region. This will enable the diamond mines in the region to take advantage of costs savings from all-weather road access to the north.

Construction of the port and the all-weather road between the port and the southern end of Contwoyto Lake begins in 2003 under the terms of Scenario 1. Once these have been completed, at the end of 2004, construction work will begin on the all-weather road southern extension from Contwoyto Lake to the Ekati and Diavik mines near Lac de Gras. This road will also take two years to complete. This will replace the section of winter road between Lupin and Lac de Gras. The remaining section of the winter road between Lac de Gras and Yellowknife will continue to operate throughout the study period.

As a result of the construction of the transportation corridor the Izok Lake base metal mine will have permanent road access to a port by 2005. Transportation from the mine to the all-weather road will be accomplished through a combination of a winter road down Contwoyto Lake in the winter and barges during the summer months. From 2007, the Diavik and Ekati diamond mines will have all-weather road access north to the deepwater port on the Arctic coast.

2.3.3 Scenario 2

Scenario 2 builds on the previous scenario by gradually extending the all-weather road from the Arctic coast past Contwoyto Lake and Lac de Gras all the way to Yellowknife. As in Scenario 1, construction on the deepwater port and on the all-weather road from the south end of Contwoyto Lake to the port begins in 2003 and finishes by the end of 2004. Similarly, the Contwoyto Lake to Lac de Gras section of the road will be built in

Exhibit 3

Transportation Scenarios

	Transportation Infrastructure	Territory	Component	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Base Case	Winter Road (Yellowknife to Lupin)	NWT	Construction																				
			Operation	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Nunavut	Construction																				
			Operation	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Scenario 1	Winter Road (Yellowknife to Lupin)	NWT	Construction																				
			Operation	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Nunavut	Construction																				
			Operation	■	■	■	■																
	All-Weather Road (Contwoyto Lake to Arctic Coast)	Nunavut	Construction			■	■																
			Operation					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Deepwater Port on Coast	Nunavut	Construction			■	■																
			Operation					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	All-Weather Road (Extension from the North to Ekati/Diavik)	NWT	Construction					■	■														
			Operation							■	■	■	■	■	■	■	■	■	■	■	■	■	■
Scenario 2	Winter Road (Yellowknife to Lupin)	NWT	Construction																				
			Operation	■	■	■	■	■	■	■	■	■	■	■	■								
		Nunavut	Construction																				
			Operation	■	■	■	■																
	All-Weather Road (Yellowknife to Arctic Coast)	NWT	Construction					■	■	■	■	■	■	■	■								
			Operation													■	■	■	■	■	■	■	■
		Nunavut	Construction			■	■																
			Operation					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Deepwater Port on Coast	Nunavut	Construction			■	■																
			Operation					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Scenario 3	Winter Road (Yellowknife to Lupin)	NWT	Construction																				
			Operation	■	■	■	■	■	■														
		Nunavut	Construction																				
			Operation	■	■	■																	
	All-Weather Road (Yellowknife to Arctic Coast)	NWT	Construction		■	■	■	■	■														
			Operation							■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Nunavut	Construction		■	■																	
			Operation				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Deepwater Port on Coast	Nunavut	Construction		■	■																	
			Operation				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Source: The Northwest Territories Department of Transportation.

2005 and 2006. The final southern segment of the road between Lac de Gras and Yellowknife will be built between 2007 and 2012, replacing the existing winter road.

2.3.4 Scenario 3

This scenario provides no additional extensions to the transportation corridor contained in Scenario 2. However, Scenario 3 does assume that the transportation corridor is built as soon and as rapidly as possible. The port and the all-weather road linking it to Contwoyto Lake are built a year earlier than in Scenario 2. In addition, construction work on the Yellowknife to Contwoyto Lake segment also begins in 2002 and in this scenario only takes five years to complete rather than eight. As a result, the entire transportation corridor is open at the start of 2007.

3 Land Corridors and Economic Development

This chapter explores the relationship between land corridors and economic development, with a particular focus on the mining sector. The first two sections provide a brief summary of the historical and theoretical relationship between land corridors and mineral prospecting in Canada. In the next section the effect of transportation corridors and new mine discoveries is presented and discussed, while the fourth section looks at their effect on existing mines. The final section of the chapter will discuss other potential impacts of transportation infrastructure on the Northwest Territories.

3.1 Overview

Land corridors have played an important role in the social and economic development of Canada. For the purposes of this study, land corridors are defined as any corridors that permits ground access to a region. As such, roads (winter and all-weather), railways, and utility corridors (electrical transmission right of way, pipelines) are all included in this definition.

Agriculture, trapping, forestry, and mining were the focus of economic development in the early development of Canada during the European era. In many instances, ground access built to aid in the development of one sector led to the development of other sectors in later years. For example, railways built to open up areas for agricultural settlement led to the development of forestry and mining in the same region.

3.2 Theoretical Relationship

This study examined three impacts that a road or land corridor can have on mineral development in a region, namely:

1. New transportation infrastructure may increase the probability of discovering new deposits;
2. New transportation infrastructure may make some known deposits economic to mine;
3. New transportation infrastructure may reduce the operating costs of existing mines, extending their operational life.

3.3 The Impact of Transportation Corridors on New Mine Discoveries

3.3.1 Background

In developing the economic development scenarios, the introduction of a new transportation corridor is assumed to increase the probability of making new mine discoveries (all other things being equal). This assumption was tested, however, by analysing the impact that new transportation corridors have had historically on mine discoveries in other similar jurisdictions.

3.3.2 The Historical Context

Given the extensive use of technology in modern prospecting, why is ground access still important in making mineral discoveries? Of course, remote sensing from fixed-wing aircraft, helicopters or even satellites is widely used to identify promising areas for further exploration. At some point, however, prospectors still need ground access to properly assess deposits. If the surface geology still looks promising, diamond drilling may be required. Thus, although personnel and equipment can be flown into remote sites, it is much less expensive with ground access. In many cases—particularly with small resource companies or individual prospectors— the costs associated with chartering helicopters or fixed-wing aircraft prevent further ground exploration.

There are numerous historical examples of major mineral finds that are associated with transportation corridors. Indeed, the huge mineral discovery at Sudbury occurred when the Canadian National Railway literally blasted through heavily mineralised deposits during construction. Professor Wallace of Queen's University notes that prior to World War I,

> *…expansion of the railway network was the principal mechanism whereby knowledge was acquired of major mineral deposits, as the Temiskaming and Northern Ontario's stumbling across the silver veins at Cobalt typically demonstrates. Indeed, had the location of heavily mineralised areas been more fully known at the time, the railway map would almost certainly be different in the Abitibi region and northern Manitoba, where through routes bypassed large, unknown reserves that subsequently called for branch line access.*[1]

Although transportation corridors played a more important role in mineral discoveries in the early part of the 20th century, they remain important. The Chibougamau region of Québec, for example, was suspected to have copper and gold but it was not until a road was constructed in 1950 that mines were discovered. Although not in our sample of mines, a similar situation occurred in northern Newfoundland in the 1960s when a prospector noted some promising structures on a geologic map,

> *"'Nothing much had been found…but when it was learned that the coastal road north of Bonne Bay had only been completed in 1962 it was suspected that little prospecting had been done because of poor access. Now we would have 300 miles from which to prospect'"*[2]

Again, the new transportation corridor allowed more prospectors to gain easier access to the area, resulting in new mineral finds.

1 Iain Wallace, *The Transportation Impact of the Canadian Mining Industry*, (Kingston: Queen's University, 1977), p. 5.

2 Monica Hanula (editor), *The Discoverers* (Toronto: Pitt Publishing Company Limited, 1982) p. 149.

3.3.3 Approach

Three Canadian jurisdictions with a roughly similar geologic makeup as that of the Slave Geologic Province were examined. These three comprised:

- Ontario;
- Québec; and
- Northern Manitoba.

The methodology involved a literature review, interviews with experts and a statistical analysis linking transportation corridors and mine discoveries. The literature review was conducted using a combination of on-line searches, literature provided by the Government of the Northwest Territories and suggested reading from the experts that were contacted. A combination of face-to-face and telephone interviews were conducted with experts at Natural Resources Canada, provincial departments responsible for mining, economic development and transportation and with several associations representing prospectors.

For the statistical analysis of the relationship between transportation corridors and mineral development, two distinct approaches were taken. In the first instance, a simple random sample of mines was taken for Ontario and Québec selected from lists of gold[3] and base metal[4] deposits (details of the mine population and sample sizes are given in Appendix A). In Ontario, the sample was comprised of around 14 per cent of producing mines (either historically or currently) while 11 per cent of mines were analysed in Québec. The size of the sample of mines taken for each province is found in Table 1. In Manitoba, all of the producing mines within 150 kilometres of the Hudson Bay railway (including some mines in Saskatchewan) were included in the analysis.

Table 1

Mine Sample Size

Province	Total Mines	Sample (%)
Ontario	497	67 (14%)
Québec	277	31 (11%)
Manitoba	32	32 (100%)

Source: The Conference Board of Canada.

The Québec and Ontario samples were analysed to determine if transportation corridors had any impact on their discovery. Due to the nature of available data, the actual analysis depends heavily on the judgement of the analyst. As a result, a conservative approach was taken when determining if new discoveries should be credited to transportation corridors. For example, only mines that were located within 150

3 Natural Resources Canada, *Gold Deposits and Occurrences in Canada* (Ottawa: Natural Resources Canada, 1989)

4 Natural Resources Canada, *Base Metal Deposits and Occurrences in Canada* (Ottawa: Natural Resources Canada, 1989)

kilometres of the transportation corridor were considered as possible candidates.[5] Also, the mineral discoveries had to come about within 20 years from the date that construction of the transportation corridor was completed.

Under the second approach, the region surrounding the Hudson Bay railway—built to provide ground access to the port on Hudson Bay at Churchill—was analysed to see if any mineral discoveries could be attributed to the railroad. The construction began in Hudson Bay Junction, Saskatchewan and ran to Churchill, Manitoba (see Exhibit 4). The railway was built in two segments, the first between 1911 and 1916 and the second between 1927 and 1929. The analysis also includes the spur line that was built between Flin Flon Junction and Sherridon, which was constructed between 1929 and 1930. All of the mines within 150 kilometres of the railway line were included in the sample. Because the railway runs through portions of eastern Saskatchewan, a number of mines within Saskatchewan (those within 150 kilometres of the railway) were included in the analysis.

Exhibit 4

The Hudson Bay Railway
(The Pas to Churchill)

Source: Omnitrax, Inc.

Ideally, the analysis for Québec and Ontario would have followed a similar approach to that used for Manitoba. In Manitoba, the Hudson Bay railway provides an ideal example of a transportation corridor built through a remote region. Because of the nature of development in Québec and Ontario, finding a similar example of a transportation corridor is not practical. Despite this restriction, there are some useful comparisons that can be made between the three jurisdictions. Details of the analysis can be found in Appendix A.

3.3.4 Results

The results of the analysis indicate a positive correlation between transportation corridors and the discovery of new mineral deposits (see Table 2). In Ontario, the analysis suggests that railways and/or roads may have played a role in the discovery of 32.8 per cent of producing mines. This result means that 32.8 per cent of the mines in

5 Prospectors routinely ventured further than 150 kilometres from the nearest road or railway during the period under consideration.

the sample for Ontario were located within 150 kilometres of a transportation corridor and discovered within 20 years of the completion of the transportation corridor. Thus, the discovery of slightly less than one third of past or currently producing mines was influenced by the presence of a nearby transportation corridor. In Québec, the discovery of 9.7 per cent of the mines in the sample was correlated with transportation corridors. In Manitoba (and north-eastern Saskatchewan), the Hudson Bay railway is correlated with the discovery of 18.8 per cent of mines. These results do not imply that the mine would never have been discovered without a nearby transportation corridor (although this is possible). Rather, the presence of a transportation corridor likely hastened their discovery.

Table 2

Results of Mine Analysis

Province	Total Mines in Sample	Discovery Correlated with Transportation Corridor (%)
Ontario	67	22 (32.8%)
Québec	31	3 (9.7%)
Manitoba	32	6 (18.8%)

Source: The Conference Board of Canada.

The analysis of the Hudson Bay Railroad also suggests a positive correlation between transportation corridors (in this case the Hudson Bay railway) and mineral discoveries. Nearly 1,000 km of track was laid (the total length of the railway track 956.64 kilometres) and six major discoveries can be attributed to access from the railway. Therefore, our results indicate that for every 1,000 kilometres of transportation corridor, 6.27 mineral discoveries will be made.

The results show a wide variation in the proportion of mine discoveries that are correlated with a nearby transportation corridor. This is partially due to the sample characteristics for each province. In Ontario, nearly all of the mines in the sample were discovered prior to 1920 whereas only one third of the sample of mines for Manitoba were discovered before 1920.

It is also interesting to analyse the results by segmenting the sample for each province into three time periods:

- up to 1919 (prior to the introduction of the bush plane);
- between 1920 and 1959; and
- from 1960 to present (remote sensing and helicopters used extensively).

The result for each time period is presented in Table 3. For each province the proportion of mines that are correlated with transportation corridors is significantly higher in the time period prior to 1920 and the

Table 3

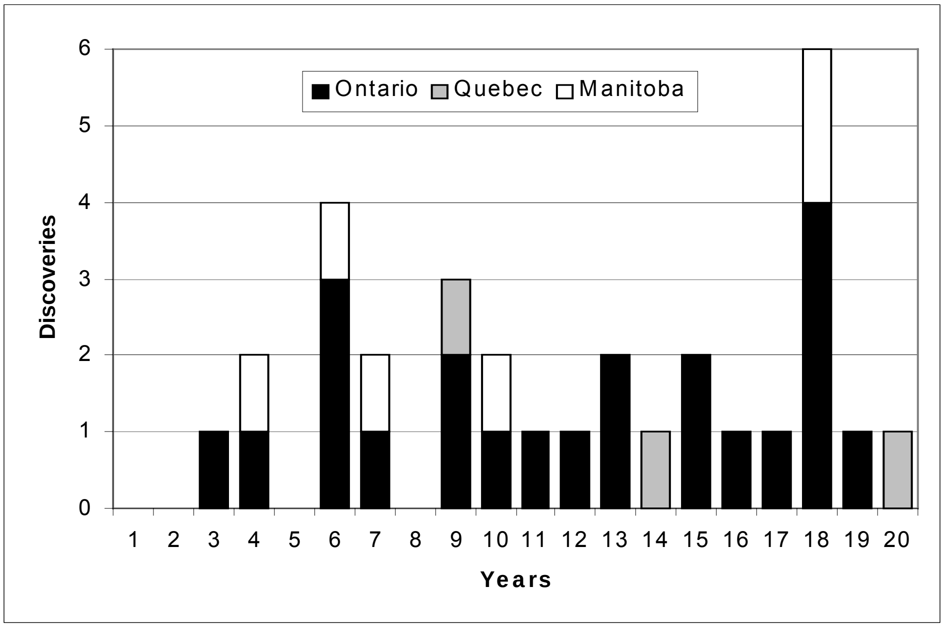
Proportion of Mines Correlated with Transportation Corridors by Time Period
(per cent)

Province	< 1920	1920 - 1960	> 1960
Ontario	65.6%	3.2%	0.0%
Québec	20.3%	5.3%	14.3%
Manitoba	100.0%	28.6%	N/A

Note: N/A - not applicable.
Source: The Conference Board of Canada, NRCan

Chart 1

Time Lag for Mine Discoveries
(new mine discoveries per year following completion of transportation corridor)



Source: The Conference Board of Canada.

advent of the bush plane. In Ontario, for example, the proportion of mines drops from 65.6 per cent prior to 1920 to 0 per cent after 1960. Thus the strength of the correlation between transportation corridors and the discovery of new mines has clearly diminished over time. At the same time, however, the impact appears to be greater than zero.

Although the results suggest a strong relationship between transportation corridors and mine discoveries, there is an important pattern to the mine discoveries. In many cases, the following pattern was observed:

1. A nearby transportation corridor may have played a role in the discovery of a new mine.
2. The discovery of the new mine spurs greater exploration activity in the area leading to further mine discoveries.

The time lag between the completion of the new transportation corridor and the discovery of the new mine is presented in Chart 1. Overall, the average (mean) time lag is 12.0 years with a standard deviation of 5.3 years. The lag is shorter in Manitoba, where the average time lag is 10.5 years and longer in Québec, with an average time lag of 14.3 years.

3.3.5 Discussion

Depending on the jurisdiction, the results indicate that the discovery of between 10 per cent and 33 per cent of mines may have been influenced by the existence of a nearby transportation corridor. Thus, there is a positive relationship between new transportation infrastructure and the discovery of new mines. In transferring these results to the Northwest Territories and Nunavut, however, a number of factors need to be considered. These factors include:

1. **Differences in Geology.** The geology of the Slave Geological Province is not identical to that found in the three provinces under analysis. It is unclear as to whether the differences in geology would result in a greater or lesser probability of discovery in the Slave Geological Province due to a new transportation corridor. Associated with the differences in geology is the confirmed presence of diamonds in the Slave Geological Province. The analysis of other jurisdictions included only gold and base metal mines. Again, it is unclear what influence that diamonds would have on the discovery of new mines due to the presence of a new transportation corridor.
2. **Differences in Technology.** Improvements in technology over the past 200 years have greatly increased the likelihood of making a mineral discovery. As a result, the probability of a mineral discovery due to the completion of a new transportation corridor is likely lower than it was in the past.

In constructing mineral development scenarios for the Slave Geological Province, it is clear that a new transportation corridor will increase the likelihood of making new mineral discoveries. In general, it is our judgement the pattern of discoveries will less likely reflect the historical experience in Québec and Ontario but rather may be closer to that of Manitoba. As a result, we would prefer to err on the side of conservatism and suggest using the 6.3 mines per 1,000 kilometres derived from the Manitoba data.

Finally, there may need to be some adjustment that accounts for the replacement of a winter road with an all-weather road (Scenarios 2 and 3). Under these scenarios, the winter road provides some access to remote regions that can be used to aid in exploration during winter months. Thus, the number of mines discovered would be less than the 6.3 mines proposed previously.

3.3.6 Analysis of Uncertainty

The results of the analysis indicate a positive correlation between transportation corridors and the discovery of new mineral deposits. For the analysis in Ontario and Québec, preliminary results suggest that railroads and/or roads influenced the discovery of between 10 to 33 per cent of mines in our sample. This result does not imply that the mine in question would never have been discovered without a nearby transportation corridor. Rather the result implies that transportation corridors are positively correlated with the discovery of between 10 and 33 per cent of mines in our sample.

The analysis of the Hudson Bay Railroad in northern Manitoba also suggest a positive correlation between transportation corridors (in this case the Hudson Bay railway) and mineral discoveries. Nearly 1,000 km of track was laid and six major discoveries can be attributed to access from the railway. Our preliminary results indicate that for every 1,000 kilometres of transportation corridor, 6.3 mineral discoveries were made.

The literature, the statistical evidence that we have analysed, and expert opinion all suggest a positive correlation between transportation corridors and new mineral discoveries. That said, there is a great deal of uncertainty around the strength of the relationship. Although similar in many regards, the geology of the Slave Geological Province is not identical to that of Northern Manitoba, Ontario and Québec. In addition, historical results are not directly transferable to the present day due to changes in technology and the nature of modern-day prospecting.

As a result, the statistical results should be applied with wide confidence intervals to reflect the inherent uncertainty. It is suggested that confidence intervals representing 100 per cent of the median value be used. Thus the result from the Hudson Bay railway would suggest that for every 1,000 km of transportation corridor, between 0 and 12.5 mineral discoveries will take place.

3.4 The Impact of Transportation Corridors on Existing Mines

3.4.1 Facilitating the Development of Known Deposits

While the existence of mineral deposits in given locations may be known, the lack of adequate transport infrastructure may mean that firms do not find it profitable to develop these sites. For example, the Izok Lake site remains as yet undeveloped due to the magnitude of the expected infrastructure costs[6]. However, the opening up of a transportation corridor may bring substantial savings both during the construction of mines and for their continued operation. Similarly, the presence of an all-weather road and a deepwater port on the Arctic coast would reduce the costs of shipping out base-metal concentrate to markets. Appendix B, prepared by the Northwest Territories Department of Resources, Wildlife and Economic Development, gives details of the potential cost savings that might result from the opening up of a transportation corridor. This study assumes that the construction of the all-weather road between Contwoyto Lake and the Arctic coast together with the opening of a deepwater port at its terminus are prerequisites for the development of the Izok Lake and Hackett River base-metal deposits.

3.4.2 Extension of Life for Existing Mines

In general, the last few years of production for a mine are the ones most costly to producers in terms of operating costs. At first deposits relatively close to the surface may be extracted by open-pit mining. Subsequent deposits lying further below the surface may require underground mining and may lie in more difficult to access locations. The opening up of a transportation corridor has the effect not only of reducing the costs of shipping in inputs during the construction phases of mines, but also the ongoing costs of re-supplying individual mines. In turn, this lowering of production costs

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6 "*Annual Information Form*", Inmet Mining Corporation, March 15, 2000.

will have the effect, all else being equal, of increasing the profitability of these mines, regardless of the level of difficulty and cost of extraction.

Although this discussion implies that the opening up of a transportation corridor would tend to increase the length of operation of existing mines analytical evidence on the subject is hard to obtain. This is because of the difficulty of controlling for other factors, such as commodity prices, other operating costs, closure costs, the regulatory environment, etc., which also have an affect on the decision of when mine closures take place. Thus, the uncertainty surrounding the extent to which the construction of transportation corridors has on extending the lives of existing mines means that this factor has been discounted for the purposes of this study.

3.5 Other Impacts

The development of transportation infrastructure in the Northwest Territories and Nunavut will have widespread impacts that go far beyond the mining sector. Although there are a large number of potential impacts, six principal impacts will be discussed here: tourism; renewable resource development; training and human resource development; municipal infrastructure development; environmental impacts; and social/cultural impacts. This section will also indicate how these other impacts will be incorporated into the scenarios.

3.5.1 Tourism

Apart from its effect on the mining industry, this study looks at the impact on renewable resource development of the opening up of a transportation corridor through the Slave Geological Province. One of the principal impacts will be on the tourism industry. It is assumed that the presence of an all-weather road from Yellowknife north to the Arctic coast will help attract northern residents, other Canadians and also foreign visitors to the region. As a result the additional purchases of goods and services by tourists have been estimated only for those scenarios where the all-weather road link exists.

3.5.2 Other Renewable Resource Development

Each of the scenarios, except the base case, includes the construction of a deepwater seaport on the Coronation Gulf. While it would be used primarily to serve mines it could also become the basis for a commercial fishing industry and related processing activities. Such a development would provide a valuable source of training and employment opportunities for the local community. In addition, a deepwater port could be used as a regional supply point for communities in the Kitikmeot region of Nunavut, especially if an all-weather road link to Yellowknife were also available. At present, there is no deepwater seaport in the whole of Nunavut, apart from two serving mining sites.

The opening up of the land and sea transportation corridor could also stimulate other economic activities as a result of cheaper and quicker access to outside markets. Such activities might include hunting and trapping; the processing of food and other animal products; arts and crafts production; and hydro-electric power generation. Due to data constraints, however, the only renewable resource that has been quantified in this study is tourism

3.5.3 Training and Human Resource Development

A significant share of the workers that will be employed as a result of the components contained in the base case and the scenarios will be from the Northwest Territories. However, not all of these workers will have the necessary labour skills needed for these positions. As a result training programs will be required. Nonetheless, the costs of training programs for these workers are assumed to be relatively small and have not have been estimated.

Training will also be required to provide Northern residents with the skill sets necessary for work in other new industries generated by the development of new mines. For example, Aurora College in Yellowknife has opened a course on diamond cutting and polishing. Such indirect training costs have not been included in the scenarios.

3.5.4 Municipal Infrastructure Development

The economic activity generated in the development scenarios through the opening up of new transportation corridors and mines will attract a number of workers to the Northwest Territories. Although some of these workers will not become residents, this study assumes that a considerable number of workers will become residents (the exact number of workers varies by scenario and by type of project). These new workers and their families will place demands on existing facilities and will create demand for new municipal infrastructure (e.g., schools, hospitals, water & sewers, etc.). Nonetheless, the costs of building and maintaining this new infrastructure are assumed to be relatively small and have not have been estimated.

3.5.5 Environmental Impacts

The construction of a land transportation corridor and the opening of new mines will clearly have an impact on the environment of the region. Indeed, new developments are subject to a rigorous environmental vetting procedure before they are allowed to go ahead and are subject to ongoing monitoring. In general, the environmental impacts of transport infrastructure and mine development effects will be felt foremost at the time of construction, although longer-lasting changes also occur. Examples of environmental impacts include: habitat destruction; point-source pollution including spills of hazardous materials; disruption of caribou migration; and the cleanup costs of mine sites. While the costs of environmental change are evidently important they have not been quantified for the purposes of this study. Nonetheless, the potential environmental impacts have been outlined for each scenario in the following chapter.

3.5.6 Social/Cultural Impacts

The extension of transportation links and construction of mines is likely to have important non-economic impacts on the Aboriginal and other communities of the Northwest Territories. Owing to their non-financial aspect, such impacts have not been quantified for the purposes of this study. Nonetheless, one area of potential benefits lies in the opportunity for Aboriginal people and other Northerners to gain valuable labour force experience and exposure to non-traditional forms of economic activity. In fact, a formal arrangement to ensure local participation in the economic benefits of mine development already exists between the owners of the Ekati mine and traditional landowners and governments. This agreement includes an employment target of 62 per cent for Northern residents, half of whom are to be Aboriginal people, as well as targets for the share of supplies to be provided by local firms. However, the opening up of transport links and mines will also increase the exposure of traditional cultures and lifestyles to potentially damaging external influences.

4 Scenario Descriptions

This chapter describes the components of the base case scenario and of the other development scenarios against which the base case will be compared. These scenarios will then be used in the subsequent economic impact, taxation revenue and benefit-cost analyses.

The preceding analyses of potential transportation infrastructure developments and their potential effects on mining and other economic activity formed a major input of the scenario development process. Underlying each of the development scenarios is the construction and maintenance of transportation infrastructure. These investments in transportation infrastructure (described in Chapter 2) are then assumed to act as a spur to additional mining and other economic development (described in Chapter 3). The base case, however, represents a "status quo" option representing the level of activity forecast to occur in the event of no new investment in transportation infrastructure. While the scenarios attempt to provide a realistic assessment of future activities in the Slave Geological Province, the uncertainty associated with this forecasting exercise is acknowledged. As a result the scenarios were developed to bound the range of potential future activities in the Slave Geological Province rather than to forecast actual future events.

4.1 Overview

In contrast to the development scenarios, the base case presents a "status quo" option in which there is no new transportation infrastructure investment. However, the non-existence of a new transportation corridor through the Slave Geological Province does not mean that there will be no new mineral developments in the region. Instead, the base case assumes that operations will continue at two existing mines and that three existing deposits will be developed. In addition, exploration activities using existing transportation infrastructure are assumed to result in the development of one additional diamond site.

In Scenario 1 an all-weather road is built through the North of the Slave Geological Province to a new deepwater port on the Arctic coast in tandem with the development of the Izok Lake base metal mine. The development of this transportation corridor is also assumed to make the existing deposit at Hackett River viable. In addition, the transportation corridor will improve access to the region for exploration purposes. Scenario 1 assumes that this leads to the discovery and development of an additional base metal deposit.

Scenario 2 adds to the previous scenario with the slow extension of the all-weather road to Yellowknife by the end of 2012. The improved access this will bring to the region for exploration purposes is assumed to lead to the discovery and development of an additional diamond deposit. Scenario 3 is an "optimistic" one in which the transportation corridor in the previous scenario is built as soon and as quickly as possible. As a result of the more rapid development of the transportation corridor some of the deposits are developed sooner and exploration activities begin earlier. These exploration activities are assumed to lead to the discovery and development of one more diamond deposit

The following sections will briefly outline the transportation infrastructure investments involved in each of the development scenarios together with a detailed presentation of the additional mining and other economic activity generated by these investments. Appendix B, prepared by Northwest Territories Department of Resources, Wildlife and Economic Development, provides a description of the anticipated costs savings for mine construction and operation that would result from the building of a transportation corridor. It also presents the models used to estimate the viability of these mines in the event of construction of the transportation corridor together with estimates of the timing and duration of output for the individual mines. A description of the methodology used to develop forecasts of some of the key inputs used in the mine production models is presented in Appendix C. These inputs were the prices of lead, zinc, gold and diesel, the user cost of capital and average weekly wages in the construction industry.

4.2 Base Case

The base case presents a scenario in which there is no new additional investment in transportation infrastructure. Indeed, the only expenditures on the transportation corridor are those on operating and maintaining the existing winter road between Yellowknife and Lupin. Although, this can be considered as a "status quo" scenario some mineral development does go ahead using the existing infrastructure. These new mine developments are assumed to take place regardless of whether all-weather road access is available or not. The timetable of components included in the base case is shown in Exhibit 5.

Exhibit 5

Base Case Development Scenario

		Territory	Component	Year																			
				2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Transportation Infrastructure	Winter Road (Yellowknife to Lupin)	NWT	Construction																				
			Operation	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Nunavut	Construction																				
			Operation	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Mineral Developments	Ekati (diamond)	NWT	Construction																				
			Production	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
	Diavik (diamond)	NWT	Construction	■	■	■																	
			Production			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Snap Lake (diamond)	NWT	Construction	■	■	■	■																
			Production				■	■	■	■	■	■	■	■	■	■	■	■					
	Jericho (diamond)	Nunavut	Construction		■	■	■																
			Production					■	■	■	■	■	■	■	■								
	New Diamond Mine	NWT	Construction										■	■	■								
			Production													■	■	■	■	■	■	■	■
	Lupin (gold)	Nunavut	Construction																				
			Production	■	■	■	■	■	■	■													

Source: The Northwest Territories Department of Transportation.

Notwithstanding the lack of an all-year road link, one diamond mine has already begun production. The Ekati mine near Lac de Gras, Canada's first diamond mine, was opened in late 1998 and, under the base case, production is assumed to continue until the end of 2016. The base case also assumes that construction work currently under way on the Diavik mine, another diamond deposit in the Lac de Gras region, continues. The mine is set to begin production in 2003 and maintain output throughout the remainder of the 20-year forecast period.

Various mineral exploration reports indicate that there are several promising diamond-bearing kimberlite pipes in the Slave Geological Province offering the potential for further diamond projects in the region. Construction work on two further diamond mines is assumed to go ahead in the near future under the terms of the base case. The Snap Lake site, 220km north-east of Yellowknife, is due to come on stream in 2004 and production is set to last twelve years until the end of 2015. The Jericho site at the northern end of Contwoyto Lake is set to take three years to develop with production due to begin in 2005. The mine is forecast to maintain output for eight years until the end of 2012. In addition to these two imminent projects, the base case anticipates the development of another new diamond mine. Construction will take place between 2010 and 2012 with production starting in 2013 and continuing throughout the forecast period. The base case also assumes that production at the Lupin gold mine, which was brought back into commission in 2000, will continue until the end of 2007.

In terms of (unquantified) environmental impacts, more traffic can be expected on the existing winter road to serve the Snap Lake, Jericho and new diamond mines. Increased traffic will raise the risk of damage resulting from spills of hazardous materials as more hazardous materials are transported, and may result in disruption of the migration of caribou herds. In addition, localised destruction of terrestrial and freshwater habitat can be expected at each new mine site to allow for infrastructure development and disposal of tailings and other wastes. Local fish and wildlife populations may be eliminated or forced to relocate as a result of the loss of habitat.

The base case and other scenarios do not include the costs of providing additional municipal infrastructure required to meet the needs of the population increases brought about by the new mine and other developments. These costs, primarily for healthcare and education needs, are relatively small.

4.3 Scenario 1

In this scenario an all-weather road between Contwoyto Lake and the Arctic coast with a deepwater seaport at its terminus is built in conjunction with the development of the Izok Lake base metal mine. In addition, the all-weather road is extended to the Lac de Gras region. This will enable the diamond mines in the region to take advantage of costs savings from all-weather road access to the north.

The all-weather road between Contwoyto Lake and the Arctic coast and the deepwater seaport will be built in 2003 and 2004 and will be open to traffic in the following year. The extension of the all-weather road from Contwoyto Lake to the Ekati and Diavik mines is to be built between 2005 and 2006. The winter road between Contwoyto Lake and Yellowknife will continue to operate and will require annual operations and maintenance expenditures.

The construction of the transportation corridor is assumed to be a prerequisite for the development of the base metal deposits at Izok Lake, which is situated at the northern end of Contwoyto Lake, and at Hackett River, which lies between Contwoyto Lake and Bathurst Inlet. Construction work at Izok Lake is set to begin in 2003 and last for three years. The scenario assumes that production will last for twelve years from 2006 to 2017. Hackett River is also set to take three years to develop (2006 to 2008) with production starting in 2009. Furthermore, the opening of the transportation corridor is assumed to act as a spur to the development of an additional base metal mine. Again construction will take three years (2009 to 2011) with production beginning in 2012. Overall, Scenario 1 results in an additional thirty-three years worth of base metal production over the forecast period compared to that in the base case.

The construction and production scenarios for the Ekati, Diavik, Snap Lake, Jericho, Lupin and new diamond mines are the same as those laid out in the base case (see Exhibit 6). However, some of these mines will benefit from reduced operating costs as a result of the construction of the all-weather road. From 2005 the Lupin and Jericho mines will have all-weather road access to the North. In summer these two mines will have a barge connection running from the mine area to the southern end of Contwoyto Lake, while the existing winter road will be used in the remainder of the year. The Ekati and Diavik mines will have direct road access to the Arctic coast from 2007. The additional new diamond mine will also incur lower capital and running costs as a result of its connection to the transport corridor.

In addition to the potential environmental impacts described under the base case, additional destruction of terrestrial, freshwater and marine habitat can be expected to result from construction work at the Izok Lake, Hackett River and new base metal mine developments. The building of additional transportation infrastructure under this scenario will also affect the environment. The all-weather road will require significant

Exhibit 6

Development Scenario 1

		Territory	Component	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Transportation Infrastructure	Winter Road (Yellowknife to Lupin)	NWT	Construction																				
			Operation	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Nunavut	Construction																				
			Operation	■	■	■	■																
	All-Weather Road (Contwoyto Lake to Arctic Coast)	Nunavut	Construction			■	■																
			Operation					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Deepwater Port on Coast	Nunavut	Construction			■	■																
			Operation					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	All-Weather Road (Extension from the North to Ekati/Diavik)	NWT	Construction					■	■														
			Operation							■	■	■	■	■	■	■	■	■	■	■	■	■	■
Mineral Developments	Ekati (diamond)	NWT	Construction																				
			Production	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
	Diavik (diamond)	NWT	Construction	■	■	■																	
			Production			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Snap Lake (diamond)	NWT	Construction	■	■	■	■																
			Production				■	■	■	■	■	■	■	■	■	■	■	■					
	Jericho (diamond)	Nunavut	Construction		■	■	■																
			Production					■	■	■	■	■	■	■	■								
	New Diamond Mine	NWT	Construction										■	■	■								
			Production													■	■	■	■	■	■	■	■
	Lupin (gold)	Nunavut	Construction																				
			Production	■	■	■	■	■	■	■													
	Izok Lake (base metal)	Nunavut	Construction			■	■	■															
			Production						■	■	■	■	■	■	■	■	■	■	■	■			
	Hackett River (base metal)	Nunavut	Construction						■	■	■												
			Production									■	■	■	■	■	■	■	■	■	■	■	■
	New Base Metal Mine	Nunavut	Construction									■	■	■									
			Production												■	■	■	■	■	■	■	■	■

Source: The Northwest Territories Department of Transportation.

amounts of aggregate (e.g., sand, gravel) which, for the most part, can be found in eskers along the route. Withdrawal of material from these eskers could reduce the amount of denning habitat available to grizzly bears and may disrupt the use of the eskers by other wildlife. Use of the road by non-mine vehicles is expected to be minimal as the new road will not connect to any existing roads. Ships serving the deepwater port will create additional traffic through the Northwest Passage and extend the length of the current shipping season. Increased shipping may affect migratory patterns and usage of certain habitats as well as causing changes to the ice regime along the route.

4.4 Scenario 2

Scenario 2 builds on the previous scenario by extending the all-weather road from the Arctic coast past Contwoyto Lake and Lac de Gras all the way to Yellowknife. The construction and operation of the deepwater port and the all-weather road sections between the Arctic coast and Contwoyto Lake and Contwoyto Lake and Lac de Gras are the same as in Scenario 1. The remaining southern segment of the road between Lac de Gras and Yellowknife will be built between 2007 and 2012, replacing the existing winter road.

The construction and production scenarios for those mines included in Scenario 1 carry over to Scenario 2 (see Exhibit 7). There are, however, a few changes regarding these mines' connections to the transportation corridor which have some impact on their operating costs. The Ekati and Diavik mines have all-weather road access to the South starting in 2013. The Snap Lake mine will have all-weather road access to Yellowknife from 2009 on.

Scenario 2 includes the development of an additional new diamond mine as a result of the improved access to the region brought about by the completion of the transportation corridor between the Lac de Gras region and Yellowknife. This mine will benefit from lower construction and operating costs due to the new road. The mine will be built between 2013 and 2015 with production taking place during the final five years of the forecast period.

Scenario 2 also includes the effects of additional tourist expenditures not included in either the base case or Scenario 1. It is assumed that the completion of the all-weather road from Yellowknife right through to the Arctic coast will attract visitors from other parts of Canada and overseas. In the scenario, tourist expenditures begin in 2013 with the completion of the all-weather road.

Exhibit 7

Development Scenario 2

		Territory	Component	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Transportation Infrastructure	Winter Road (Yellowknife to Lupin)	NWT	Construction																				
			Operation	■	■	■	■	■	■	■	■	■	■	■	■								
		Nunavut	Construction																				
			Operation	■	■	■	■																
	All-Weather Road (Yellowknife to Arctic Coast)	NWT	Construction					■	■	■	■	■	■	■	■								
			Operation													■	■	■	■	■	■	■	■
		Nunavut	Construction			■	■																
			Operation					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Deepwater Port on Coast	Nunavut	Construction			■	■																
			Operation					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Mineral Developments	Ekati (diamond)	NWT	Construction																				
			Production	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
	Diavik (diamond)	NWT	Construction	■	■	■																	
			Production			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Snap Lake (diamond)	NWT	Construction	■	■	■	■																
			Production				■	■	■	■	■	■	■	■	■	■	■	■					
	Jericho (diamond)	Nunavut	Construction		■	■	■																
			Production					■	■	■	■	■	■	■	■								
	New Diamond Mine	NWT	Construction										■	■	■								
			Production													■	■	■	■	■	■	■	■
	New Diamond Mine	NWT	Construction													■	■	■					
			Production																■	■	■	■	■
	Lupin (gold)	Nunavut	Construction																				
			Production	■	■	■	■	■	■	■													
	Izok Lake (base metal)	Nunavut	Construction			■	■	■															
			Production						■	■	■	■	■	■	■	■	■	■	■	■			
	Hackett River (base metal)	Nunavut	Construction						■	■	■												
			Production									■	■	■	■	■	■	■	■	■	■	■	■
	New Base Metal Mine	Nunavut	Construction									■	■	■									
			Production												■	■	■	■	■	■	■	■	■
Other	Tourism Expenditures		Nunavut													■	■	■	■	■	■	■	■
			NWT													■	■	■	■	■	■	■	■

Source: The Northwest Territories Department of Transportation.

In terms of (unquantified) environmental impacts, the inclusion of an additional diamond mine will cause extra localised destruction of habitat. While the potential impacts resulting from aggregate extraction to build the additional all-weather road link will result in habitat destruction and attendant impacts on wildlife, the potential impacts resulting from unrestricted vehicular use can be expected to be a major concern. With all-weather road access to the Arctic Coast and increased tourism, the road can be expected to draw additional traffic compared to the other scenarios. Increased traffic will increase the risk of spills of hazardous materials; may disrupt caribou migration; may cause an increase in impacts to fish and wildlife and their habitat; and will likely result in increased harvesting of fish and wildlife.

4.5 Scenario 3

This scenario provides no additional extensions to the transportation corridor contained in Scenario 2. However, Scenario 3 does assume that the transportation corridor is built as soon and as rapidly as possible. The port and the all-weather road linking it to Contwoyto Lake are built a year earlier than in Scenario 2. In addition, construction work on the Yellowknife to Contwoyto Lake segment also begins in 2002 and in this scenario only takes five years to complete rather than eight. As a result, the entire transportation corridor is open at the start of 2007.

The timing of the construction and production scenarios for the Ekati, Diavik, Snap Lake, Jericho and Lupin mines remain unchanged from the base case and the previous two scenarios (see Exhibit 8). However, the accelerated construction of the transportation corridor does bring these mines all-weather road access to Yellowknife and the coast faster and, consequently, delivers costs savings earlier. The Lac de Gras region now has all-weather road access to the north as early as 2004 (as does Jericho) and to the south from 2007 on. The Lupin mine now has all-weather road access to the north from 2004 while the Snap Lake mine is connected to the south in 2005.

Scenario 3 also assumes that the faster completion of the transportation corridor speeds up the development plans for the other mines included in Scenario 2. The timing of construction and production at the two new diamonds is brought forward by three years, those at Hackett River and the new base metal mine by two years and that at Izok Lake by one year. This means that production at Hackett River will cease at the end of 2018 when the mine’s working life comes to an end. The improved access to the region brought by this more rapid development scenario also leads to the development of a further new diamond mine. As with the other diamond mines, construction is assumed to take three years starting in 2013. Production will begin in 2016.

Overall, Scenario 3 results in an additional eleven years worth of diamond production and two years of base metal production over the forecast period compared to that in Scenario 2. In addition, tourism expenditures start an extra six years earlier with the opening up of the all-weather road in 2007.

With the more rapid completion of the transportation infrastructure, the potential environmental impacts described in Scenario 2 will be felt correspondingly sooner. In addition, the construction of an additional diamond mine will cause extra localised destruction of habitat as described in previous scenarios.

Exhibit 8

Development Scenario 3

		Territory	Component	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Transportation Infrastructure	Winter Road (Yellowknife to Lupin)	NWT	Construction																				
			Operation	■	■	■	■	■	■														
		Nunavut	Construction																				
			Operation	■	■	■																	
	All-Weather Road (Yellowknife to Arctic Coast)	NWT	Construction		■	■	■	■	■														
			Operation							■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Nunavut	Construction		■	■																	
			Operation				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Deepwater Port on Coast	Nunavut	Construction		■	■																	
			Operation				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Mineral Developments	Ekati (diamond)	NWT	Construction																				
			Production	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
	Diavik (diamond)	NWT	Construction	■	■	■																	
			Production			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Snap Lake (diamond)	NWT	Construction	■	■	■	■																
			Production				■	■	■	■	■	■	■	■	■	■	■	■					
	Jericho (diamond)	Nunavut	Construction		■	■	■																
			Production					■	■	■	■	■	■	■	■								
	New Diamond Mine	NWT	Construction							■	■	■											
			Production										■	■	■	■	■	■	■	■	■	■	■
	New Diamond Mine	NWT	Construction										■	■	■								
			Production													■	■	■	■	■	■	■	■
	New Diamond Mine	NWT	Construction													■	■	■					
			Production																■	■	■	■	■
	Lupin (gold)	Nunavut	Construction																				
			Production	■	■	■	■	■	■	■													
	Izok Lake (base metal)	Nunavut	Construction		■	■	■																
			Production					■	■	■	■	■	■	■	■	■	■	■	■				
	Hackett River (base metal)	Nunavut	Construction				■	■	■														
			Production							■	■	■	■	■	■	■	■	■	■	■	■		
	New Base Metal Mine	Nunavut	Construction							■	■	■											
			Production									■	■	■	■	■	■	■	■	■	■	■	■
Other	Tourism Expenditures		Nunavut							■	■	■	■	■	■	■	■	■	■	■	■	■	■
			NWT							■	■	■	■	■	■	■	■	■	■	■	■	■	■

Source: The Northwest Territories Department of Transportation.

Appendix A: New Mine Discovery statistical Analysis

This appendix provides details of the statistical analysis used to examine the relationship between the opening up of land transportation corridors and new mine development, as discussed in Section3.3. The first two tables show the size of the samples and populations used in the analysis for Québec and Ontario. The following three tables provide details of the analytical results.

Table A-1

Mine Sample Size and Population: Québec

Mine Type	Sample Size	Population Size	Per Cent
Base Metal:	23	122	18.9%
Gold:	8	155	5.2%
Total	**31**	**277**	**11.2%**

Source: Natural Resources Canada; The Conference Board Of Canada

Table A-2

Mine Sample Size and Population: Ontario

Mine Type	Sample Size	Population Size	Per Cent
Base Metal:	36	233	15.5%
Gold:	31	264	11.7%
Total	**67**	**497**	**13.5%**

Source: Natural Resources Canada; The Conference Board Of Canada

Table A-3

Correlation Between Ground Transportation Corridors and Mineral Discoveries: Québec

Mine Information					Transportation Corridor Information					
Mine Name	**Principal Mineral(s)**	**NRCan Designation**	**Year of Discovery**	**Mine Location**	**Corridor Name (Type)**	**Routing**	**Year Completed**	**Distance to Mine**	**Correlation**	**Discussion**
Jeffrey	Asbestos	ASB-1	1879	City of Asbestos	Numerous roads and water links	n/a	n/a	n/a	0	Area was colonized more than 20 years before mine discovery
Isle Dieu	Zinc	ZN-5	1985	10 km south of Matagami	Northern Trunk Railway	Barraute to Dupuy	1912	120 km	0	Mine discovery occurred more than 20 years after railway completion
Coniagas	Zinc	ZN-2	1947	150 km southwest of Chibougamau	Northern Trunk Railway	Sanmaur to Senneterre	1913	135 km	0	Mine discovery occurred more than 20 years after railway completion
Delbridge	Zinc	ZN-1	1949	5 km northeast of Noranda	Canadian Pacific Railway	Mattawa to Angliers	1894	100 km	0	Mine discovery occurred more than 20 years after railway completion
Vendome	Zinc	ZN-1	1951	3 km southwest of Barraute	Northern Trunk Railway	Barraute to Dupuy	1912	3 km	0	Mine discovery occurred more than 20 years after railway completion
Barvue	Zinc	ZN-1	1950	44 km north of Val d'Or	Northern Trunk Railway	Barraute to Dupuy	1912	5 km	0	Mine discovery occurred more than 20 years after railway completion
New Calumet	Zinc	ZN-1	1893	100 km northwest of Ottawa	Canadian Pacific Railway	Ottawa to Mackey	1879	50 km	1	Both criteria met
Icon Sullivan	Copper	CU-2	1966	55 km northeast of Chibougamau	Canadian National Railway	Franquet to Chibougamau	1957	70 km	1	Both criteria met
Copper Cliff	Copper	CU-46	1950	6 km northeast of Chibougamau	Northern Trunk Railway	Sanmaur to Senneterre	1913	215 km	0	Both criteria not met
Obalski	Copper	CU-36	1936	10 km southwest of Chibougamau	Northern Trunk Railway	Sanmaur to Senneterre	1913	205 km	0	Both criteria not met
Copper Rand-Bouzan	Copper	CU-2	1955	15 km west of Chibougamau	Quebec & Lac St. Jean Railway	Linton to Chambord	1888	210 km	0	Both criteria not met
Opemiska Copper	Copper	CU-6	1936	15 km southwest of Chibougamau	Northern Trunk Railway	Sanmaur to Senneterre	1913	200 km	0	Both criteria not met
New Hosco	Copper	CU-46	1960	17 km west of Matagami	Northern Trunk Railway	Barraute to Dupuy	1912	125 km	0	Mine discovery occurred more than 20 years after railway completion
Poirier	Copper	CU-2	1962	110 km southwest of Matagami	Northern Trunk Railway	Barraute to Dupuy	1912	90 km	0	Mine discovery occurred more than 20 years after railway completion
Hunter	Copper	CU-1	1955	40 km north of Rouyn	Canadian Pacific Railway	Mattawa to Angliers	1894	140 km	0	Mine discovery occurred more than 20 years after railway completion
Newbec	Copper	CU-6	1927	15 km north of Noranda	Canadian Pacific Railway	Mattawa to Angliers	1894	115 km	0	Mine discovery occurred more than 20 years after railway completion
Norbec	Copper	CU-5	1961	25 km north of Noranda	Canadian Pacific Railway	Mattawa to Angliers	1894	125 km	0	Mine discovery occurred more than 20 years after railway completion
Dunraine	Copper	CU-1	1942	25 km east of Val d'Or	Canadian Pacific Railway	Mattawa to Angliers	1894	140 km	0	Mine discovery occurred more than 20 years after railway completion
East Sullivan	Copper	CU-2	1946	15 km east of Rouyn	Ontario Northland Railway	Englehart to Swastika	1908	5 km	0	Mine discovery occurred more than 20 years after railway completion
Lorraine	Copper	CU-2	1963	80 km southeast of Angliers	Canadian Pacific Railway	Mattawa to Angliers	1894	30 km	0	Mine discovery occurred more than 20 years after railway completion
Huntingdon	Copper	CU-9	1865	40 km southwest of Sherbrooke	Numerous roads and water links	n/a	n/a	n/a	0	Area was colonized more than 20 years before mine discovery
Capelton	Copper	CU-13	1863	15 km southwest of Sherbrooke	Numerous roads and water links	n/a	n/a	n/a	0	Area was colonized more than 20 years before mine discovery
Eustis	Copper	CU-12	1865	15 km southwest of Sherbrooke	Numerous roads and water links	n/a	n/a	n/a	0	Area was colonized more than 20 years before mine discovery
Lake Rose	Gold	AU-2	1935	60 km northeast of Matagami	Northern Trunk Railway	Barraute to Dupuy	1912	200 km	0	Both criteria not met
Laronde	Gold	AU-5	1963	30 km east of Rouyn	Canadian Pacific Railway	Mattawa to Angliers	1894	100 km	0	Mine discovery occurred more than 20 years after railway completion
Chadbourne	Gold	AU-23	1924	Noranda	Canadian Pacific Railway	Mattawa to Angliers	1894	80 km	0	Mine discovery occurred more than 20 years after railway completion
Jacola-Legault	Gold	AU-15	1924	2 km northwest of Val d'Or	Canadian Pacific Railway	Mattawa to Angliers	1895	120 km	0	Mine discovery occurred more than 20 years after railway completion
Beaufor	Gold	AU-6	1932	27 km northeast of Val d'Or	Northern Trunk Railway	Barraute to Dupuy	1912	80 km	1	Both criteria met
Joe Mann	Gold	AU-1	1952	67 km south of Chibougamau	Northern Trunk Railway	Sanmaur to Senneterre	1913	135 km	0	Mine discovery occurred more than 20 years after railway completion
Dumont	Gold	AU-38	1936	10 km northeast of Val d'Or	Canadian Pacific Railway	Mattawa to Angliers	1895	140 km	0	Mine discovery occurred more than 20 years after railway completion
McWatters	Gold	AU-7	1932	9 km east of Rouyn	Canadian Pacific Railway	Mattawa to Angliers	1895	90 km	0	Mine discovery occurred more than 20 years after railway completion

Source: The Conference Board Of Canada

Table A-4

Correlation Between Ground Transportation Corridors and Mineral Discoveries: Ontario

Mine Information					Transportation Corridor Information					
Mine Name	**Principal Mineral(s)**	**NRCan Designation**	**Year of Discovery**	**Mine Location**	**Corridor Name (Type)**	**Routing**	**Year Completed**	**Distance to Mine**	**Correlation**	**Discussion**
Prace	Lead	PB-1	1973	32 km north of Sault Ste. Marie	Canadian Pacific Railway	Algoma to Sudbury	1883	120 km	0	Mine discovery occurred more than 20 years after railway completion
Algoma Galena	Lead	PB-2	1940	30 km north of Sault Ste. Marie	Canadian Pacific Railway	Algoma to Sudbury	1883	120 km	0	Mine discovery occurred more than 20 years after railway completion
Jardun	Lead	PB-1	1875	22 km northeast of Sault Ste. Marie	Canadian Pacific Railway	Algoma to Sudbury	1883	110 km	0	Mine discovery predates railway completion
Geneva Lake	Lead	PB-1	1928	50 km northwest of Sudbury	Canadian Pacific Railway	Sudbury to Mattawa	1883	50 km	0	Mine discovery occurred more than 20 years after railway completion
Ramsay	Lead	PB-1	1858	40 km southeast of Ottawa	Numerous roads and water links	n/a	n/a	n/a	0	Area was colonized more than 20 years before mine discovery
Hollandia	Lead	PB-5	1898	55 km north of Belleville	Numerous roads and water links	n/a	n/a	n/a	0	Area was colonized more than 20 years before mine discovery
Frontenac Lead	Lead	PB-1	1866	30 km north of Kingston	Numerous roads and water links	n/a	n/a	n/a	0	Area was colonized more than 20 years before mine discovery
Hudson Bay	Silver	AG-6	1910	100 km north of Sudbury	Canadian Pacific Railway	Sudbury to Mattawa	1883	100 km	0	Mine discovery occurred more than 20 years after railway completion
University	Silver	AG-78	1905	5 km northeast of Cobalt	Canadian Pacific Railway	Mattawa to Angliers	1894	20 km	1	Both criteria met
Beaver	Silver	AG-18	1907	5 km southeast of Cobalt	Canadian Pacific Railway	Mattawa to Angliers	1894	25 km	1	Both criteria met
Ruby	Silver	AG-5	1907	5 km east of Cobalt	Canadian Pacific Railway	Mattawa to Angliers	1894	30 km	1	Both criteria met
Bailey	Silver	AG-15	1906	5 km east of Cobalt	Canadian Pacific Railway	Mattawa to Angliers	1894	30 km	1	Both criteria met
Lorrain Trout	Silver	AG-5	1923	20 km south of Cobalt	Canadian Pacific Railway	Mattawa to Angliers	1894	15 km	0	Mine discovery occurred more than 20 years after railway completion
Levack Mine	Nickel	NI-17	1914	35 km northwest of Sudbury	Canadian Pacific Railway	Sudbury to Cartier	1883	35 km	0	Mine discovery occurred more than 20 years after railway completion
Onaping	Nickel	NI-10	1950	45 km northwest of Sudbury	Canadian Pacific Railway	Sudbury to Cartier	1883	20 km	0	Mine discovery occurred more than 20 years after railway completion
McKim Mine	Nickel	NI-7	1947	7 km northwest of Sudbury	Canadian Pacific Railway	Sudbury to Cartier	1883	0 km	0	Mine discovery occurred more than 20 years after railway completion
Frood-Stobie	Nickel	NI-21	1886	Sudbury	Canadian Pacific Railway	Sudbury to Mattawa	1883	0 km	1	Both criteria met
Blezard	Nickel	NI-12	1889	5 km northeast of Sudbury	Canadian Pacific Railway	Sudbury to Mattawa	1883	1 km	1	Both criteria met
North Star	Nickel	NI-16	1902	5 km northeast of Sudbury	Canadian Pacific Railway	Sudbury to Mattawa	1883	1 km	1	Both criteria met
Copper Cliff South	Nickel	NI-10	1967	5 km southwest of Sudbury	Canadian Pacific Railway	Algoma to Sudbury	1883	3 km	0	Mine discovery occurred more than 20 years after railway completion
Zenith	Zinc	ZN-1	1895	140 km northeast of Thunder Bay	Canadian Pacific Railway	Thunder Bay to Sudbury	1885	10 km	1	Both criteria met
Willroy	Zinc	ZN-2	1957	3 km north of Manitouwadge	Canadian Pacific Railway	Thunder Bay to Sudbury	1885	55 km	0	Mine discovery occurred more than 20 years after railway completion
Maybrun Mine - Atikwa Lake	Copper	CU-1	1955	70 km southeast of Kenora	Canadian Pacific Railway	Thunder Bay to Winnepeg	1882	45 km	0	Mine discovery occurred more than 20 years after railway completion
Shield Zone - Burchell Lake	Copper	CU-2	1928	80 km northwest of Thunder Bay	Canadian National Railway	Thunder Bay to Fort Frances	1902	10 km	0	Mine discovery occurred more than 20 years after railway completion
Big Nama Creek	Copper	CU-2	1954	3 km northeast of Manitouwadge	Canadian Pacific Railway	Thunder Bay to Winnepeg	1882	45 km	0	Mine discovery occurred more than 20 years after railway completion
Geco Mine	Copper	CU-3	1953	3 km northeast of Manitouwadge	Canadian Pacific Railway	Thunder Bay to Winnepeg	1882	45 km	0	Mine discovery occurred more than 20 years after railway completion
Munro Copper - Centre Hill	Copper	CU-1	1952	22 km east of Matheson	Temisgamingue & Northern Ontario/Ontario	Swastika to Porquis Jct	1908	18 km	0	Mine discovery occurred more than 20 years after railway completion
Bi-Ore	Copper	CU-8	1929	150 km west of Sudbury	Canadian Pacific Railway	Sudbury to Algoma	1883	50 km	0	Mine discovery occurred more than 20 years after railway completion
Crownbridge	Copper	CU-5	1942	145 km west of Sudbury	Canadian Pacific Railway	Sudbury to Algoma	1883	35 km	0	Mine discovery occurred more than 20 years after railway completion
Bruce Mine	Copper	CU-2	1846	48 km east of Sault Ste Marie	Water access from Lake Superior	n/a	n/a	n/a	0	Area was colonized more than 20 years before mine discovery
Massey	Copper	CU-2	1901	85 km southwest of Sudbury	Canadian Pacific Railway	Sudbury to Algoma	1883	4 km	1	Both criteria met
Temagami	Copper	CU-4	1951	50 km north of Sudbury	Canadian National Railway	Sudbury to Algoma	1883	50 km	0	Mine discovery occurred more than 20 years after railway completion

Cont…

Table A-4, cont.

Correlation Between Ground Transportation Corridors and Mineral Discoveries: Ontario

Mine Information					Transportation Corridor Information					
Mine Name	**Principal Mineral(s)**	**NRCan Designation**	**Year of Discovery**	**Mine Location**	**Corridor Name (Type)**	**Routing**	**Year Completed**	**Distance to Mine**	**Correlation**	**Discussion**
Consolidated Sudbury Basin Mine	Copper	CU-3	1953	27 km west of Sudbury	Canadian Pacific Railway	Sudbury to Cartier	1884	7 km	0	Mine discovery occurred more than 20 years after railway completion
Vermillion Mine	Copper	CU-2	1887	27 km southwest of Sudbury	Canadian Pacific Railway	Sudbury to Algoma	1883	2 km	1	Both criteria met
Victoria Mine (McConnell Mine)	Copper	CU-3	1899	30 km southwest of Sudbury	Canadian Pacific Railway	Sudbury to Algoma	1883	2 km	1	Both criteria met
Wilcox	Copper	CU-1	1899	15 km southwest of Parry Sound	Canadian Pacific Railway	Mattawa to Sturgeon Falls	1882	135 km	1	Both criteria met
Laurentian (Eelora)	Gold	AU-2	1903	38 km southeast of Dryden	Canadian Pacific Railway	Thunder Bay to Eagle River	1881	29 km	0	Mine discovery occurred more than 20 years after railway completion
Olive (Preston)	Gold	AU-1	1897	55 km east of Fort Frances	Canadian Pacific Railway	Thunder Bay to Winnepeg	1882	100 km	1	Both criteria met
Talmora Longlac	Gold	AU-11	1934	4 km southwest of Geraldton	Canadian Pacific Railway	Thunder Bay to Sudbury	1885	110 km	0	Mine discovery occurred more than 20 years after railway completion
Hays Lake-Jedder	Gold	AU-11	1937	8 km east of Schreiber	Canadian Pacific Railway	Thunder Bay to Sudbury	1885	1 km	0	Mine discovery occurred more than 20 years after railway completion
Hiawatha	Gold	AU-3	1937	48 km southwest of Oba	Canadian Pacific Railway	Thunder Bay to Sudbury	1885	60 km	0	Mine discovery occurred more than 20 years after railway completion
Pick	Gold	AU-3	1924	16 km south of Franz	Canadian Pacific Railway	Thunder Bay to Sudbury	1885	4 km	0	Mine discovery occurred more than 20 years after railway completion
Magnacon (Macassa-Bishu)	Gold	AU-2	1984	55 km south of White River	Canadian Pacific Railway	Thunder Bay to Sudbury	1885	55 km	0	Mine discovery occurred more than 20 years after railway completion
Nudulama	Gold	AU-2	1948	69 km northwest of Chapleau	Canadian Pacific Railway	Thunder Bay to Sudbury	1885	18 km	0	Mine discovery occurred more than 20 years after railway completion
Renabie	Gold	AU-1	1941	70 km northwest of Chapleau	Canadian Pacific Railway	Thunder Bay to Sudbury	1885	30 km	0	Mine discovery occurred more than 20 years after railway completion
Joburke (MacKeith Lake)	Gold	AU-2	1947	80 km southwest of Timmins	Canadian Pacific Railway	Thunder Bay to Sudbury	1885	80 km	0	Mine discovery occurred more than 20 years after railway completion
J. Huddlestone	Gold	AU-10	1923	20 east of Timmins	Ontario Northland Railway	North Bay to New Liskeard	1905	140 km	1	Both criteria met
Bell Creek	Gold	AU-11	1958	7 km north of South Porcupine	Ontario Northland Railway	North Bay to Engelheart	1906	130 km	0	Mine discovery occurred more than 20 years after railway completion
Tisdale-Ankerite (Fuller-Tisdale)	Gold	AU-76	1938	20 km southeast of Timmins	Ontario Northland Railway	North Bay to New Liskeard	1905	130 km	0	Mine discovery occurred more than 20 years after railway completion
Ankerite	Gold	AU-20	1911	6 km southeast of Timmins	Ontario Northland Railway	North Bay to New Liskeard	1905	145 km	1	Both criteria met
Preston	Gold	AU-13	1911	15 km southeast of Timmins	Ontario Northland Railway	North Bay to New Liskeard	1905	135 km	1	Both criteria met
McIntyre Porcupine (Schumacher)	Gold	AU-12	1913	2 km south of Timmins	Ontario Northland Railway	North Bay to Engelheart	1906	130 km	1	Both criteria met
Naybob (Hayden)	Gold	AU-2	1915	10 km south of Timmins	Ontario Northland Railway	North Bay to Engelheart	1906	125 km	1	Both criteria met
Lake Shore	Gold	AU-27	1914	1 km west of Kirkland Lake	Ontario Northland Railway	North Bay to New Liskeard	1905	110 km	1	Both criteria met
Crescent Kirkland (Swastika)	Gold	AU-18	1909	1 km north of Swastika	Canadian Pacific Railway	Mattawa to Angliers	1894	0 km	1	Both criteria met
Young-Davidson	Gold	AU-5	1916	50 km southwest of Kirkland Lake	Canadian Pacific Railway	Mattawa to Angliers	1894	80 km	0	Mine discovery occurred more than 20 years after railway completion
Young-Shannon	Gold	AU-1	1932	30 km northwest of Ruel	Canadian Pacific Railway	Thunder Bay to Sudbury	1885	16 km	0	Mine discovery occurred more than 20 years after railway completion
Tionaga (Smith-Thorne)	Gold	AU-8	1935	90 km southwest of Timmins	Canadian Pacific Railway	Thunder Bay to Sudbury	1885	80 km	0	Mine discovery occurred more than 20 years after railway completion
Joburke	Gold	AU-2	1946	95 km southwest of Timmins	Canadian Pacific Railway	Thunder Bay to Sudbury	1885	95 km	0	Mine discovery occurred more than 20 years after railway completion
Centennial (Kitchigami)	Gold	AU-6	1903	10 km southeast of Wawa	Canadian Pacific Railway	Thunder Bay to Sudbury	1885	50 km	1	Both criteria met
Surluga	Gold	AU-2	1929	1 km east of Wawa	Canadian Pacific Railway	Thunder Bay to Sudbury	1885	45 km	0	Mine discovery occurred more than 20 years after railway completion
Bousquet	Gold	AU-1	1911	15 km south of Espagnola	Canadian Pacific Railway	Sudbury to Algoma	1883	15 km	0	Mine discovery occurred more than 20 years after railway completion
Detour Lake	Gold	AU-1	1977	150 km northeast of Cochrane	Northern Trunk Railway	Cochrane to Dupuy	1910	120 km	0	Mine discovery occurred more than 20 years after railway completion
Moffat-Hall Mine	Gold	AU-40	1931	9 km northeast of Kirkland Lake	Canadian Pacific Railway	Mattawa to Angliers	1894	100 km	0	Mine discovery occurred more than 20 years after railway completion

Source: The Conference Board Of Canada

Table A-5

Correlation Between Ground Transportation Corridors and Mineral Discoveries: Hudson Bay Railway

Mine Information					Transportation Corridor Information					
Mine Name	**Principal Mineral(s)**	**NRCan Designation**	**Year of Discovery**	**Mine Location**	**Corridor Name (Type)**	**Routing**	**Year Completed**	**Distance to Mine**	**Correlation**	**Discussion**
Ferro	Gold	AU-2	1932	7 km northeast of Herb Lake	Hudson Bay Railway	Flin Flon Jct to Sipiwesk	1914	50 km	1	Both criteria met
Bingo Prospect	Gold	AU-3	1921	2 km northeast of Herb Lake	Hudson Bay Railway	Flin Flon Jct to Sipiwesk	1914	24 km	1	Both criteria met
Osborne Lake	Copper	CU-1	1961	20 km northeast of Herb Lake	Hudson Bay Railway	Flin Flon Jct to Sipiwesk	1914	50 km	0	Mine discovery occurred more than 20 years after railway completion
Stall Lake	Copper	CU-2	1957	12 km northwest of Herb Lake	Hudson Bay Railway	Flin Flon Jct to Sipiwesk	1914	40 km	0	Mine discovery occurred more than 20 years after railway completion
Rod (Little Stall Lake)	Copper	CU-3	1962	13 km northwest of Herb Lake	Hudson Bay Railway	Flin Flon Jct to Sipiwesk	1914	40 km	0	Mine discovery occurred more than 20 years after railway completion
Anderson Lake	Copper	CU-4	1964	15 km northwest of Herb Lake	Hudson Bay Railway	Flin Flon Jct to Sipiwesk	1914	42 km	0	Mine discovery occurred more than 20 years after railway completion
Spruce Point	Copper	CU-1	1984	25 km northwest of Dyce	Hudson Bay Railway	Flin Flon Jct to Sipiwesk	1914	25 km	0	Mine discovery occurred more than 20 years after railway completion
White Lake	Copper	CU-1	1970	10 km southeast of Flin Flon	Canadian National Railway	Hudson Bay Jct to The Pas	1910	105 km	0	Mine discovery occurred more than 20 years after railway completion
Centennial	Copper	CU-2	1973	15 km southeast of Flin Flon	Canadian National Railway	Hudson Bay Jct to The Pas	1910	101 km	0	Mine discovery occurred more than 20 years after railway completion
Schist Lake	Copper	CU-4	1950	6 km southeast of Flin Flon	Canadian National Railway	Hudson Bay Jct to The Pas	1910	110 km	0	Mine discovery occurred more than 20 years after railway completion
Mandy	Copper	CU-6	1916	6 km southeast of Flin Flon	Canadian National Railway	Hudson Bay Jct to The Pas	1910	110 km	1	Both criteria met
Westarm	Copper	CU-10	1975	15 km south of Flin Flon	Canadian National Railway	Hudson Bay Jct to The Pas	1910	100 km	0	Mine discovery occurred more than 20 years after railway completion
Cuprus	Copper	CU-11	1946	10 km southeast of Flin Flon	Canadian National Railway	Hudson Bay Jct to The Pas	1910	105 km	0	Mine discovery occurred more than 20 years after railway completion
Flin Flon Mine	Copper	CU-3	1920	Flin Flon	Canadian National Railway	Hudson Bay Jct to The Pas	1910	110 km	1	Both criteria met
Don Jon	Copper	CU-4	1953	20 km east of Flin Flon	Canadian National Railway	Hudson Bay Jct to The Pas	1910	105 km	0	Mine discovery occurred more than 20 years after railway completion
Trout Lake	Copper	CU-12	1980	5 km north of Flin Flon	Canadian National Railway	Hudson Bay Jct to The Pas	1910	115 km	0	Mine discovery occurred more than 20 years after railway completion
North Star	Copper	CU-5	1951	20 km east of Flin Flon	Canadian National Railway	Hudson Bay Jct to The Pas	1910	105 km	0	Mine discovery occurred more than 20 years after railway completion
Dickstone	Copper	CU-2	1967	55 km northeast of Dyce	Hudson Bay Railway	Flin Flon Jct to Sipiwesk	1916	55 km	0	Mine discovery occurred more than 20 years after railway completion
Sherridon	Copper	CU-3	1928	Sherridon	Canadian National Railway	Hudson Bay Jct to The Pas	1910	145 km	1	Both criteria met
Ghost Lake	Zinc	ZN-2	1970	40 km northwest of Wekusko	Hudson Bay Railway	Flin Flon Jct to Sipiwesk	1914	40 km	0	Mine discovery occurred more than 20 years after railway completion
Chisel Lake	Zinc	ZN-1	1957	8 km southwest of Snow Lake	Hudson Bay Railway	Flin Flon Jct to Sipiwesk	1914	50 km	0	Mine discovery occurred more than 20 years after railway completion
Manibridge	Nickel	NI-1	1969	32 km southwest of Wabowden	Hudson Bay Railway	Flin Flon Jct to Sipiwesk	1914	4 km	0	Mine discovery occurred more than 20 years after railway completion
Thompson	Nickel	NI-2	1957	2 km southeast of Thompson	Hudson Bay Railway	Flin Flon Jct to Sipiwesk	1914	40 km	0	Mine discovery occurred more than 20 years after railway completion
Soab South	Nickel	NI-1	1967	68 km southwest of Thompson	Hudson Bay Railway	Flin Flon Jct to Sipiwesk	1914	15 km	0	Mine discovery occurred more than 20 years after railway completion
Soab North	Nickel	NI-2	1966	69 km southwest of Thompson	Hudson Bay Railway	Flin Flon Jct to Sipiwesk	1914	15 km	0	Mine discovery occurred more than 20 years after railway completion
Pipe	Nickel	NI-3	1960	32 km southwest of Thompson	Hudson Bay Railway	Flin Flon Jct to Sipiwesk	1914	30 km	0	Mine discovery occurred more than 20 years after railway completion
Henning-Malonney Mine	Gold	AU-2	1934	7 km southwest of Flin Flon	Canadian National Railway	Hudson Bay Jct to The Pas	1910	105 km	0	Mine discovery occurred more than 20 years after railway completion
Prince Albert	Gold	AU-1	1914	25 km west of Flin Flon	Canadian National Railway	Hudson Bay Jct to The Pas	1910	120 km	1	Both criteria met
Hanson Lake	Lead	PB-1	1965	60 km west of Flin Flon	Canadian National Railway	Hudson Bay Jct to The Pas	1910	140 km	0	Mine discovery occurred more than 20 years after railway completion
Coronation	Copper	CU-2	1955	20 km southwest of Flin Flon	Canadian National Railway	Hudson Bay Jct to The Pas	1910	100 km	0	Mine discovery occurred more than 20 years after railway completion
Birch Lake	Copper	CU-1	1952	15 km southwest of Flin Flon	Canadian National Railway	Hudson Bay Jct to The Pas	1910	110 km	0	Mine discovery occurred more than 20 years after railway completion
Flexar	Copper	CU-5	1963	15 km southwest of Flin Flon	Canadian National Railway	Hudson Bay Jct to The Pas	1910	110 km	0	Mine discovery occurred more than 20 years after railway completion

Source: The Conference Board Of Canada

Appendix B: Mine Production Model Description

1 Introduction

As part of this study, the Northwest Territories Department of Resources, Wildlife and Economic Development (RWED) used mine production models to estimate the timing and duration of mine production in the Slave Geological Province. This appendix (information supplied by RWED) describes the mine production models and how they fed into the scenario development process.

2 Methodology

Diamond mine production model templates were developed by Ellis Consulting using the Ekati and Diavik mines as prototypes. Variable values were confirmed with mine operations and construction managers. These models were applied to potential mine developments for the properties in the scenarios: Snap Lake (formerly Winspear), Kennady Lake and Jericho (in Nunavut). Model inputs were derived from the existing base model defaults, interviews with the managers of operations for Ekati and Diavik, and the construction management team which managed the construction of Ekati and was managing Diavik. Information on Snap Lake, Kennady Lake and Jericho was extracted from publicly available information.

All the models were subjected to risk analysis using *@Risk for Excel 4.0* software. Monte Carlo simulations of 1000 iterations each were run to estimate the range of values for variables with uncertain parameters. Variables with uncertain values were assigned a risk probability distribution that reflected currently known information. For properties not yet under construction, the degree of risk attached was higher than for projects all ready in production or under construction. For a complete description of the variables, the range of values and the nature of the probability distribution applied, see below.

Properties not yet under construction were screened for inclusion in each scenario based on the criterion that the project would have to achieve a minimum net present value (NPV) of 15 per cent on cash flow. An NPV of less than 15 per cent would eliminate the project from the scenario.

The Ekati mine is the only diamond mine considered in this analysis that is actually in production. It was assumed that the most accurate estimates of impacts on operations were those resulting from discussions held with the Ekati mine manager and the managers who handled the construction of Ekati. Therefore, the impacts of an all-weather road on operations at the Ekati mine were scaled to the production of other mines to produce estimates of impacts on operations.

3 All-Weather Roads

3.1 Overview

Two all-weather roads were considered in this analysis: a road from the north, linking the diamond mines to a deep water port in Bathurst Inlet, and an all-weather road south, linking the diamond mines to Yellowknife.

The following assumptions regarding operations of these roads were made:

1. Access to the northern road is dependent upon crossing Contwoyto Lake by barge in summer and ice road in winter, effectively cutting access into two seasons.
2. In the absence of an all-weather road south, a winter road to Yellowknife would still be constructed and maintained even if an all-weather road in Nunavut is constructed. In this situation, all fuel would be transported by ocean and over the northern road, and all other supplies would be hauled up the winter road from the south
3. No analysis of the impact was made of an all-weather road from the south in isolation from an all-weather road from the north. In all scenarios where both all-weather roads are present, it is assumed that fuel is transported over the northern road, and all other materials are transported over the southern road

3.2 Impacts of All-weather road Access on Operations

3.2.1 Overview

The impacts of an all-weather road from the south were assessed on the basis of interviews with the managers of construction and operations for the Ekati and Diavik diamond mines. The managers suggested that substantial benefits could be realised in both construction and operations if an all-weather road was available.

The impacts of an all-weather road from the north were estimated based on information in consultants' reports completed for the Kitikmeot Corporation[7] and the GNWT Department of Transportation[8]. This analysis used the cost assumptions from those reports, with an additional cost of carrying inventory which was not applied in those reports.

All-weather road access from the south would affect operations costs in the following main areas:

1. Carrying costs of inventory;

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[7] Nishi-Khon / SNC*Lavalin *Kitkmeot Road and Port Preliminary Economic Study* March 2000.

[8] Arther Andersen *Slave Geologic Province Transportation Corridor Need/Feasibility Study*.

2. Air transport of food and perishable goods;
3. Winter road charges.

3.2.2 Carrying Costs of Inventory

Mines currently using the winter road must bring a 10-month supply of bulk commodities necessary for operations. The largest of these goods is fuel; both Ekati and Diavik carry an annual inventory of over 50 million litres of diesel fuel. However, an annual supply of other consumable goods must also be purchased and stored. These include items such as chemicals, and a large stock of spare parts for vehicle and machinery. Some of the more unusual items are the extremely large tires for the giant rock trucks. The tires are too large to be transported on a Hercules aircraft, so a 9-month inventory must be brought in over the ice road. Ekati maintains an annual inventory of 200 tires, valued at $25,000 each for a total inventory value of $4 million.

The carrying charges on inventory represent a substantial cost to the mine operations. The mine operations manager for Ekati estimated that these charges amount to 25 per cent of the $60 million dollar value of their consumable inventory, or $15 million. However, a more reasonable alternative for a mine that is a subsidiary of a very large company would be the financing of inventory carrying costs from internal debt. Therefore, two estimates of carrying costs were used: 25 per cent of the inventory cost, and the opportunity cost of capital. There is a substantial difference between these two rates.

3.2.3 Air Transport

Lack of an all-weather road requires air transport of perishable goods weekly to the mine sites. The cost of air cargo is much higher than truck transport. The operations manager for Ekati estimates that 10 tonnes of food are flown into the minesite weekly. At a cost of $0.66/kg, the freight cost for food alone is $277,000 for the 42-week period during which the mine has no road access.

The Ekati mine receives on average eight 737-jet flights per week. These are combi-jets, transporting both people and cargo. Four of these flights could be eliminated each week if the mine were accessible by an all-weather road. At an approximate cost of $2000 per flight, this represents a saving of over $300,000 over the 42-week period that the ice road is closed.

3.2.4 Winter Road Charges

Echo Bay Mines, owner of the Lupin gold mine, constructs the winter road servicing the Lupin, Ekati and Diavik mine sites. The road is constructed under a license which prescribes that charges to other users be levied on a cost-recovery basis, with no profit generated. The rate change is inversely proportional to the change in total freight moved; the relative cost of the road decreases as the number of users and the amount of freight increases.

Hypothetically, an all-weather road from the south could have the following impacts on the Ekati diamond mine:

1. Reduce carrying costs – a maximum 25 per cent of $60 million, equal to $15 million per year;
2. Lower opportunity cost of capital - estimated at $3.24 million peryear;
3. Eliminate Hercules supply flights - average 4 per month at $16,000 per trip, equal to $64,000/month, or $768,000/year;
4. Reduce rock truck tire inventory – estimated reduction from 200 to 10;
5. Reduce food transportation costs – 10 tonnes of food currently flown in weekly for 42 weeks at $0.66/kg at a cost of $277,000. Shipping by truck freight at $0.22/kg would cost $92,400 for a net savings of $184,600;
6. Eliminate four 737 flights per week at $2,000 per week giving estimated savings of $336,000.
7. Cost increase: 2 extra bodies for security at $75,000 each = $150,000/year.

Table B-1 summarises the net savings from a southern all-weather road.

3.3 Impacts of All-weather road from the North and Scenario Building

3.3.1 Overview

For the analysis, it was decided to use the minimum carrying cost calculations based on the cost of capital applied to inventory. The calculations presented above are based on the benefits from a southern all-weather road only. In the scenarios required for this study, a southern all-weather road never exists alone; it always appears in conjunction with an all-weather road from the Arctic coast. Therefore, this section presents the summary of impacts of both roads together.

3.3.2 Scenario 1

In scenario 1, an all-weather road from the north is constructed, linking the diamond mines to the Arctic coast via a connecting road to Contwoyto Lake and barge service in summer, and a winter road crossing the lake in winter. Fuel is be delivered via the northern road in summer. All other materials and supplies are brought in over the southern winter road. The annual operating requirement for fuel has to be purchased over the period the port is

Table B-1

Net Benefits

Source	Amount
Carrying Costs (max)	$15,000,000
Carrying Costs (min)1	$3,240,000
Herc Costs	$786,000
Food Freight	$184,600
Other Aircraft	$1,040,000
Winter Road	$1,568,000
Sub-Total	$17,874,600
Less Security	-$150,000
Total Savings (max)	**$17,724,600**
Total Savings (min)	**$6,668,600**

1 Based on cost of capital applied to inventory.

Source: RWED

open. Therefore, no cost savings will be realised for carrying costs. However, the cost of shipping fuel via the ocean and the north all-weather road is significantly cheaper than trucking from the south. Savings are also realised in winter road charges foregone, but there are additional costs in terms of port fees and road freight charges.

The benefits accruing from this scenario relative to the base case, based on Ekati operations, are summarised in Table B-2.

Table B-2

Benefits of Scenario 1 Relative to Base Case

Source	Amount
Other Aircraft	$72,000
Winter Road	$588,000
Freight: north/site	-$296,500
Fuel Freight (Ocean)	$2,600,000
Port Fees	-$700,000
Total Benefits	**$2,263,500**

Source: RWED

3.3.3 Scenarios 2 and 3

In scenarios 2 and 3, an all-weather road from the south is constructed as well as a northern all-weather road. Once the southern all-weather road is complete and the northern all-weather road is functional, it is assumed that all fuel is brought in over the northern road and all other materials and supplies are brought in from the south. This situation results in savings on the cost of transporting fuel, but adds costs relating to carrying charges, port fees and freight costs. Still, the benefit of reduced transportation costs outweighs these other costs.

The benefits of the all-weather roads north and south are summarised in Table B-3.

Table B-3

Benefits of All-weather road from North and South

Source	Amount
Base benefits from all-weather road south	$6,668,600
Fuel cost difference	$2,600,000
Fuel carrying charges	-$968,760
Port fees	-$700,000
Trucking Fees from north	-$296,500
Total Benefits	**$7,303,340**

Source: RWED

3.4 Impacts of an All-weather road on Construction

3.4.1 Overview

The impacts on construction from an all-weather road would be apparent in three major areas:

1. The elimination of the winter road fees.
2. The elimination of air freight;

3. The reduction in the physical storage required for bulk goods, especially fuel, and;

In addition, the construction managers for Ekati and Diavik estimate that winter road access results in a 5 per cent cost premium on pre-construction costs.

The following analysis suggests the hypothetical savings that may have accrued to the Diavik mine if an all-weather road had been available during the construction period.

3.4.2 Winter Road Charges

Winter road charges would be eliminated. Diavik publicly released data provides estimates at $0.14/kilometre/tonne.

3.4.3 Air Freight

An all-weather road link would have vastly reduced air freight requirements. Construction management (HA Simons Ltd) suggests 30 per cent of non-fuel tonnage may be flown in (air freight charges estimated at $0.66/kg or $660/tonne). In the case of Diavik estimated savings amount to $8.35 million on winter road charges and $26.4 million on air freight charges.

The calculation for these savings is derived as follows. The total tonnage moved over four seasons amounts to 208,220 tonnes, of which 36 per cent, or 75,000 tonnes, is fuel. Of the remaining 133,220 tonnes of materials and supplies, 30 per cent, or about 40,000 tonnes[9] would have been transported by air, resulting in potential savings of $26.4 million (40,000 tonnes at a cost of $660 per tonne). Winter road charge savings would amount to $8.35 million ($0.14 per kilometre/tonne over a distance of 355 kilometres for 75,000 tonnes of fuel and 93,000 tonnes of remaining non-fuel materials).

3.4.4 Reduced fuel storage requirements

Lupin mine vice-president of operations, and Ekati and Diavik construction project management suggest that an all-weather road would reduce the requirements for 12 months of fuel storage to anywhere from 3 months to one month of available fuel.

The following calculation provides cost estimates for the Ekati tank farm. Material costs amount to $0.10/litre for every litre of storage. This implies a cost of $5.4 million for 54 million litres. Adding another $2.6-3.6 million for land development gives a total cost of $8 to $9 million.

An all-weather road could result in cost reductions for tank farm construction in the range of $6-8.25 million.

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[9] Hercules aircraft are used as much as possible. A Hercules has a maximum payload of 4.5 tonnes with a range of 3,770 km. Project manager estimates that they used 775 Hercules loads to build Ekati, which would result in transport of approximately 35,000 tonnes of material (maximum). For Diavik, the estimate of 40,000 tonnes should be fairly accurate, since Diavik will be a more costly mine to build.

3.4.5 Pre-Construction Costs

It is estimated that $5 million could be saved on the costs of flying in labour and materials out of total estimated pre-construction expenses of $102 million.

Table B-4 summarises the possible savings on Diavik Construction Costs. The total savings of $45.75 million to $48.25 million represent 3-3.2 per cent of the total cost of $1.5 billion.

Table B-4

Possible Savings on Diavik Construction Costs

Source	Amount ($ millions)
Tank farm savings	6 to 8.5
Pre-construction site preparation	5
Winter road charges	8.35
Air freight	26.4
Total Benefits	**45.75 to 48.25**

Source: RWED

3.4.6 Hypothetical Savings for Kennady Lake Construction

In the case of Kennady Lake, which is the only property examined which did not meet the 15 per cent NPV criteria for inclusion in the scenarios, the impacts on construction costs could be as follows:

Freight costs:

Winter road charges for materials = $0.14 * 160 km* 0.7 * 13,075 = $205,000;

Air freight for materials = $660 * 0.3 * 13,075 = $2,600,000;

Winter road charges for fuel = $0.14 * 160km * 4,773 = $107,000;

Total Freight Cost from Yellowknife = $2,912,000.

Tank storage:

Cost = 5,472,000 litres * 0.10 = $547,200

Plus site development (one fifth of Diavik cost) cost of $520,000 = $ 1,067,200.

Savings from an all-weather road = 0.75 * $1,067,200 = $800,000. Fuel requirement is reduced by 75 per cent because of 12-month access)

Pre-construction costs:

5 per cent premium on costs $17 million because of lack of an all-weather road resulting in savings of $850,000.

Carrying costs on capital:

$7.5 million, based on 9 months of capital tied up per year, with a normal delivery rate of 4 times of year should an all-weather road be available.

Total possible hypothetical savings for construction of the Kennady Lake are given in Table B-5.

Table B-5

Possible Savings on Kennady Lake Project

Source	Amount
Pre-construction	$850,000
Freight	$2,912,000
Tank farm	$800,000
Carrying costs	$7,500,000
Total Benefits	**$12,062,000**

Source: RWED

4 Results

4.1 Introduction

The model template building and data gathering led to the construction of two models for each mine or property under consideration in each scenario: a maximum reduction model and a minimum reduction model. Maximum reduction models were run with the higher estimate of carrying cost savings that could be attributed to an all-weather road; minimum reduction models were run with the lower estimate of carrying cost savings.

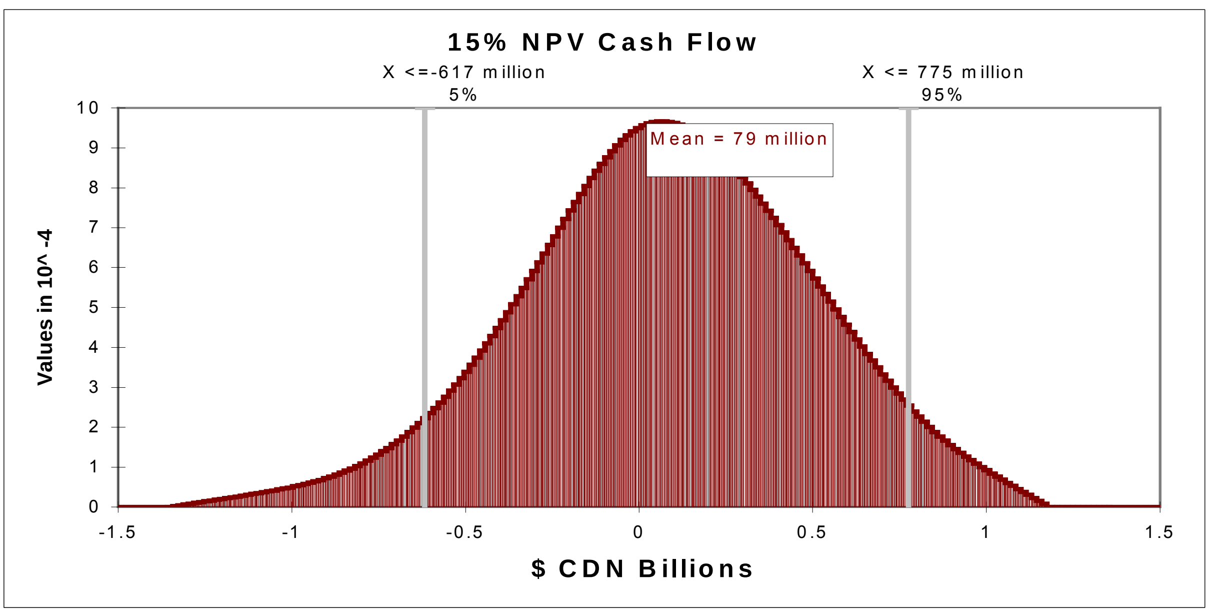
Results of the Monte Carlo simulations for each mine for the base case are presented in the following sections.

4.2 Diavik Diamond Mine Base Case

Results of the Monte Carlo analysis for the base case show a mean positive return at a discount rate of 15 per cent. The probability of a positive return is 58 per cent (42 per

Chart B-1

Diavik Mine Cash Flow



Source: RWED

cent of simulation results were negative). The risk of a not achieving a 15 per cent return is much higher than for Ekati, which has a 22 per cent risk. Chart B-1 and Table B-6 present the summary results for the Diavik base case.

Table B-6

Diavik Diamond Mine Base Case: Summary Variables

Reserve		**Schedule**		
Tonnes (millions)	32.1	Year Start Construction	2000	
Grade (carats/tonne)	3.63	Years of Operation	20	
Value ($US/carat)	65.00	Year Start Operation	2003	
Value ($CDN/carat)	97.01	Year End Operation	2022	
Capital Expenditures ($CDN millions, constant)		**Production ($CDN millions, constant)**		
			Total	**Annual**
Total Capital Expenditures	2,300	Value of Production	11,315	566
Mine Development	273	Operating Costs	3,242	162
Mine Construction	1,319	Capital Consumption Allowances	2,300	115
Additional New Construction	412	Closure Costs	106	5
Equipment Replacement	295	Resource Income	5,667	283
Employment (Person Years)	2,603	Employment (Person Years)	11,122	556
NWT	1,225	NWT	7,880	394
Rest of Canada	1,378	Rest of Canada	3,242	162

Financial ($CDN millions, constant)					
	Total	**Annual**		**Total**	**Annual**
Resource Income	5,667	283	Before-Tax Cash Flow	7,967	398
Direct Mine Taxes	2,626	131	Income Tax and Government Royalties	2,626	131
Federal Corporate Taxes	1,238	62	After-Tax Cash Flow	5,341	267
Federal Royalties	793	40	Capital Pay-Back (years)	3.3	
Territorial Corporate Taxes	595	30	Net Present Value 15 per cent	100	
Income After Taxes	3,041	152			

Source: RWED

4.3 Ekati Diamond Mine Base Case

Results of the Monte Carlo analysis for the base case show a mean positive return at a discount rate of 15 per cent. The probability of a positive return is 78 per cent (22 per cent of simulation results were negative). Chart B-2 and Table B-7 present the results for the Ekati base case.

Table B-7

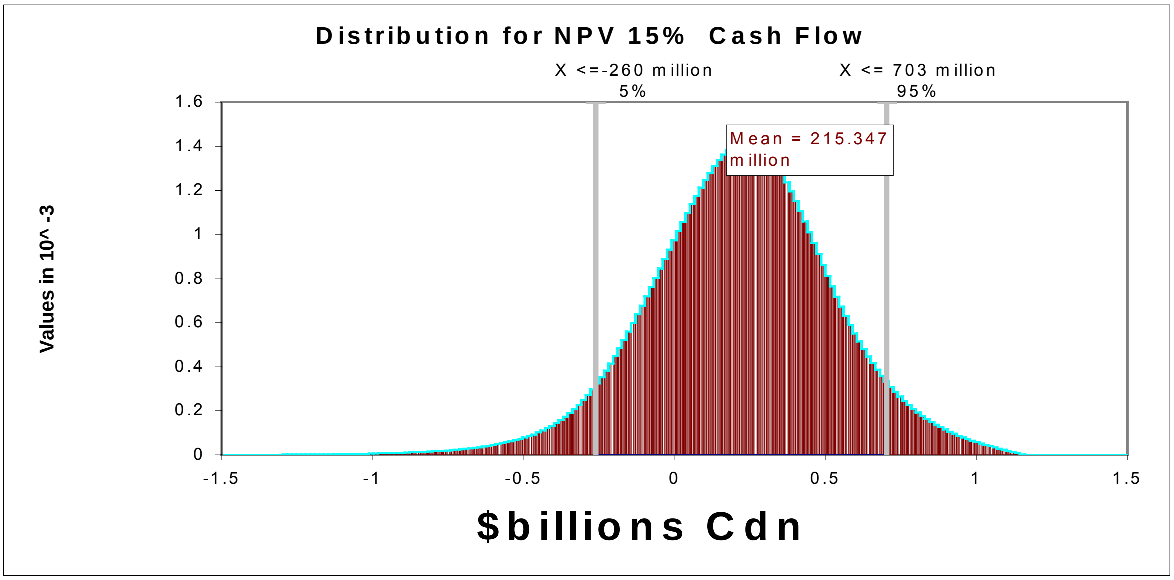
Ekati Diamond Mine Base Case: Summary Variables

Reserve			**Schedule**		
Tonnes (millions)	60.8		Year Start Construction	1997	
Grade (carats/tonne)	1.09		Years of Operation	17	
Value ($US/carat)	84.00		Year Start Operation	2000	
Value ($CDN/carat)	125.37		Year End Operation	2016	
Capital Expenditures ($CDN millions, constant)			**Production ($CDN millions, constant)**		
				Total	**Annual**
Total Capital Expenditures	1,536		Value of Production	8,302	488
Mine Development	104		Operating Costs	2,221	131
Mine Construction	1,066		Capital Consumption Allowances	1,536	90
Additional New Construction	213		Closure Costs	78	5
Equipment Replacement	153		Resource Income	4,466	263
Employment (Person Years)	3,338		Employment (Person Years)	9,145	538
NWT	1,571		NWT	6,479	381
Rest of Canada	1,767		Rest of Canada	2,666	157
Financial ($CDN millions, constant)					
	Total	**Annual**		**Total**	**Annual**
Resource Income	4,466	263	Before-Tax Cash Flow	6,002	353
Direct Mine Taxes	2,070	122	Income Tax and Government Royalties	2,070	122
Federal Corporate Taxes	975	57	After-Tax Cash Flow	3,933	231
Federal Royalties	625	37	Capital Pay-Back (years)	3.0	
Territorial Corporate Taxes	469	28	Net Present Value 15 per cent	225	
Income After Taxes	2,397	141			

Source: RWED

Chart B-2

Ekati Diamond Mine Cash Flow

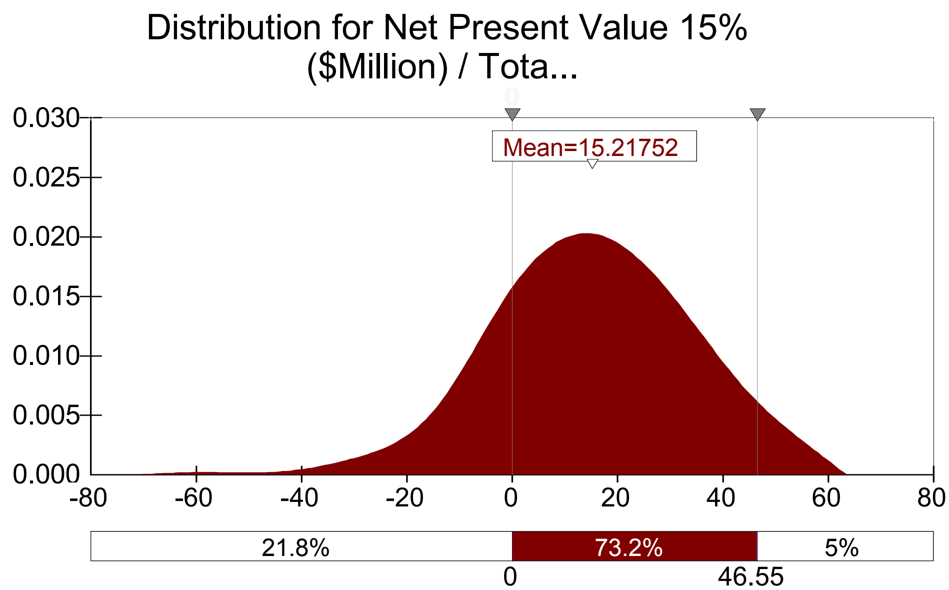


Source: RWED

4.4 Jericho Diamond Mine Base Case

Chart B-3

Jericho Diamond Mine Cash Flow



Source: RWED

Results of the Monte Carlo analysis for the base case show a mean positive return at a discount rate of 15 per cent. The probability of a positive return is almost 80 per cent. Chart B-3 and Table B-8 present the results for the Jericho base case.

Table B-8

Jericho Diamond Mine Base Case: Summary Variables

Reserve		**Schedule**		
Tonnes (millions)	3.7	Year Start Construction	2002	
Grade (carats/tonne)	1.09	Years of Operation	8	
Value ($US/carat)	74.00	Year Start Operation	2005	
Value ($CDN/carat)	110.45	Year End Operation	2012	
Capital Expenditures ($CDN millions, constant)		**Production ($CDN millions, constant)**		
			Total	**Annual**
Total Capital Expenditures	74	Value of Production	442	55
Mine Development	6	Operating Costs	230	29
Mine Construction	46	Capital Consumption Allowances	74	9
Additional New Construction	13	Closure Costs	4	0
Equipment Replacement	9	Resource Income	134	17
Employment (Person Years)	112	Employment (Person Years)	947	118
NWT	53	NWT	671	84
Rest of Canada	59	Rest of Canada	276	35

Financial ($CDN millions, constant)

	Total	**Annual**		**Total**	**Annual**
Resource Income	134	17	Before-Tax Cash Flow	208	26
Direct Mine Taxes	62	8	Income Tax and Government Royalties	62	8
Federal Corporate Taxes	29	4	After-Tax Cash Flow	146	18
Federal Royalties	19	2	Capital Pay-Back (years)	1.7	
Territorial Corporate Taxes	14	2	Net Present Value 15 per cent	16	

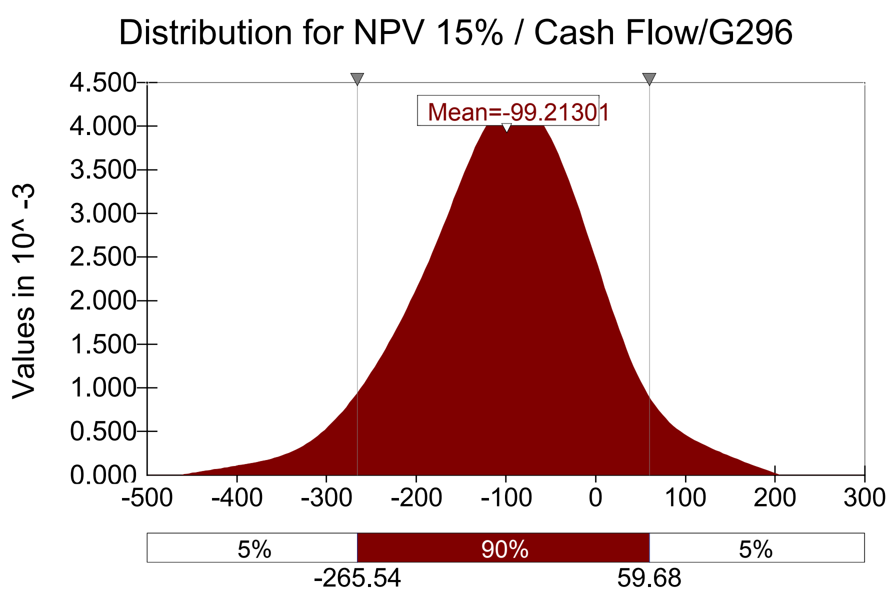
Source: RWED

4.5 Kennady Lake Base Case

Results of the base case Monte Carlo simulation show that the likelihood of achieving a positive net present value of 15 per cent is very unlikely given the current information on the resource and the projected average diamond price. The mean value for the net present value of cash flow is negative $99 million; 84 per cent of all cash flow values generated in the Monte Carlo analysis were negative. The project shows negative returns at the 10 per cent level as well, and as of May 25, 2000, the project partners admit that at current projected costs and revenues, the project does not meet the required return on investment. Therefore, under current conditions, a mine will not be developed. Chart B-4 and Table B-9 summarise the results of the base case model for Kennady Lake.

Chart B-4

Kennady Lake Diamond Mine Cash Flow



Source: RWED

Table B-9

Kennady Lake Diamond Mine Base Case: Summary Variables

Reserve			**Schedule**		
Tonnes (millions)	34.0		Year Start Construction	2003	
Grade (carats/tonne)	1.32		Years of Operation	15	
Value ($US/carat)	56.00		Year Start Operation	2006	
Value ($CDN/carat)	83.58		Year End Operation	2020	
Capital Expenditures ($CDN millions, constant)			**Production ($CDN millions, constant)**		
				Total	**Annual**
Total Capital Expenditures	974		Value of Production	3,742	249
Mine Development	58		Operating Costs	1,751	117
Mine Construction	710		Capital Consumption Allowances	974	65
Additional New Construction	120		Closure Costs	51	3
Equipment Replacement	86		Resource Income	966	64
Employment (Person Years)	2,567		Employment (Person Years)	7,207	480
NWT	1,208		NWT	5,106	340
Rest of Canada	1,359		Rest of Canada	2,101	140
Financial ($CDN millions, constant)					
	Total	**Annual**		**Total**	**Annual**
Resource Income	966	64	Before-Tax Cash Flow	1,940	129
Direct Mine Taxes	448	30	Income Tax and Government Royalties	448	30
Federal Corporate Taxes	211	14	After-Tax Cash Flow	1,492	99
Federal Royalties	135	9	Capital Pay-Back (years)	5.4	
Territorial Corporate Taxes	101	7	Net Present Value 15 per cent	-95	
Income After Taxes	518	35			

Source: RWED

4.6 Snap Lake Diamond Mine Base Case

Results of the Monte Carlo analysis for the base case show a mean positive return at a discount rate of 15 per cent. The probability of a positive return is over 99 per cent. Chart B-5 and Table B-10 present the results for the Snap Lake base case.

Table B-10

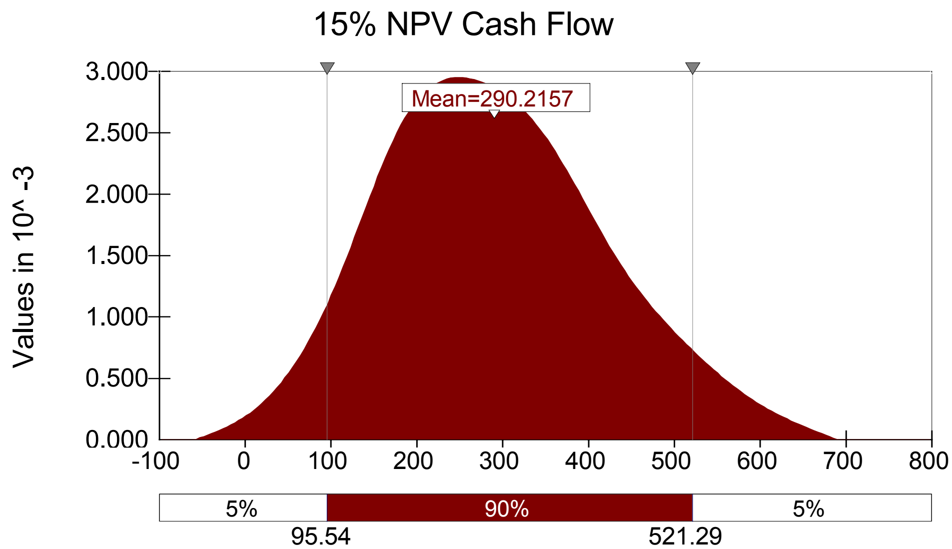
Snap Lake Diamond Mine Base Case: Summary Variables

Reserve			**Schedule**		
Tonnes (millions)	16.3		Year Start Construction	2001	
Grade (carats/tonne)	1.97		Years of Operation	12	
Value ($US/carat)	87.33		Year Start Operation	2004	
Value ($CDN/carat)	130.35		Year End Operation	2015	
Capital Expenditures ($CDN millions, constant)			**Production ($CDN millions, constant)**		
				Total	**Annual**
Total Capital Expenditures	400		Value of Production	4,191	349
Mine Development	28		Operating Costs	1,528	127
Mine Construction	273		Capital Consumption Allowances	400	33
Additional New Construction	57		Closure Costs	20	2
Equipment Replacement	41		Resource Income	2,244	187
Employment (Person Years)	831		Employment (Person Years)	6,289	524
NWT	391		NWT	4,456	371
Rest of Canada	440		Rest of Canada	1,833	153
Financial ($CDN millions, constant)					
	Total	**Annual**		**Total**	**Annual**
Resource Income	2,244	187	Before-Tax Cash Flow	2,591	216
Direct Mine Taxes	1,040	87	Income Tax and Government Royalties	1,016	85
Federal Corporate Taxes	490	41	After-Tax Cash Flow	1,574	131
Federal Royalties	314	26	Capital Pay-Back (years)	1.3	
Territorial Corporate Taxes	236	20	Net Present Value 15 per cent	283	
Income After Taxes	1,204	100			

Source: RWED

Chart B-5

Snap Lake Diamond Mine Cash Flow



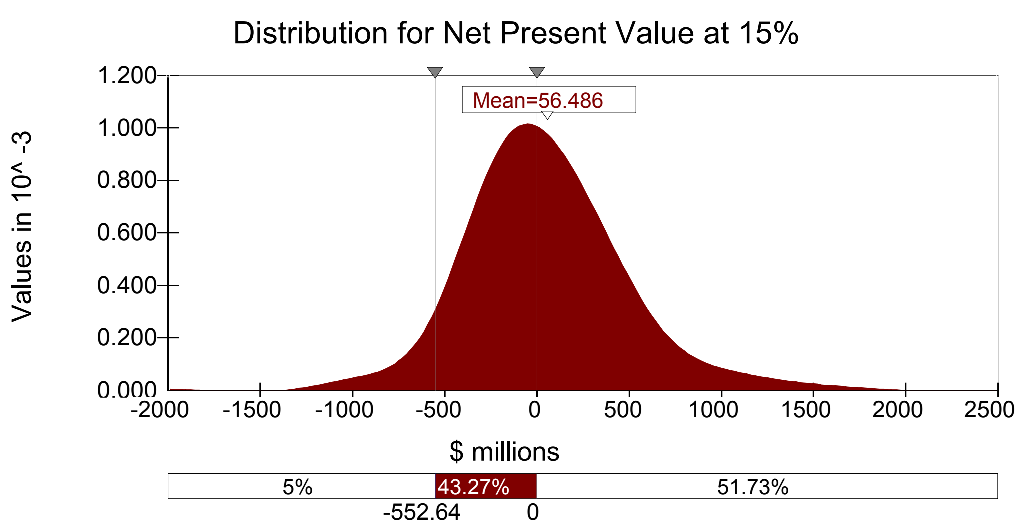
Source: RWED

4.7 New Diamond Mine Base Case

In the base case scenario one new diamond mine is forecast to open begin construction in 2010. Parameter values are averages based on values for the other properties

Chart B-6

New Diamond Mine Cash Flow



Source: RWED

modelled (Ekati, Diavik, Jericho and Snap Lake). The exact distributions and their values are given at the end of this report. Results of the Monte Carlo analysis indicate that a new diamond mine would have just over a 50 per cent probability of achieving the net present value criteria required to go ahead. Chart B-6 and Table 11 present the summary results for the new diamond mine base case.

Table B-11

New Diamond Mine Base Case: Summary Variables

Reserve			**Schedule**		
Tonnes (millions)	28.5		Year Start Construction	2010	
Grade (carats/tonne)	1.92		Years of Operation	15	
Value ($US/carat)	67.80		Year Start Operation	2013	
Value ($CDN/carat)	101.19		Year End Operation	2027	
Capital Expenditures ($CDN millions, constant)			**Production ($CDN millions, constant)**		
				Total	**Annual**
Total Capital Expenditures	1,146		Value of Production	5,547	370
Mine Development	149		Operating Costs	1,960	131
Mine Construction	553		Capital Consumption Allowances	1,146	76
Additional New Construction	276		Closure Costs	51	3
Equipment Replacement	169		Resource Income	2,390	159
Employment (Person Years)	1,073		Employment (Person Years)	7,395	493
NWT	505		Nunavut	5,239	349
Rest of Canada	568		Rest of Canada	2,156	144
Financial ($CDN millions, constant)					
	Total	**Annual**		**Total**	**Annual**
Resource Income	2,390	159	Before-Tax Cash Flow	3,536	236
Direct Mine Taxes	1,107	74	Income Tax and Government Royalties	1,107	74
Federal Corporate Taxes	522	35	After-Tax Cash Flow	2,429	162
Federal Royalties	335	22	Capital Pay-Back (years)	2.3	
Territorial Corporate Taxes	251	17	Net Present Value 15 per cent	116	

Source: RWED

4.8 Kennady Lake under the Reduced Construction and Operating Cost Scenarios

The base case model for Kennady Lake produces a very high probability that the project would not achieve the target net present value, thereby excluding it from the base case scenario. The project is also excluded from other scenarios including southern all-weather road access on the basis of the following results, which also show a very high probability of not meeting the 15 per cent NPV criteria at both the maximum reduction and the minimum reduction operating cost levels. Both levels include the reduced construction cost impact that an all-weather road might have.

4.8.1 Impact of Reduced Operating Costs Resulting From Road: $29.98/tonne

The results are shown in Chart B-7 and Table B-12.

Table B-12

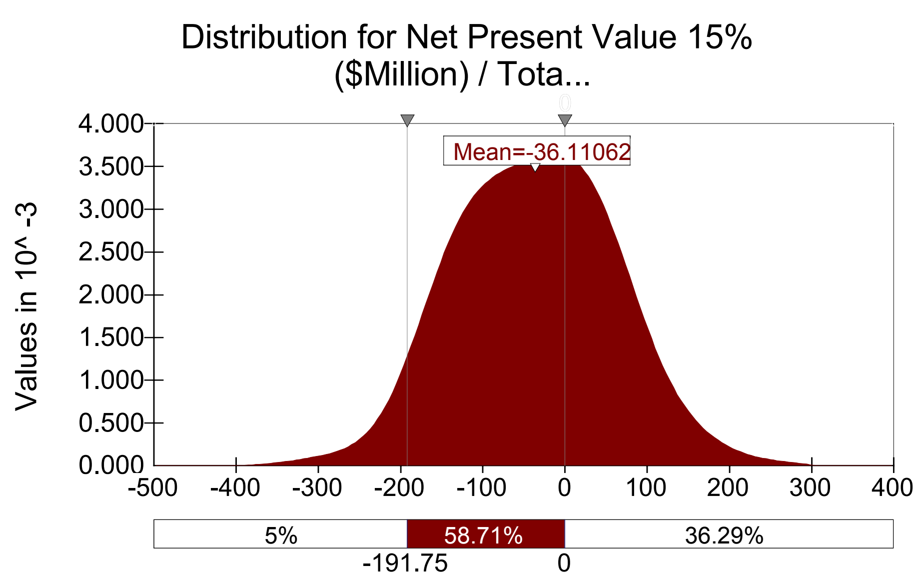
Impact of Reducing Operating Costs to $29.98/tonne

Financial	Total	Annual
Before-Tax Cash Flow	2,172	145
Income Tax and Government Royalties	580	39
After-Tax Cash Flow	1,592	106
Capital Pay-Back (years)	4.4	
Net Present Value 15 per cent ($millions)	-33	

Source: RWED

Chart B-7

Kennady Lake Diamond Mine Cash Flow: Operating Costs of $29.98/tonne



Source: RWED

4.8.2 Impact of Reduced Operating Costs To $32.95/tonne

The results are shown in Chart B-8 and Table B-13.

Table B-13

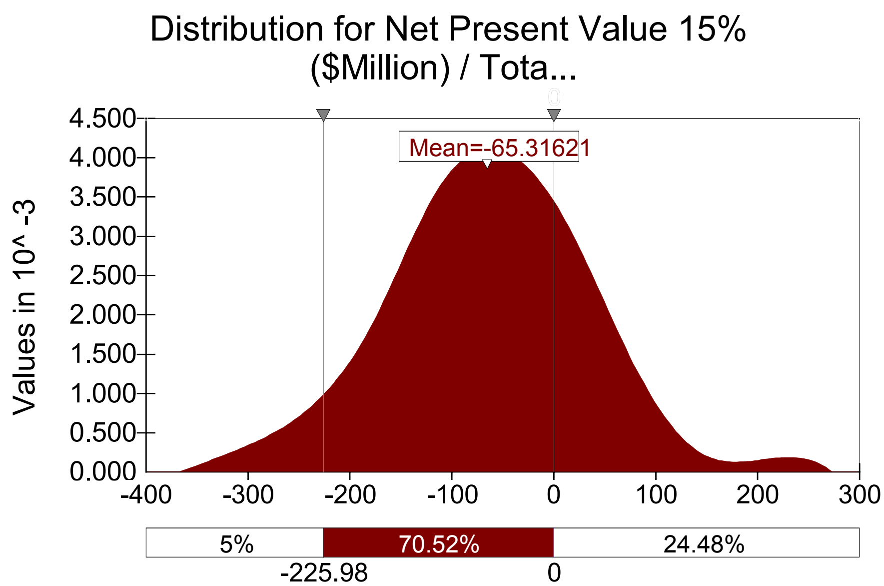
Impact of Reducing Operating Costs to $32.95/tonne

Financial	Total	Annual
Before-Tax Cash Flow	1,987	132
Income Tax and Government Royalties	495	33
After-Tax Cash Flow	1,492	99
Capital Pay-Back (years)	4.8	
Net Present Value 15 per cent ($millions)	-62	

Source: RWED

Chart B-8

Kennady Lake Diamond Mine Cash Flow: Operating Costs of $32.95/tonne



Source: RWED

5 Attachments: Variable Parameters for Diamond Mine Production Models

5.1 Diavik

Table B-14

Diavik Diamond Mine Parameters

Resource			**Other Variables**	
	Tonnes (millions)	Grade (carats/tonne)	Average Diamond Value	US$65/carat
Measured	16.6	4.8	Mine Life	20 years
Indicated	15.5	3.4	Construction Starts	First Quarter 2000
Inferred	6.3	2.4	Cost of Construction	$CDN2.0 billion
Total	37	3.7	Operating Cost	$CDN101/tonne

Source: RWED

Table B-15

Diavik Diamond Mine Risk Variables

Resource (millions/tonnes)		**Grade (carats/tonnes)**	
Probability Distribution	Normal	Probability Distribution	Triangular
Mean	32.1	Minimum	2.4
90 per cent Confidence Interval	±15 per cent	Most Likely	3.7
		Maximum	4.8
Value ($US/carat)		**Cost of Construction ($CDN)**	
Probability Distribution	Normal	Probability Distribution	Normal
Mean	65	Mean	2 billion
Standard Deviation	8.30	Standard Deviation	153 million
Operating Cost ($CDN/tonne)			
Probability Distribution	Normal		
Mean	101		
Standard Deviation	7.73		

Source: RWED

5.2 Ekati

Table B-16

Ekati Diamond Mine Parameters

Resource	Tonnes (millions)	Grade (carats/tonne)	Other Variables	
			Average Diamond Value	US$84/carat
Measured	43.5		Mine Life	20 years
Probable	22.4		Construction Starts	First Quarter 1997
			Cost of Construction	$US700 million
Total	65.9	1.09	Operating Cost	$US22-27 per tonne

Source: RWED

Table B-17

Ekati Diamond Mine Risk Variables

Resource (millions/tonnes)		Value ($US/carat)	
Probability Distribution	Normal	Probability Distribution	Normal
Mean	60.75	Mean	84
Standard Deviation	8 per cent	Standard Deviation	10.71
Lower Minimum	43.5		
Operating Cost ($US/tonne)			
Probability Distribution	Normal		
Mean	24.5		
Standard Deviation	1.5		

Source: RWED

5.3 Snap Lake

Table B-18

Snap Lake Diamond Mine Parameters

Resource	Tonnes (millions)	Grade (carats/tonne)	Other Variables	
			Average Diamond Value	US$118/carat
Indicated	12.05	1.75	Mine Life	12 years
Inferred	9.27	1.97	Construction Starts	First Quarter 2001
			Cost of Construction	$CDN264 million
Total	21.32	1.97[1]	Operating Cost	$CDN93.62/tonne±25 per cent

1 1.97 carats/tonne is the figure publicly stated by Snap Lake as the grade of its global resource.

Source: RWED

Table B-19

Snap Lake Diamond Mine Risk Variables

Resource (millions/tonnes)		**Value ($US/carat)**	
Probability Distribution	Normal	Probability Distribution	Triangular
Mean	16	Minimum[1]	60
Standard Deviation	2	Most Likely	84
Maximum	21	Maximum[1]	118
Minimum	12		
Construction Cost ($CDN millions)		**Operating Cost ($CDN/tonne)**	
Probability Distribution	Normal	Probability Distribution	Normal
Mean	264	Mean	93.62
Standard Deviation	33.67	Standard Deviation	12

1 Figures based on diamond valuations from Diavik and Ekati reserves.

Source: RWED

5.4 Kennady Lake

Table B-20

Kennady Lake Diamond Mine Parameters

Resource			Other Variables	
	Tonnes (millions)	Grade (carats/tonne)	Average Diamond Value	US$43/carat
Indicated	29.6	1.22	Mine Life	10 years (estimated)
Inferred	10		Construction Starts	First Quarter 2003
			Cost of Construction	$US700 million
			Operating Cost	$CDN50/tonne

Source: RWED

Table B-21

Kennady Lake Diamond Mine Risk Variables

Resource (millions/tonnes)		Grade (carats/tonne)	
Probability Distribution	Normal	Probability Distribution	Triangular
Mean	34	Minimum	1.22
Standard Deviation	2.5	Most Likely	1.22
Truncated at	29 and 39	Maximum	1.51
Value ($US/carat)		**Cost of Construction ($US millions)**	
Probability Distribution	Normal	Probability Distribution	Normal
Mean	56	Mean	469
Standard Deviation	7.14	Standard Deviation	63.27
Operating Cost ($US/tonne)			
Probability Distribution	Triangular		
Minimum	30		
Most Likely	33.5		
Maximum	40		

Source: RWED

5.5 Jericho Diamond Project

Table B-22

Jericho Diamond Project Parameters

Resource			**Other Variables**	
	Tonnes (millions)	Grade (carats/tonne)	Average Diamond Value	$US74/carat
Indicated	3.67	1.14	Mine Life	8 years (estimated)
			Construction Starts	First Quarter 2001
			Cost of Construction	$US30.15 million
			Operating Cost	$US42/tonne

Source: RWED

Table B-23

Jericho Diamond Project Risk Variables

Construction Start		**Grade (carats/tonne)**	
Probability Distribution	Discrete	Probability Distribution	Triangular
For 2001	50 per cent probability	Minimum	0.71
For 2002	40 per cent probability	Most Likely	1.14
For 2003	10 per cent probability	Maximum	1.42
Value ($US/carat)		**Cost of Construction ($US millions)**	
Probability Distribution	Normal	Probability Distribution	Normal
Mean	74	Mean	30.15
Standard Deviation	9.44	Standard Deviation	3.85
Operating Cost ($US/tonne)			
Probability Distribution	Normal		
Mean	42		
Standard Deviation	5.36		

Source: RWED

5.6 New Diamond Project

Table B-24

New Diamond Project Parameters

Resource			Other Variables	
	Tonnes (millions)	Grade (carats/tonne)	Average Diamond Value	US$67.8/carat
Indicated	28.5	1.82	Mine Life	15 years
			Construction Starts	First Quarter 2010
			Cost of Construction	$US360 million
			Operating Cost	$US46.07/tonne

Source: RWED

Table B-25

New Diamond Project Risk Variables

Reserve (millions of tonnes)		**Length of Operation (years)**	
Probability Distribution	Lognormal	Probability Distribution	Discrete
Mean	33.5	Range	11 to 20
Standard Deviation	23	Probability	Equal
Truncated at	3 and 65.9		
Correlation Coefficient with Length of Operation	0.98		
Grade (carats/tonne)		**Value ($US/carat)**	
Probability Distribution	Lognormal	Probability Distribution	Normal
Mean	1.82	Mean	67.8
Standard Deviation	1.1	Standard Deviation	11.30
Truncated at	1 and 4		
Cost of Construction ($US millions)		**Operating Cost in $US/tonne**	
Probability Distribution	Lognormal	Probability Distribution	Normal
Mean	447	Mean	46.07
Standard Deviation	352	Standard Deviation	18
Truncated at	20 and 870		

Source: RWED

Appendix C: Forecasting Methodology Technical Note

1 Introduction

As part of this study, the Northwest Territories Department of Resources, Wildlife and Economic Development (RWED) used mine production models to estimate the timing and duration of mine production in the Slave Geological Province. The Conference Board of Canada provided forecasts of some key inputs for the mine production models. These inputs comprised the following:

- The price of lead;
- The price of zinc;
- The price of gold;
- The price of diesel;
- The user cost of capital; and
- Average weekly wage in the construction industry.

Each of these variables was forecast over a 21-year period from 2000 to 2020. In addition, confidence intervals for the forecast were calculated to provide a measure of uncertainty. The confidence interval of twice the standard error of the forecast was provided for the prices of lead, zinc and gold.

2 The Data

The historical data used in the forecast came from a number of sources as shown in Table C-. The price data for lead and zinc are annual averages from 1957 to 1999 and were supplied by Natural Resources Canada. The price of gold, represented by the average afternoon fix on the London Bullion Market, was obtained from the Kitco Minerals and Metals website (www.kitco.com). The price of diesel was supplied by Natural Resources Canada and was compiled from the Bloomberg Oil Buyer's Guide.

Table C-1

Data Sources

Data Item	Units	Note	Source
Price of Lead	¢ US / lb.	Refined Pig Lead	London Metal Exchange
Price of Zinc	¢ US / lb.	Special High Grade Zinc	London Metal Exchange
Price of Gold	¢ US / troy ounce	London average PM Fix	London Bullion Market
Price of Diesel	$ / litre	Edmonton rack price	Bloomberg Oil Buyer's Guide
User Cost of Capital	Index (1992 = 100)	Non-energy construction	The Conference Board of Canada
Construction Wage (AB)	$ / week	Includes private benefits	Statistics Canada

The Conference Board of Canada.

The index for the user cost of capital was created using data from a number of sources including the Bank of Canada, Revenue Canada and Statistics Canada. The average weekly construction wage rate in the construction industry was obtained from Statistics Canada's CANSIM database.

The historical data required very little in the way of modification for use in the forecasting exercise. For example, the price of lead and zinc were expressed in US cents per pound and were converted to US dollars per tonne to meet the specific requirements of RWED's mine production model.[1] In addition, the price of diesel was a weekly series and was converted to a quarterly average.

3 Forecasting Methodology

A number of different forecasting methods were used to derive forecasts for the variables of interest for the 21-year period between 2000 and 2020. For the price of lead, zinc and gold, a simple mean-reversion model was used (see Exhibit C-1). The US Producer Price Index for finished goods (PPI) was used to deflate the price of lead, zinc and gold.

The price of diesel was forecast using the Conference Board's crude oil price forecast as the principal explanatory variable. The cost of capital was taken directly from the Conference Board's 1999 long-term national forecast.

Standard econometric tests were performed on all of the estimated equations, looking at the individual explanatory variables, the overall fit, the residuals, and the forecasting properties. In addition, confidence intervals for the price of lead, zinc and gold were obtained using the standard error of the forecast.

Exhibit C-1

The Mean-Reverting Model

An article published in the Bank of Canada Review noted that the prices of many non-energy commodities tend to revert to their historical averages.[2] The methodology can be summarised by the following equation:

$$P_t = P_{t-1} + \beta_1 \times (P_{t-1} - P_{avg}) + \varepsilon_t$$

where: P_t is the relative price of the commodity at time t;
P_{t-1} is the relative price of the commodity at time $t-1$;
P_{avg} is the average relative price of the commodity;
β_1 is a coefficient indicating the speed with which the price reverts to its long-run average; and;
ε_t is an error term.

Note: The relative price is calculated by dividing the nominal price series by a price deflator.

The Conference Board of Canada.

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1 To convert from pounds to metric tonnes, a conversion factor of 2.20462 was used.

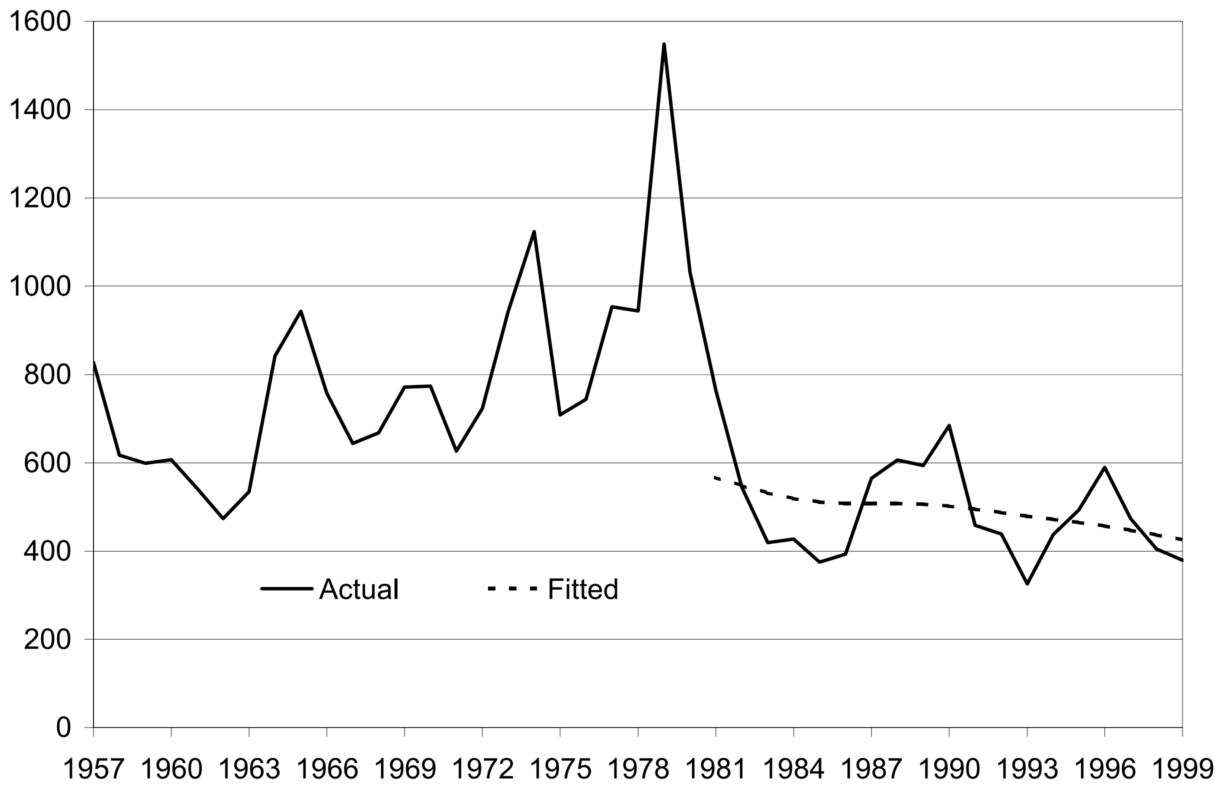
3.1 Price of Lead

The forecast for the relative price of lead was completed using the mean reversion methodology but with a moving (downward trending) equilibrium price. Although an initial analysis over the 1957 to 1999 sample period suggested that the real price of lead was mean reverting, we modified this methodology and focused on more recent movements in lead prices. Since the early 1980s, the use of lead has fallen due to a number of factors including environmental and health concerns. In addition, improvements in the longevity of many products that use lead (e.g., automotive batteries) have reduced demand for lead.

As a result, the relative price of lead has been declining over recent history. Using a shorter sample period—namely 1981 to 1999—the slope of the downward trend for the real price of lead was estimated using a Hodrick-Prescott filter (see Chart C-1). Over the

Chart C-1

Relative Price of Lead (Actual & Fitted)
(constant 1992 $US per tonne)



Sources: The Conference Board of Canada; London Metal Exchange.

2 Don Coletti, "The Long-run Behaviour of key Canadian Non-energy Commodity Prices: 1900 to 1991", *The Bank of Canada Review* (Ottawa: The Bank of Canada), Winter 1992/93, pp. 47-56.

forecasting horizon, a continued downward trend in the real price of lead is assumed but at a slower pace relative to the past two decades. This assumption is based on what is believed to be the end of the adjustment period surrounding the use of lead.

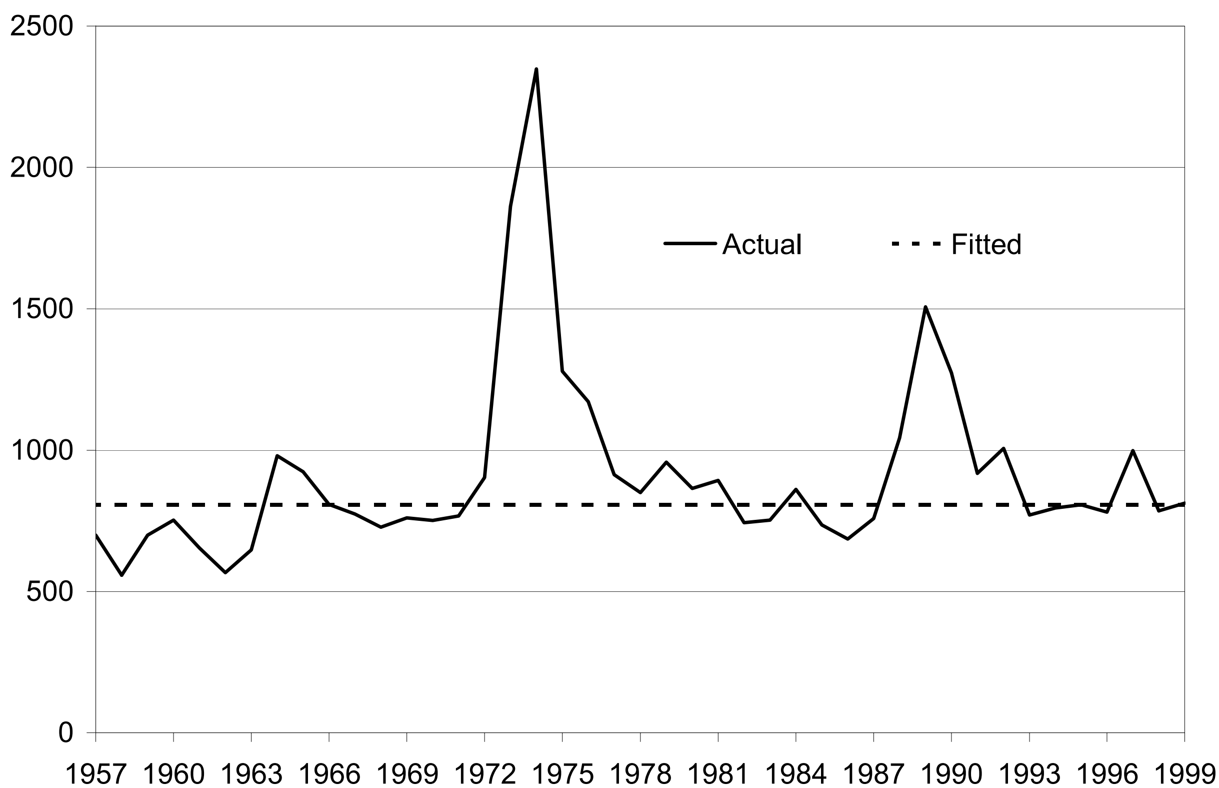
3.2 Price of Zinc

A mean reverting methodology was also used for the relative price of zinc. The average relative price was computed over the 1957 to 1999 sample period. Since peaks in commodity prices tend to be relatively high and of short duration compared with troughs, the median was used instead of the mean (see Chart C-2).

Using the mean-reverting equation found in Exhibit C-1, the speed at which the relative price of zinc revert to its median was calculated (the speed of adjustment is given by the coefficient β_1). From the starting point (in this case the 1999 value of the relative price for zinc), the relative price eventually converges to its median and then grows at the pace of the US Producer Price Index.

Chart C-2

Relative Price of Zinc (Actual & Fitted)
(constant 1992 $US per tonne)



Source: The Conference Board of Canada; London Metal Exchange.

3.3 Price of Gold

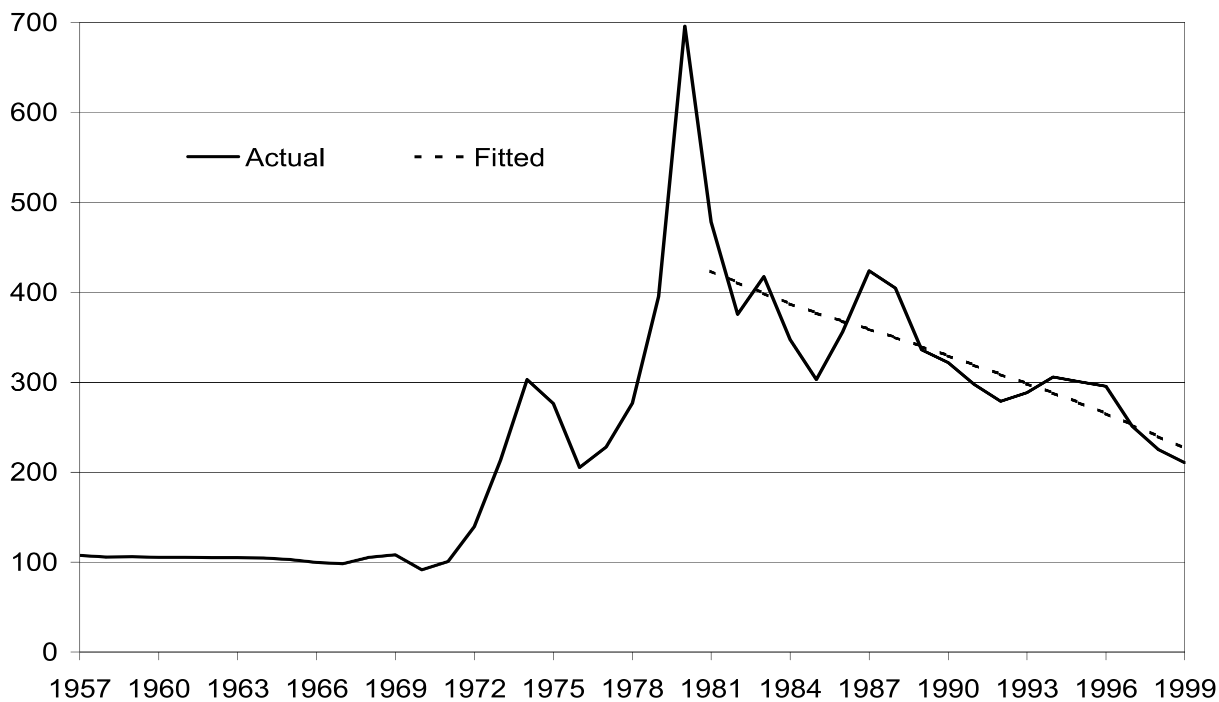
The price of gold was originally estimated over the 1975 to 1999 sample period. This sample period was used to avoid the price regulation during the Bretton-Woods era up to November 1974. The sample period was further shortened to exclude the oil price shock of the late 1970s and the accompanying period of high inflation. Thus, the price of gold was estimated between 1981 and 1999.

From 1981 to 1999, the relative price for gold declined substantially. This is due to a number of factors including heavy selling by many Central Banks, robust inventories and an easing in world inflation. As was done with the real price for lead, the downward trend in the relative price of gold was estimated using a Hodrick-Prescott filter (see Chart C-3).

The downward trend in the relative price of gold—observed over the past 18 years—is assumed to end in 1999. Indeed, the central banks of many nations have agreed to restrict sales from their reserves. At the same time, world-wide inflation is forecast to pick up, increasing the desirability of holding gold assets. Consequently, from 2000 onwards the relative price remains flat, implying that over the medium and long term, the price of gold grows at the same pace as the US Producer Price Index.

Chart C-3

Relative Price of Gold (Actual & Fitted)
(constant 1992 $US per troy ounce)



Source: The Conference Board of Canada; London Bullion Exchange.

3.4 Price of Diesel

Data on the wholesale price of diesel were obtained from the Bloomberg *Oil Buyer's Guide Petroleum Price Supplement*. The weekly average rack price for high-sulphur diesel in Edmonton was available back to June of 1990. The weekly data were then converted to quarterly by taking the simple mean.

The wholesale price of diesel was forecast using an equation estimated with ordinary least squares. After testing several specifications, the price of crude oil (West Texas Intermediate) and the price of diesel lagged one quarter were chosen because they were found to explain 86 per cent of the price movement over the estimation period.

The forecast was estimated over history on a quarterly basis. Using an exogenous forecast of crude oil prices provided by the Board's 1999 national long-term outlook, the price of wholesale diesel was forecast from 2000 to 2020. The quarterly forecast was then converted to annual averages.

3.5 User Cost of Capital

The user cost of capital measures the real acquisition and utilisation costs of new capital goods. The formulation is basically a weighted average of debt and equity financing. In calculating the user cost of capital, the following factors are used:

- the economic life of the capital asset;
- the real cost of funds;
- corporate income tax rates;
- the rate of depreciation for tax purposes; and
- investment tax credit rates.

The Conference Board's Medium Term Forecasting Model (MTFM) calculates the user cost of capital for several categories of investment spending at the national level. For this project, we used the user cost of capital for non-energy construction. The historical data and forecast were taken directly from the Board's 1999 long-term forecast.

3.6 Construction Wage (Alberta)

The average weekly construction wage data for Alberta are calculated using labour force data from Statistics Canada's CANSIM electronic database. Historical data on the average weekly wage includes private benefits. To produce a forecast for the average weekly wage in the Alberta's construction industry, the Conference Board's long-term national and provincial forecasts from 1999 were used.

First, the relationship between the average weekly wage in the construction industry and the industrial composite was calculated at the national level. This statistical relationship was then applied to the forecast of average weekly wages (industrial composite) for Alberta.

4 Results

The results of the forecasting exercise are contained in the sections that follow. In general, a twenty-one year forecast from 2000 to 2020 was produced for each of the variables. For the price of lead, zinc and gold, a confidence band of two standard errors was also produced.

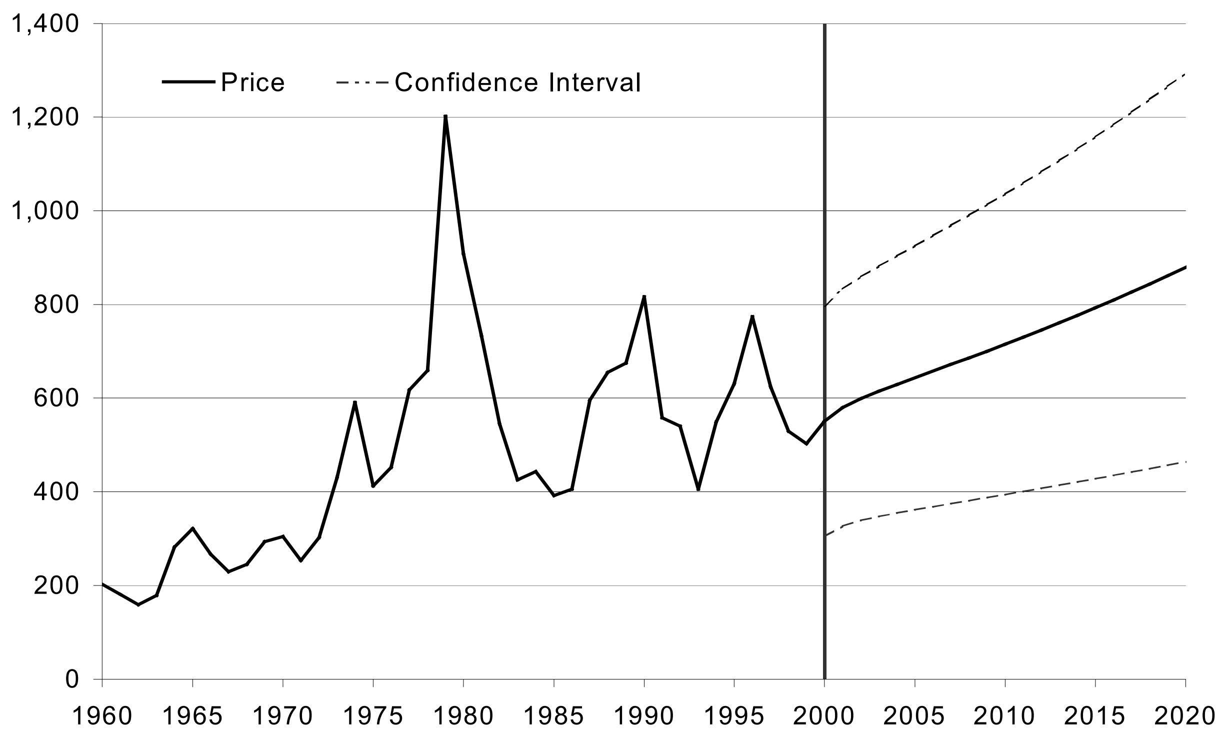
4.1 Price of Lead

The forecast for the price of lead and the confidence bands are provided in Chart C-4. Although the relative price of lead is generally forecast to decline, the “nominal” price increases over the forecast period. In 1999, the average price for refined pig lead was US$503 per tonne. By 2020, the price of lead is projected to increase to US$879 per tonne. Using 2 times the standard error of the forecast as the confidence bands, the price of lead in 2020 ranges from US$464 to US$1,294 per tonne.

This nominal forecast implies that the relative price of lead is forecast to increase slightly over the medium term to 2002. This represents a recovery in the real commodity prices after the Asian financial crisis. Thereafter, the relative price declines slowly to the end of the forecast period.

Chart C-4

Price of Lead
($US per tonne)



Source: The Conference Board of Canada; London Metal Exchange.

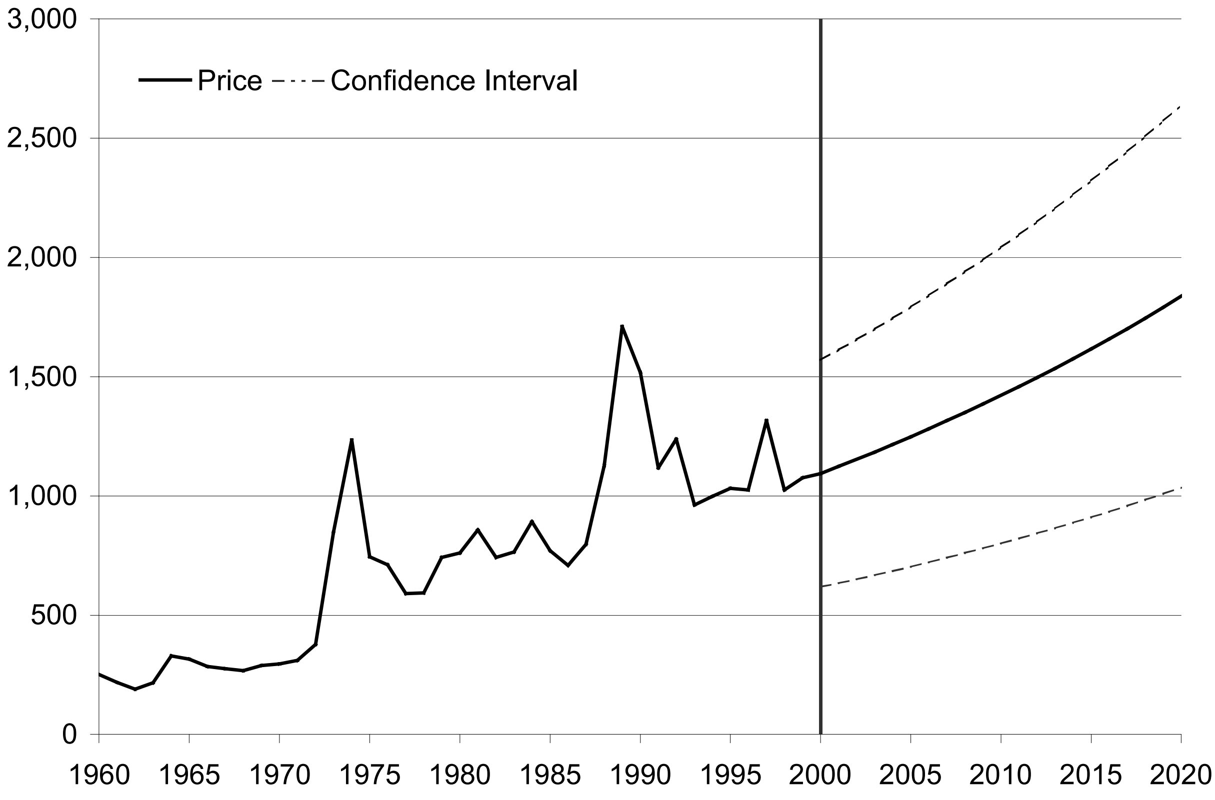
4.2 Price of Zinc

Over the forecast period, the nominal price of zinc increases at the same pace the Conference Board's forecast of the US Producer Price Index (see Chart C-5). Starting at an average of US$1,076 per tonne in 1999, the price of zinc rises steadily to reach US$1,837 by 2020. The confidence bands for the price of zinc (±2 standard errors) indicate that the price in 2020 ranges from US$1,035 to US$2,640 per tonne.

The nominal price forecast reflects the gradual return of the relative price of zinc to its long-run average. The pace with which the relative price of zinc returns to the long-run median value is dictated by the coefficient calculated by the mean-reversion model (see Exhibit C-1). After reaching the median relative price of US$806 around 2012, the forecast remains flat thereafter. The relative price of zinc between 1957 and 1999 is shown in Chart C-2 along with the median relative price of zinc.

Chart C-5

Price of Zinc
($US per tonne)



Source: The Conference Board of Canada; London Metal Exchange.

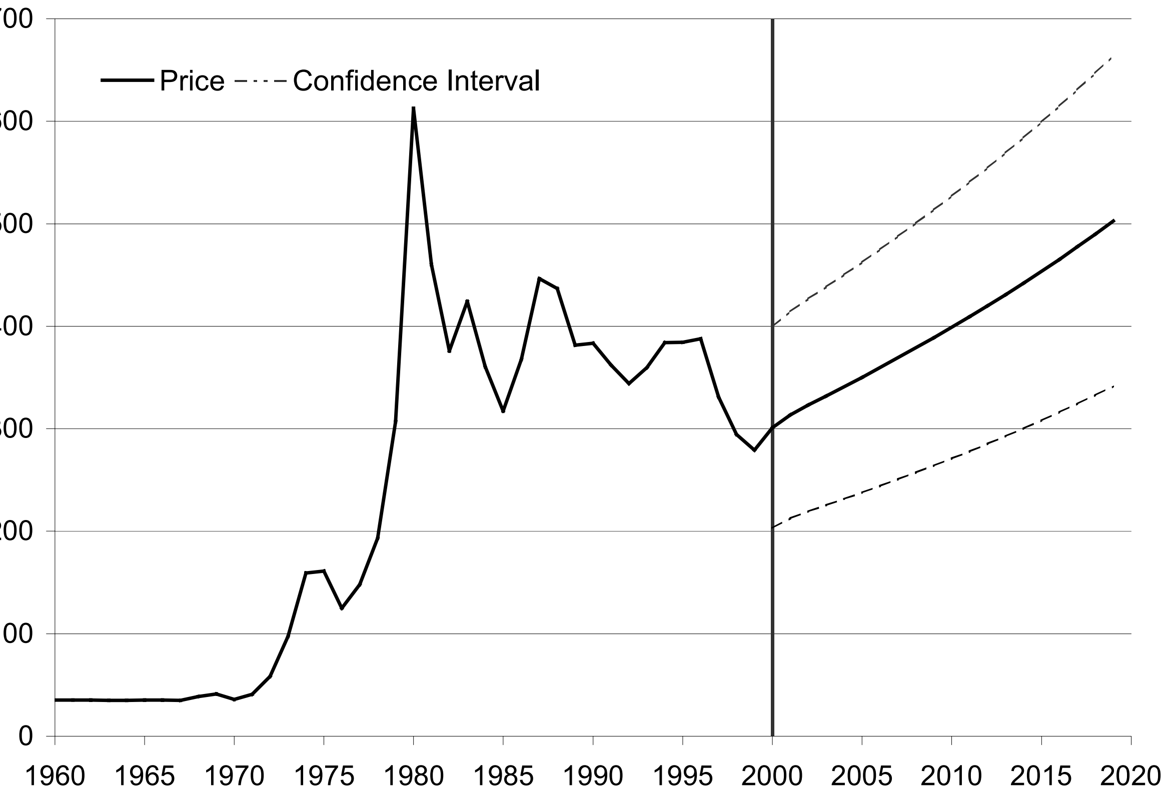
4.3 Price of Gold

The forecast for the nominal price of gold and the confidence bands are provided in Chart C-6. Although the relative price of gold remains flat over much of the forecast period, the “nominal” price increases. In 1999, the average price for gold was US$279 per troy ounce. By 2020, the price of gold is projected to increase to US$516 per ounce. Using 2 times the standard error of the forecast as the confidence bands, the price of gold in 2020 ranges from US$350 to US$681 per ounce.

The relative price of gold is forecast to increase to reach its long-run average of US$226 by 2004. Thereafter, the relative price of gold remains flat over the forecast period, implying an increase in the price equal to the growth rate in the US Producer Price Index. The relative price of gold (actual and fitted) between 1974 and 1999 is found in Chart C-3.

Chart C-6

Price of Gold
($US per troy ounce)



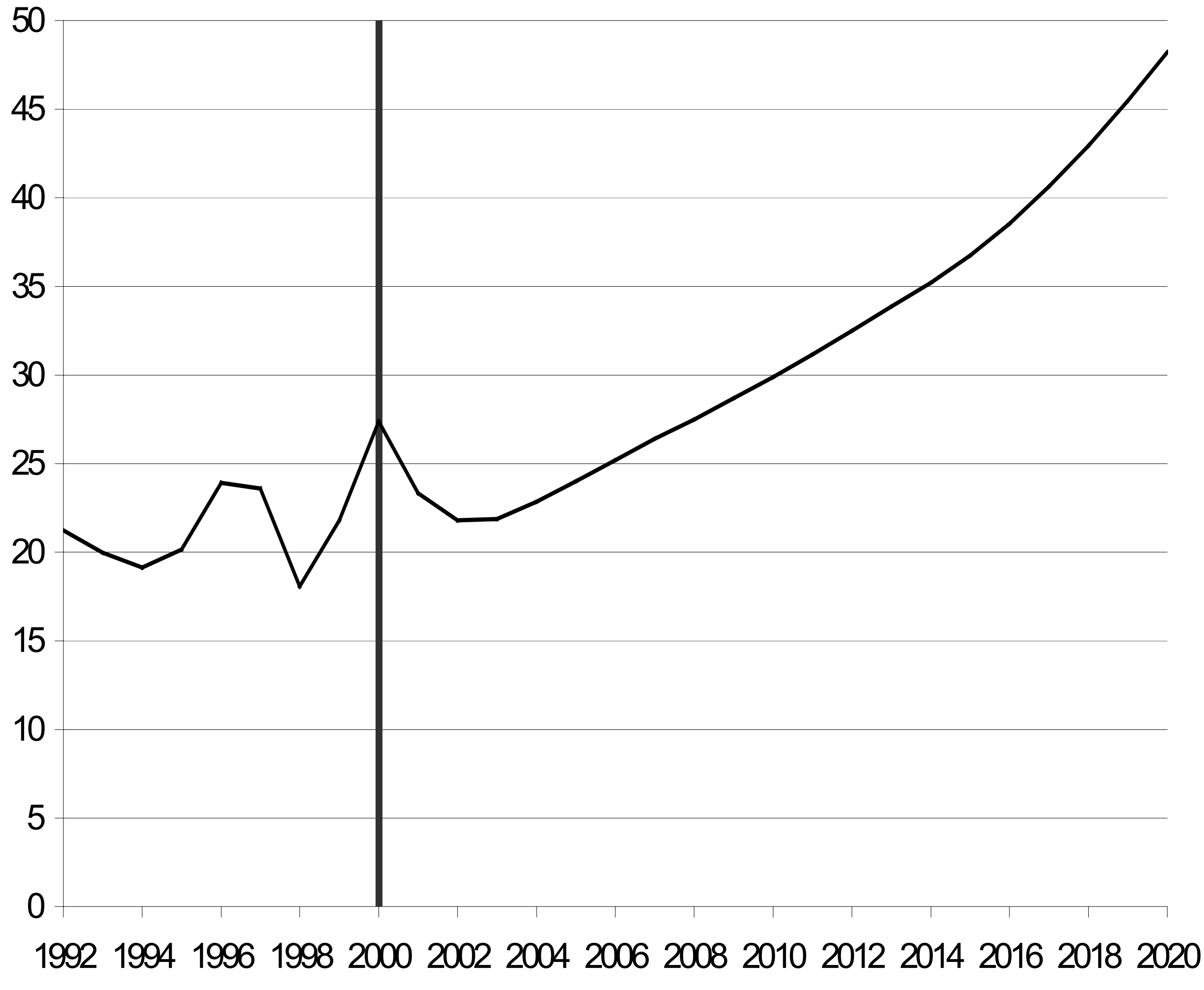
Source: The Conference Board of Canada; Bullion Metal Exchange.

4.4 Price of Wholesale Diesel

Diesel prices are forecast to increase by a compound annual growth rate of 3.8 per cent between 2000 and 2020. This growth rate is greater than the increase in the overall inflation and largely reflects the increasing scarcity of oil deposits near the end of the forecast period. Starting from an average of $21.81 per litre in 1999, diesel prices rise steadily to reach $48.21 in 2020 (see Chart C-7).

Chart C-7

Price of Wholesale Diesel in Edmonton
(cents per litre)



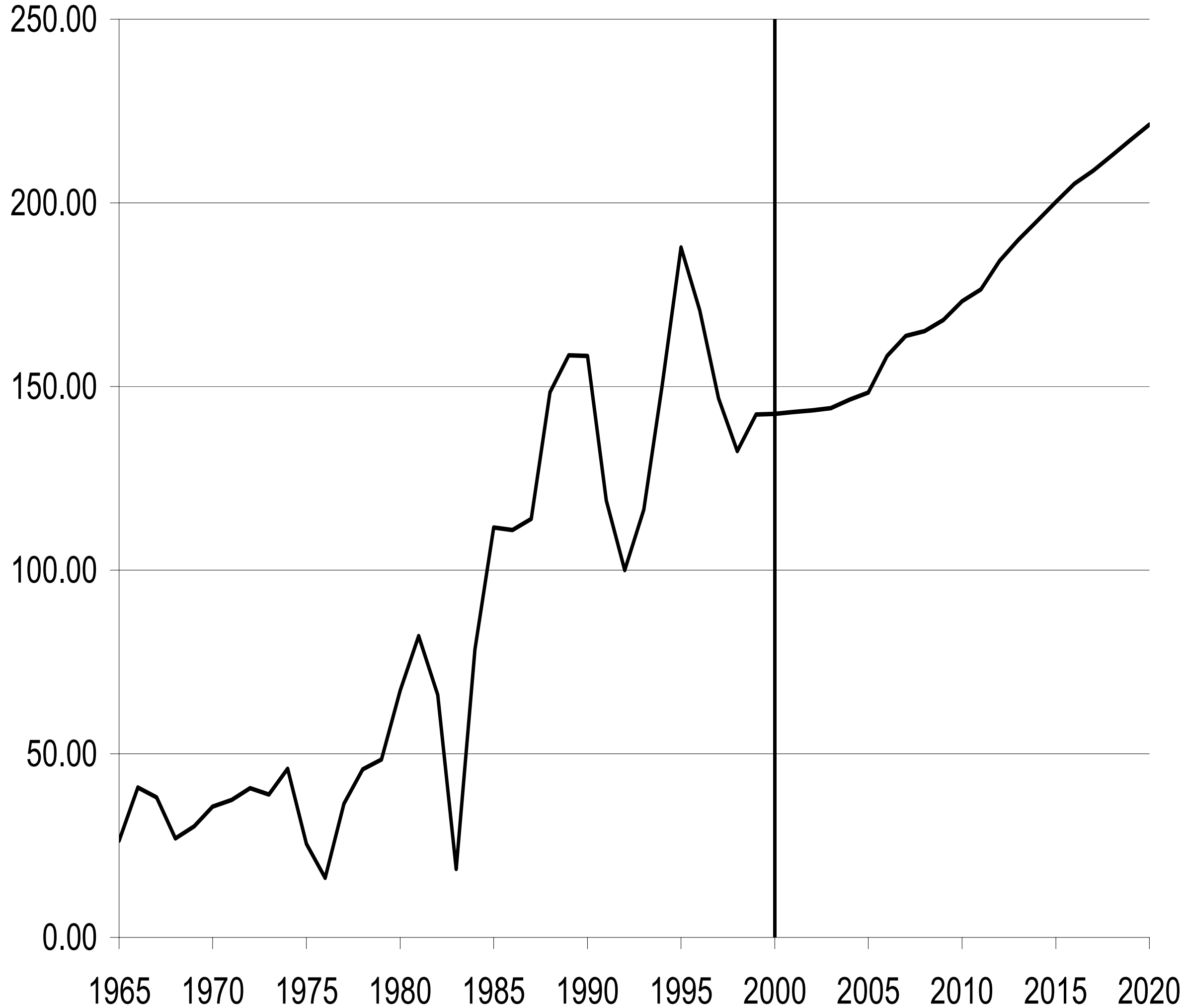
Source: The Conference Board of Canada; Bloomberg Oil Buyer's Guide.

4.5 User Cost of Capital

The forecast for the real user cost of capital is for slow growth in the index between 2000 and 2004 and slightly higher growth rate thereafter. Between 2000 and 2020 the index averages just over 2 per cent growth annually.

Chart C-8

Real User Cost of Capital, Non-Energy Construction
(Index, 1992 = 100)



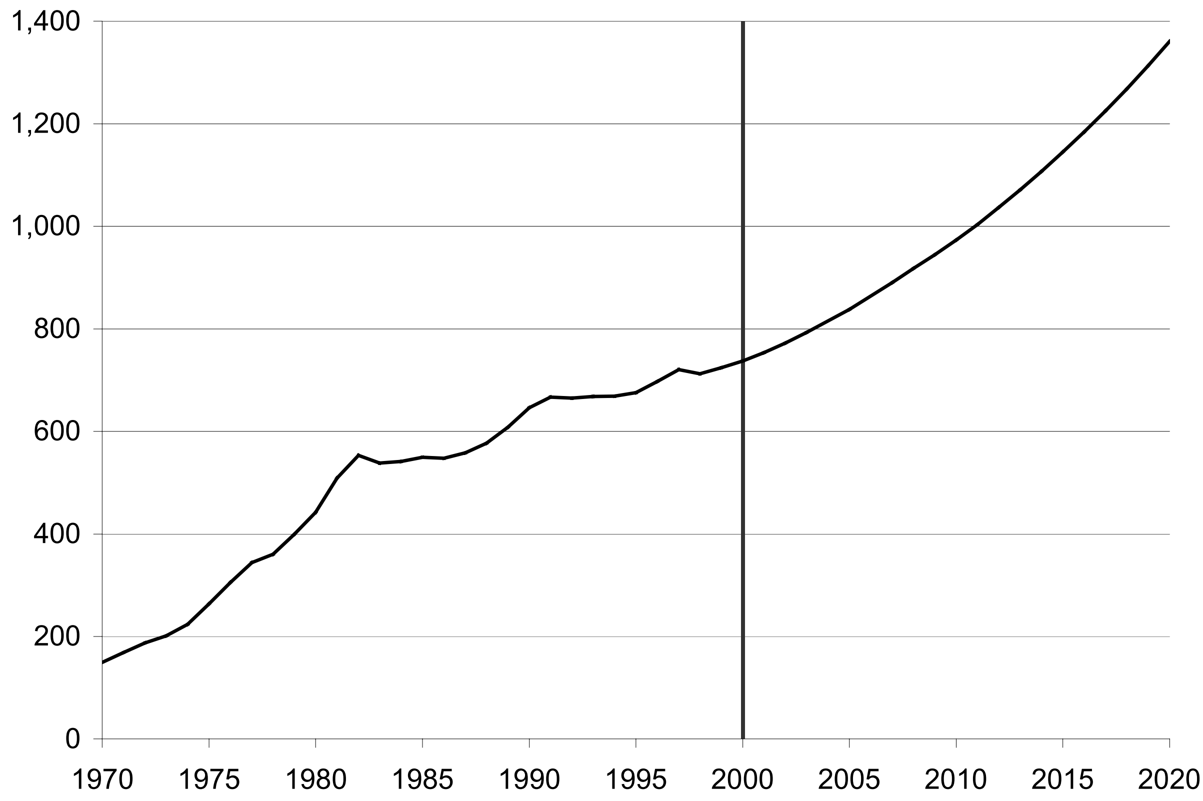
Source: The Conference Board of Canada.

4.6 Construction Wage in Alberta

Wage costs in Alberta in the construction industry are forecast to rise by an average of 3 per cent between 2000 and 2020. Thus, construction wages are projected to grow slightly faster than the growth rate in inflation. This wedge above the inflation rate represents the increase in worker productivity over the forecast period. The average wage was $724 per week in 1999 and will rise to $1,361 by 2020 (see Chart C-9).

Chart C-9

Construction Wage in Alberta
($ per week)



Source: The Conference Board of Canada; Statistics Canada.