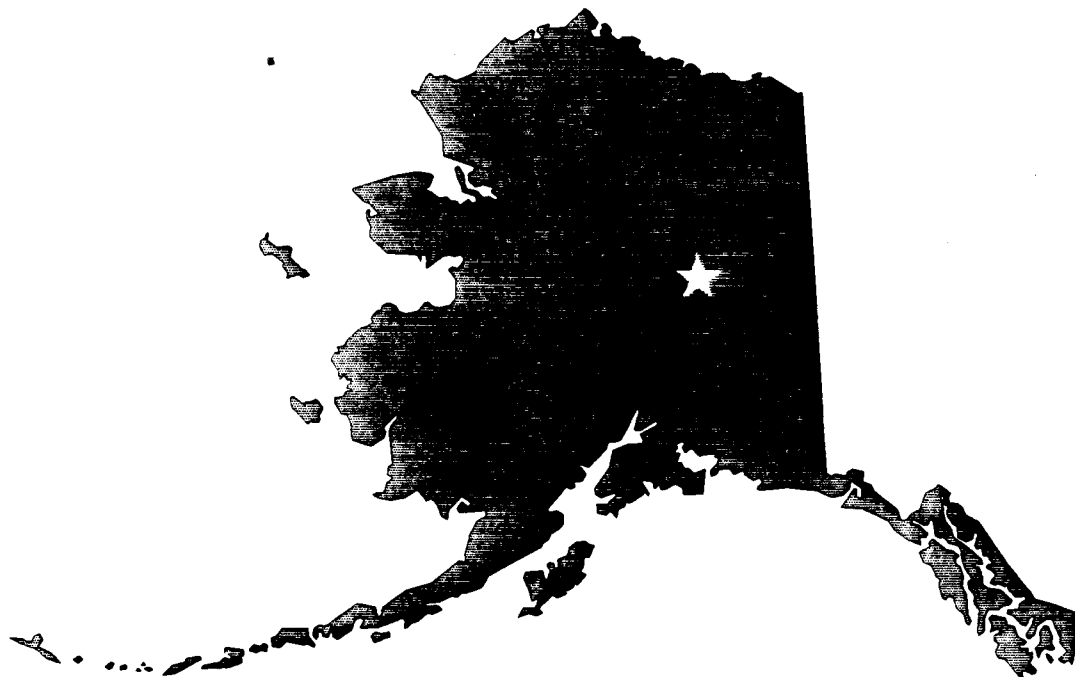


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THE POTENTIAL SUPPLY OF MINERALS
from
THE WHITE MOUNTAINS NATIONAL RECREATION AREA
and
THE STEESE NATIONAL CONSERVATION AREA
in
ALASKA



BUREAU OF MINES
U. S. DEPARTMENT OF THE INTERIOR



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Division of Policy Analysis
Bureau of Mines
Washington DC

April 1989



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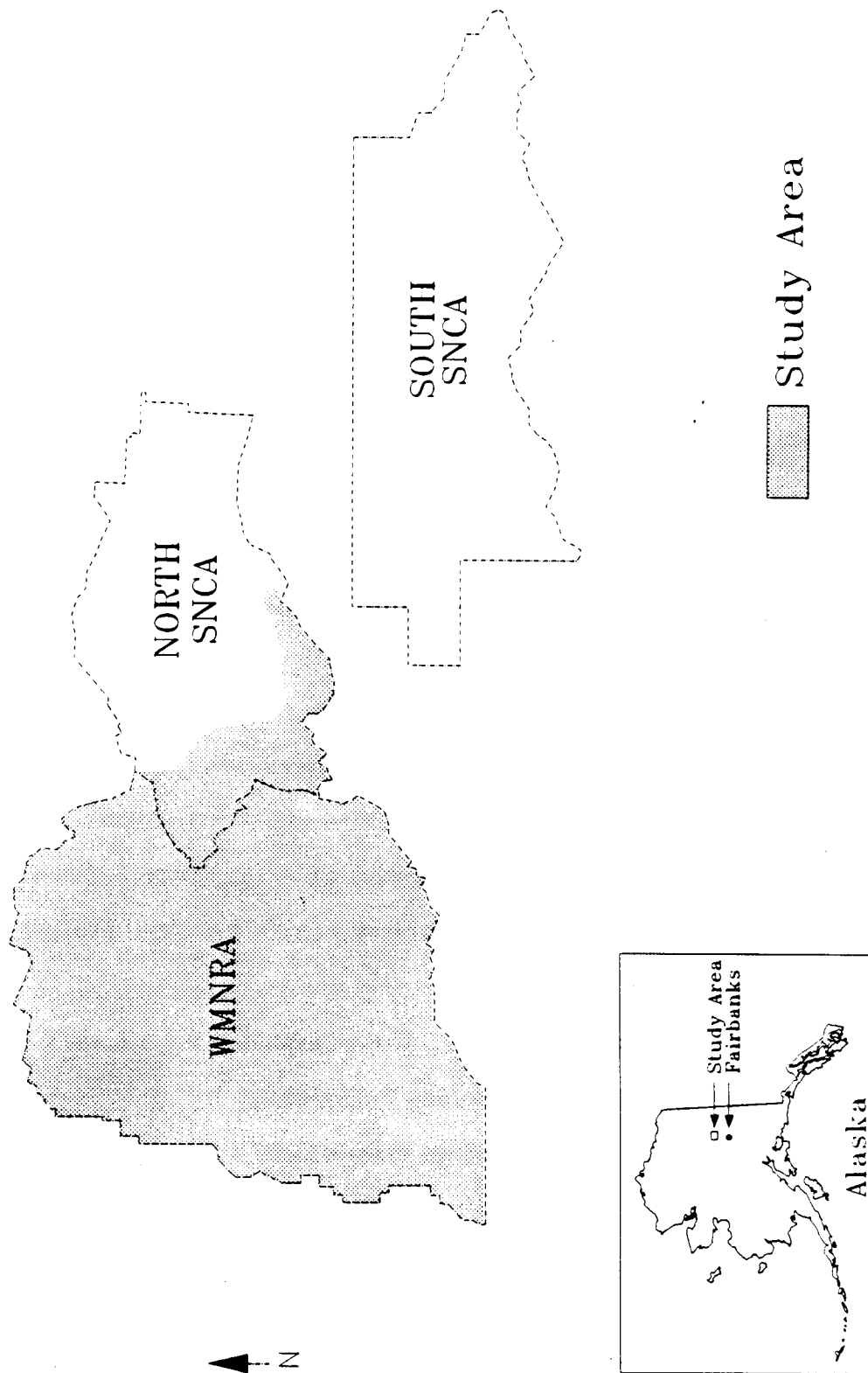
EXECUTIVE SUMMARY

This report has been prepared in response to a request by the Bureau of Land Management (BLM) Fairbanks Alaska District Office that the Bureau of Mines quantitatively assess the potential supply of minerals from undiscovered deposits in the White Mountains National Recreation Area (WMNRA) and the western part of the North Steese National Conservation Area (SNCA) in Alaska. The assessment will be used to assist in future land-use decision-making. Resource Management Plans (RMPs) for the WMNRA and the SNCA were approved by the BLM in 1986. These plans imposed significant restrictions on new mineral development in the two areas. The level of public concern regarding these actions, especially on the part of the mining industry, has spurred BLM to seek additional information about the potential supply of minerals from the two areas with assistance from the Bureau of Mines.

The assessment focuses on an area within the WMNRA and the SNCA which has been administratively closed to mineral entry. The study area encompassed approximately 1.24 million acres and included all of the WMNRA and the western portion of the North SNCA (fig. ES-1). Three quantitative estimates of the potential supply of minerals from the study area were developed:

- 1) For all lands in the study area, assuming that they are open to mineral entry--the baseline analysis;
- 2) For those lands which have been closed to mineral entry; and
- 3) For eleven prospective mineral activity areas, assuming that all are open to mineral entry.

Figure ES-1. The WMNRA/SNCA Study Area



For purposes of this study, the potential supply of minerals is defined as the quantity and value of metal(s) that could be produced from undiscovered deposits which may exist in the study area. The study specifies varying economic conditions, and assumes that the deposits would be discovered if access were permitted, and that current or nearly feasible technologies would be used.

Mineral Endowment of the Study Area

Based on current knowledge of the geology of the study area, eight types of undiscovered mineral deposits were predicted to exist in the study area: tin greisen; tungsten skarn; gold vein; polymetallic vein; sediment-hosted lead-zinc; rare earth; alkalic-associated gold; and placer gold deposits (figs. ES-2a and ES-2b). Deposits of these types typically contain varying amounts of tin, silver, tantalum, tungsten, gold, lead, zinc, uranium, thorium and rare earth oxides (REO).

Analytical Approach

The procedures used to evaluate the mineral supply potential of the WMNRA/SNCA study area consist of four major components: (1) a quantitative mineral resource appraisal; 2) an engineering cost analysis; 3) the specification of a set of economic and policy analysis assumptions and metal price scenarios; and 4) a Potential Supply Analysis Computer Model (PSACM) which integrates these components. This analytical system develops estimates of the economically recoverable resources which may be present in the study area. Because there is uncertainty in this regard, the estimates are expressed in the form of probability distributions. Finally, estimates are made of the potential impacts of developing the

different types of deposits on the employment, income and output of the Fairbanks regional economy.

The evaluation based on these procedures was a joint effort by the Alaska Division of Geological and Geophysical Surveys (ADGGS), the U.S. Bureau of Mines (BOM), and the U.S. Geological Survey (USGS).

1: The Baseline Analysis

At current metal prices (1987 annual averages), the estimated average net present value (the amount by which discounted revenues exceed discounted costs), or NPV, of the prospective undiscovered deposits within the study area is \$42.1 million. There is a 90 percent chance that the total NPV is between \$0 and \$120 million. Only three of the eight prospective types of deposits within the study area are likely to be economically recoverable. They are: 1) alkalic-associated gold deposits, 2) gold veins, and 3) gold placers. Figure ES-3a shows the location of lands within the study area which could contain economically recoverable deposits other than gold placers at current prices. Economically recoverable gold placer deposits could be located in streambeds throughout the area (fig. ES-2b), but are most likely to occur in the southern part of the WMRA in Beaver Creek, Nome Creek and their tributaries (the higher potential streams shown in fig ES-2b). At current prices, gold and silver are the only commodities estimated to be economically recoverable from the study area.

At twice current prices, the potential supply of minerals from the study area could be significantly larger than that estimated at current prices. Estimated average NPV increases approximately four and a half times, from \$42.1 million to \$193.3 million. There is a 90 percent chance

Figure ES-2a. Location of Lands Favorable for Various Types of Non-Placer Mineral Deposits

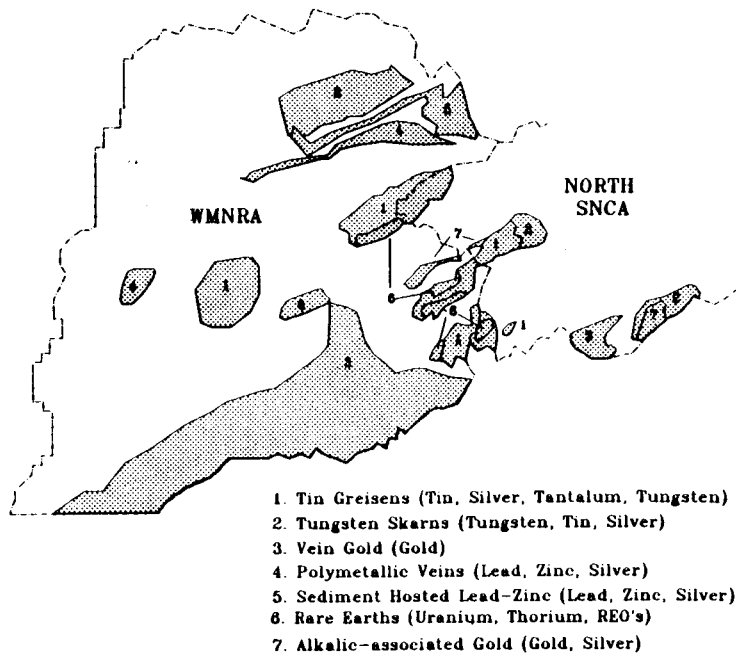


Figure ES-2b. Location of Streams Tested for Gold Placer Potential

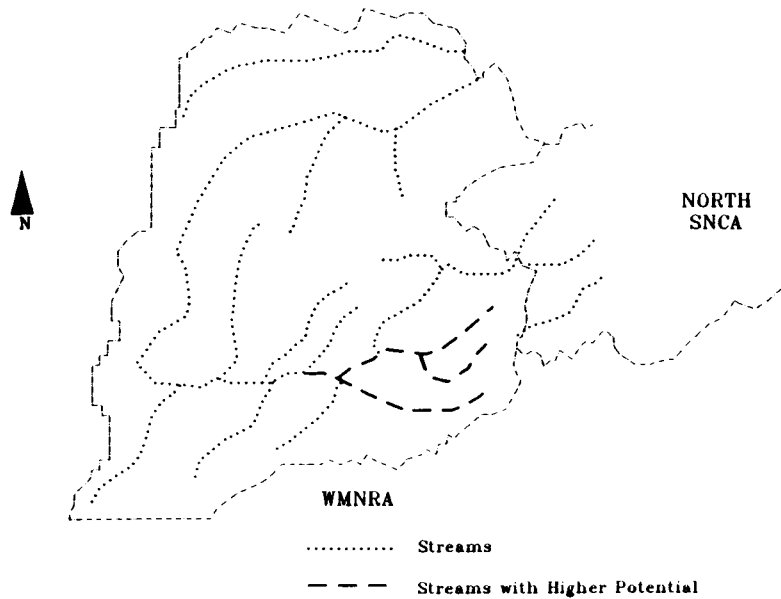


Figure ES-3a. Location of Lands which Could Contain Economically Recoverable Resources at Current Prices

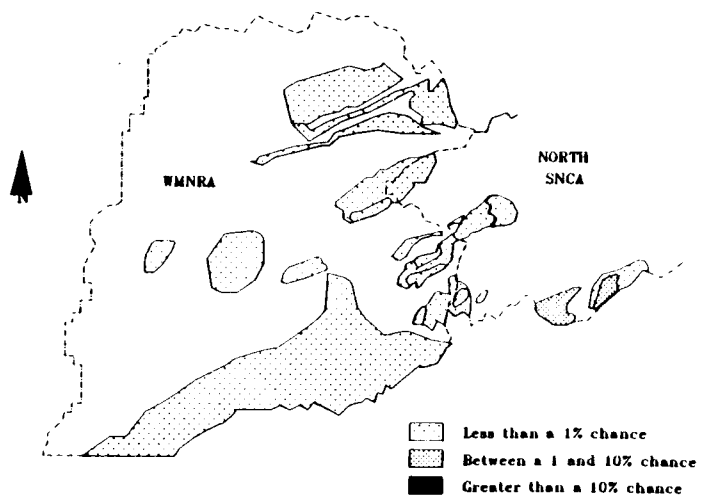
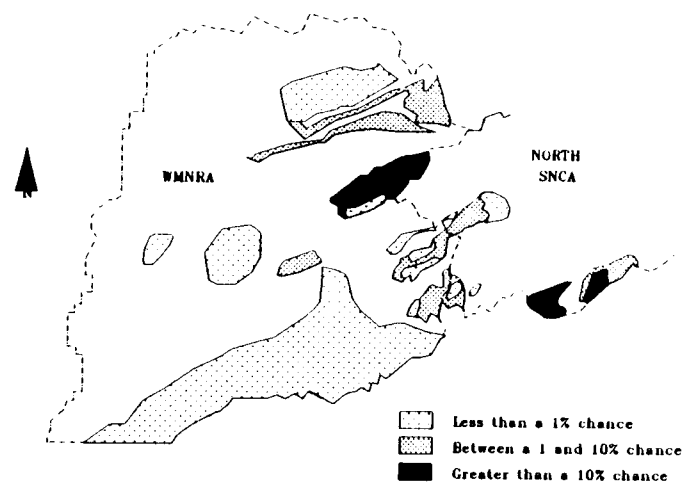


Figure ES-3b. Location of Lands which Could Contain Economically Recoverable Resources at Two Times Current Prices



that the total NPV of prospective undiscovered deposits within the area is between \$0.2 million and \$780 million. At this higher price level economically recoverable resources could be present in all eight types of deposits.

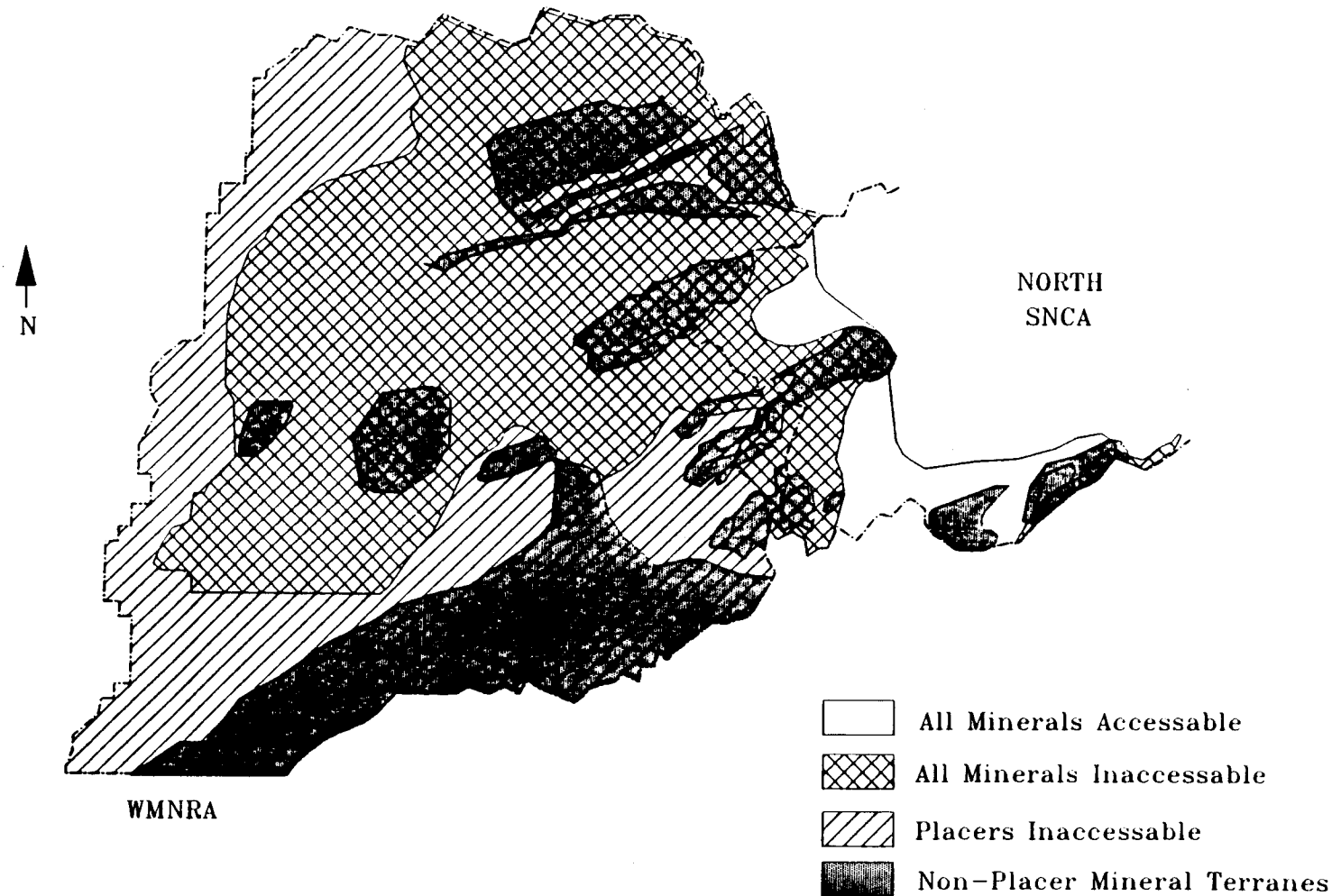
Figure ES-3b identifies the location of the lands within the study area which could contain economically recoverable resources at twice current prices. Again, gold placer deposits which contain economically recoverable resources could exist in streambeds throughout the area, but are concentrated in southern WMNRA. At this price level the potential supply of minerals from the study area includes quantities of lead, rare earth oxides (REO), tantalum, tin, tungsten, uranium and zinc, in addition to gold and silver.

2: The Value of Minerals on Lands Closed to Mineral Entry

Within the study area, approximately 44 percent of the lands identified as geologically favorable for non-placer mineral deposits were closed to mineral entry by the WMNRA and the SNCA RMPs (fig. ES-4). This includes all of the lands favorable for undiscovered polymetallic vein and sediment-hosted lead-zinc deposits; most of the lands favorable for undiscovered tin greisen deposits; most of the lands favorable for tungsten skarn deposits and a portion of the lands favorable for alkalic-associated gold and rare earth deposits. In addition, the RMPs have prohibited new placer mining throughout most of the study area.

One measure of the effect of these restrictions on mineral access is a reduction of \$3 million in the average NPV of mineral resources in the area - from \$42.1 million to \$39.1 million (at current prices). Since only gold bearing deposits are likely to be economically recoverable at current prices, this reduction (or opportunity cost) resulting from the RMPs is a consequence of the closure of lands which are geologically favorable for alkalic-associated gold and gold placer deposits.

Figure ES-4. Accessibility to Mineralized Lands In The Study Area
As A Result of Land Use Designations In WMNRA/SNCA



On average, approximately 112,000 ounces of gold, or about 10 percent of the gold estimated to be potentially recoverable from the study area under the baseline analysis has been made inaccessible by the RMPs. There is a 5 percent chance that at current prices more than 200,000 ounces of economically recoverable gold worth more than \$88 million has been foregone as a result of limiting mineral access.

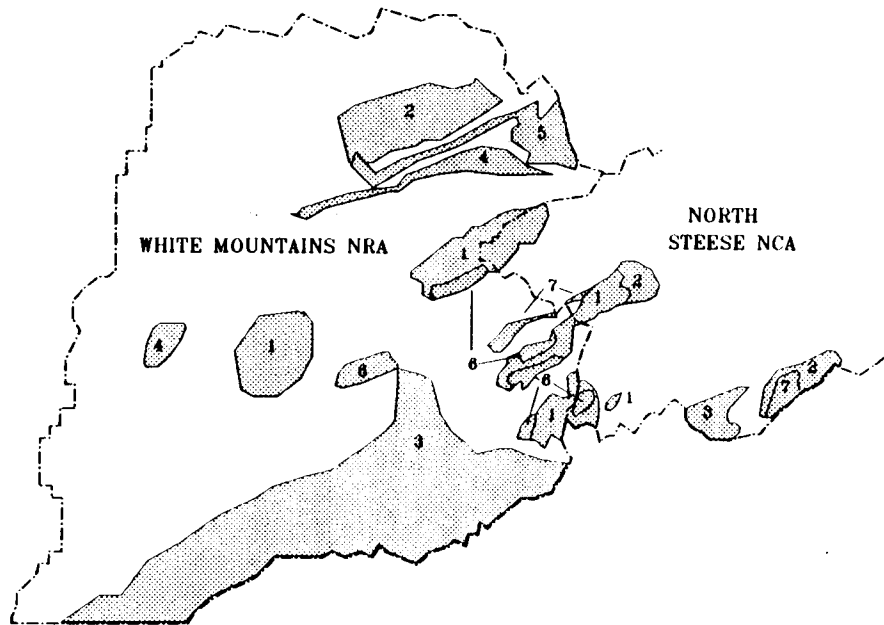
At twice current prices the estimated average total NPV of the mineral resources made inaccessible by the RMPs increases from approximately \$3 million to \$72 million. On average, the RMPs have reduced the baseline supply potential of the area by approximately 22 percent for gold, 100 percent for lead, 14 percent for REO, 96 percent for silver, 100 percent for tantalum, 94 percent for tin, 25 percent for tungsten, 20 percent for uranium, and 100 percent for zinc. These reductions amount to over \$1.7 billion on average in foregone mineral production values. The foregone mineral development will also result in a loss of direct and indirect economic benefits to the state and local economy.

3: Prospective Mineral Activity Areas

Land-use decisions within any management unit are based upon the perceived values of the resources (e.g. wildlife, forestry, scenic, watershed, recreation and mineral) within specific geographic areas of the unit. Based on the preliminary results of the potential supply analysis, the BLM identified eleven prospective mineral activity areas within the WMNRA/SNCA study area (fig. ES-5). Estimates of the potential quantities and values of minerals which may be economically recoverable from each of the prospective activity areas within the study area were developed to assist the BLM in future management actions.

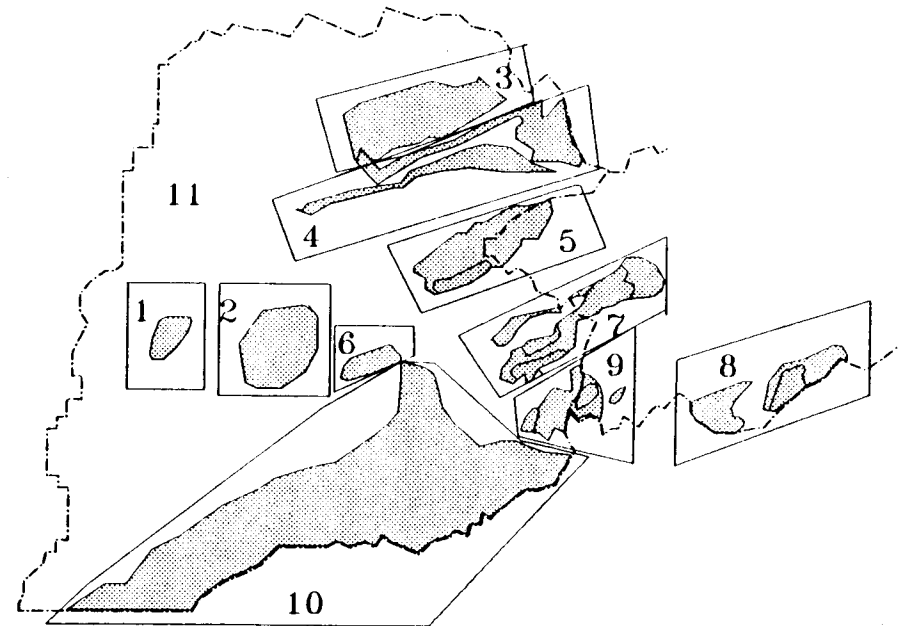
Figure ES-5. Location of Mineral Terranes and Delineation of Activity Areas in the WMNRA/SNCA Study Area

Mineral Terranes



1. Tin Greisens (Tin, Silver, Tantalum, Tungsten)
2. Tungsten Skarns (Tungsten, Tin, Silver)
3. Vein Gold (Gold)
4. Polymetallic Veins (Lead, Zinc, Silver)
5. Sediment Hosted Lead-Zinc (Lead, Zinc, Silver)
6. Rare Earths (Uranium, Thorium, REO's)
7. Alkalic-associated Gold (Gold, Silver)
8. Gold Placer Deposits Throughout the Study Area (Gold)

Activity Areas



- Area 1: Polymetallic Vein
- Area 2: Tin Greisen
- Area 3: Tungsten Skarn
- Area 4: Sediment Hosted Pb-Zn and Polymetallic Vein
- Area 5: Tin Greisen and Rare Earths
- Area 6: Rare Earths
- Area 7: Tin Greisen, Tungsten Skarn, Rare Earths and Alkalic-associated Gold
- Area 8: Tungsten Sharn, Vein Gold and Alkalic-associated Gold
- Area 9: Tin Geisen and Rare Earths
- Area 10: Vein Gold
- Area 11: Gold Placer

Based on what is presently known about the geology of the areas, it is virtually certain that area 11 contains undiscovered gold placer deposits, and very likely that areas 5 and 8 contain undiscovered deposits of other types (table ES-1). There is approximately one chance in two that deposits exist in areas 4 and 7, and one chance in three of at least one undiscovered deposit in area 9. Activity areas 1, 2, 6 and 10 have between one and two chances in ten of a deposit, and area 3 has one chance in one hundred.

The probability that deposits exist that would be economically recoverable at current metal prices is highest in area 11 (60%), followed by area 8 (11%). For the remaining areas, the probability of economic deposits at current metal prices is less than 1%. Assuming that economic deposits are found, the average NPV is highest in activity area 10 (\$597 million), area 8 (\$347 million) and area 5 (\$267 million), followed by areas 4, 6, 7 and 9 (\$25 to \$66 million), areas 1 and 11 (less than \$10 million), and areas 2 and 3, in which economic deposits were unlikely.

The activity areas were also analyzed at three times current prices at the request of BLM. At these higher prices, it is almost certain that economic deposits exist in area 11, and there is approximately one chance in two that they exist in areas 5 and 8 as well. There is one chance in eight for economic deposits at these higher prices in areas 4 and 7, and one chance in 14 for area 9. There is less than one chance in twenty for economic deposits in areas 1, 2, 3, 6 and 10.

Assuming that the study area was open to mineral entry, the areas estimated to be most likely to experience mineral activity at current prices are 8 and 11, joined by area 5 at higher prices. If mineral development did, in fact, take place, the largest NPV is estimated to result from mining activity in areas 5, 8 and 10 at current prices, and from mining activity in areas 4, 8 and 10 at three times current prices.

Table ES-1. Mineral Deposit Probabilities and Average Net Present Value of Economic Deposits In Eleven Activity Areas in the White Mountains National Recreation Area and the Steese National Conservation Area.

<u>Activity Areas</u>	<u>Probability of Deposits</u>	<u>At Current Prices:</u>		<u>At Three Times Current Prices:¹</u>	
		<u>Probability of Economic Deposits</u>	<u>Average NPV \$10⁶ (Conditional)</u>	<u>Probability of Economic Deposits</u>	<u>Average NPV \$10⁶ (Conditional)</u>
1	0.110	0.002	8	.012	20
2	0.100	0.000	0	.000	0
3	0.010	0.000	0	.006	30
4	0.460	0.005	66	.131	482
5	0.940	0.001	267	.424	171
6	0.190	0.003	27	.034	81
7	0.560	0.008	63	.137	181
8	0.990	0.108	347	.521	338
9	0.320	0.002	34	.076	177
10	0.090	0.002	597	.013	464
11	1.000	0.595	3	.984	13

¹ The conditional average Net Present Value for an area may decline as prices increase, since the values from marginal deposits are averaged with those of highly profitable deposits. For example, an activity area with a single recoverable deposit having a NPV of \$20 million at current prices has a conditional average NPV of \$20 million. At higher prices the NPV of this deposit may increase to \$30 million, and another deposit may become recoverable with an NPV of \$2 million. The conditional average NPV at the higher prices is then $(\$30 + \$2) / 2$, or \$16 million.

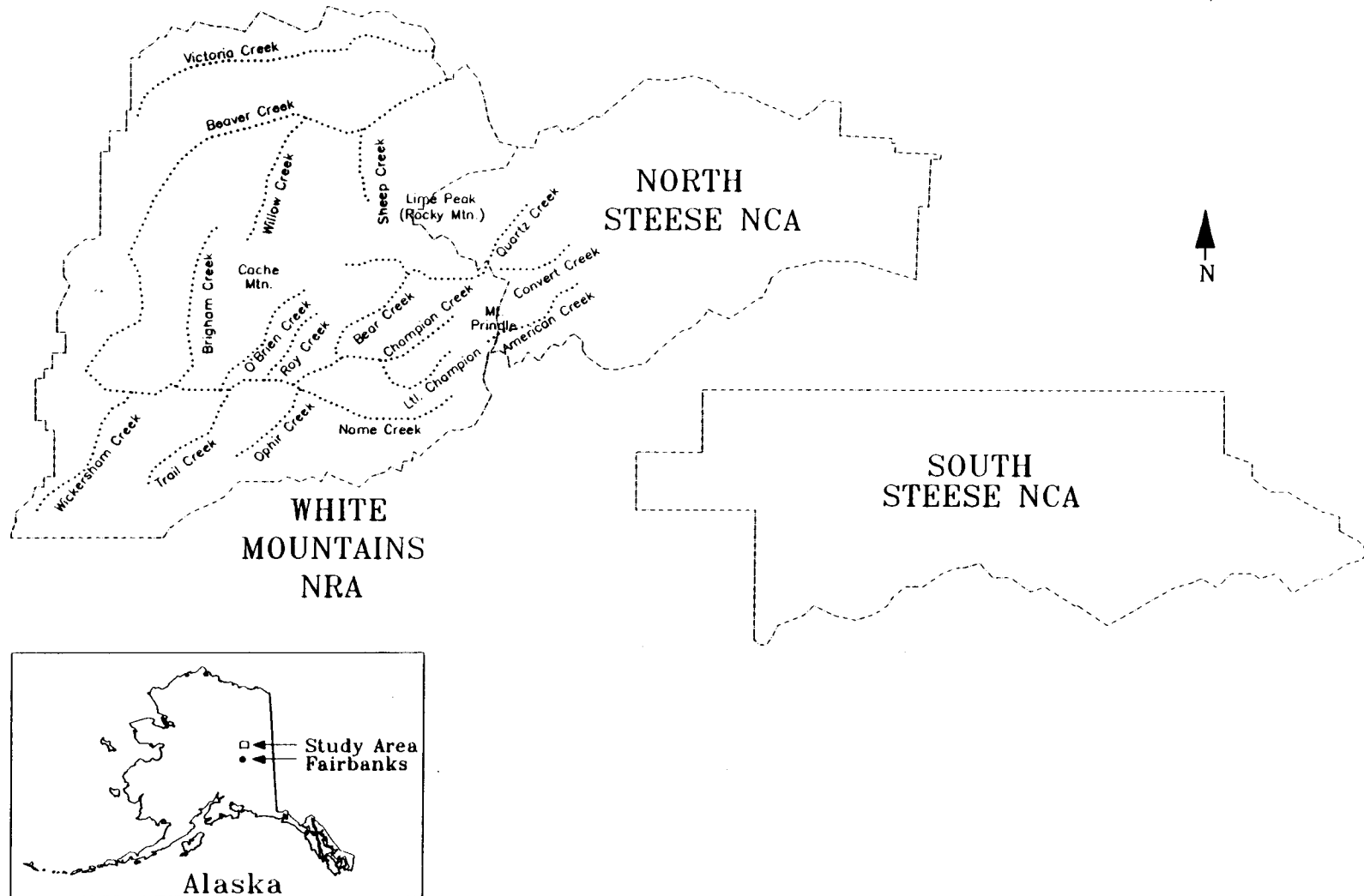
INTRODUCTION

Background

This report has been prepared in response to a request by the Bureau of Land Management (BLM) Steese/White Mountain District Office in Alaska that the Bureau of Mines quantitatively assess the potential supply of minerals from undiscovered deposits in the White Mountains National Recreation Area (WMNRA) and part of the Steese National Conservation Area (SNCA). Results of the assessment will be used during future land-use decisions affecting these two management units.

The WMNRA and the SNCA are adjacent areas approximately 40 miles north of Fairbanks, Alaska (fig. 1). The WMNRA, encompasses approximately 1,000,000 acres and includes the Beaver Creek National Wild and Scenic River. It was established in 1980 by the Alaska National Interest Lands Conservation Act (ANILCA, P.L.96-487) for public outdoor recreation use, for the conservation of values which contribute to public enjoyment, and for such utilization or disposal of natural resources as will promote, be compatible with, or not significantly impair public recreation. The SNCA was established by the same act which provides for a program of multiple use and sustained yield, and for the maintenance of the area's environmental quality. A corridor of State-owned lands divides this 1,220,000 acre management unit into two separate parts: the North and South SNCA. The North SNCA shares its western boundary with the WMNRA. The South SNCA is southeast of the North SNCA, and includes the Birch Creek National Wild and Scenic River.

Figure 1. White Mountains National Recreation Area and Steese National Conservation Area Location Map and Area Place Names



Resource management plans (RMPs) for the two units¹ were approved by the BLM in 1986. The plans include significant restrictions on new mineral development, especially in the WMNRA. The level of public concern regarding these actions, particularly on the part of the mining industry, has spurred the BLM to seek a more thorough assessment of the mineral values of the two areas, with assistance from the Bureau of Mines, the Alaska Division of Geological and Geophysical Surveys and the U.S. Geological Survey.

Study Area

This assessment focuses primarily on those lands within the WMNRA and the SNCA which have been administratively closed to mineral entry as a result of their respective RMPs. The study area encompasses approximately 1.24 million acres and includes all of the WMNRA and the western portion of the North SNCA (fig. 2).

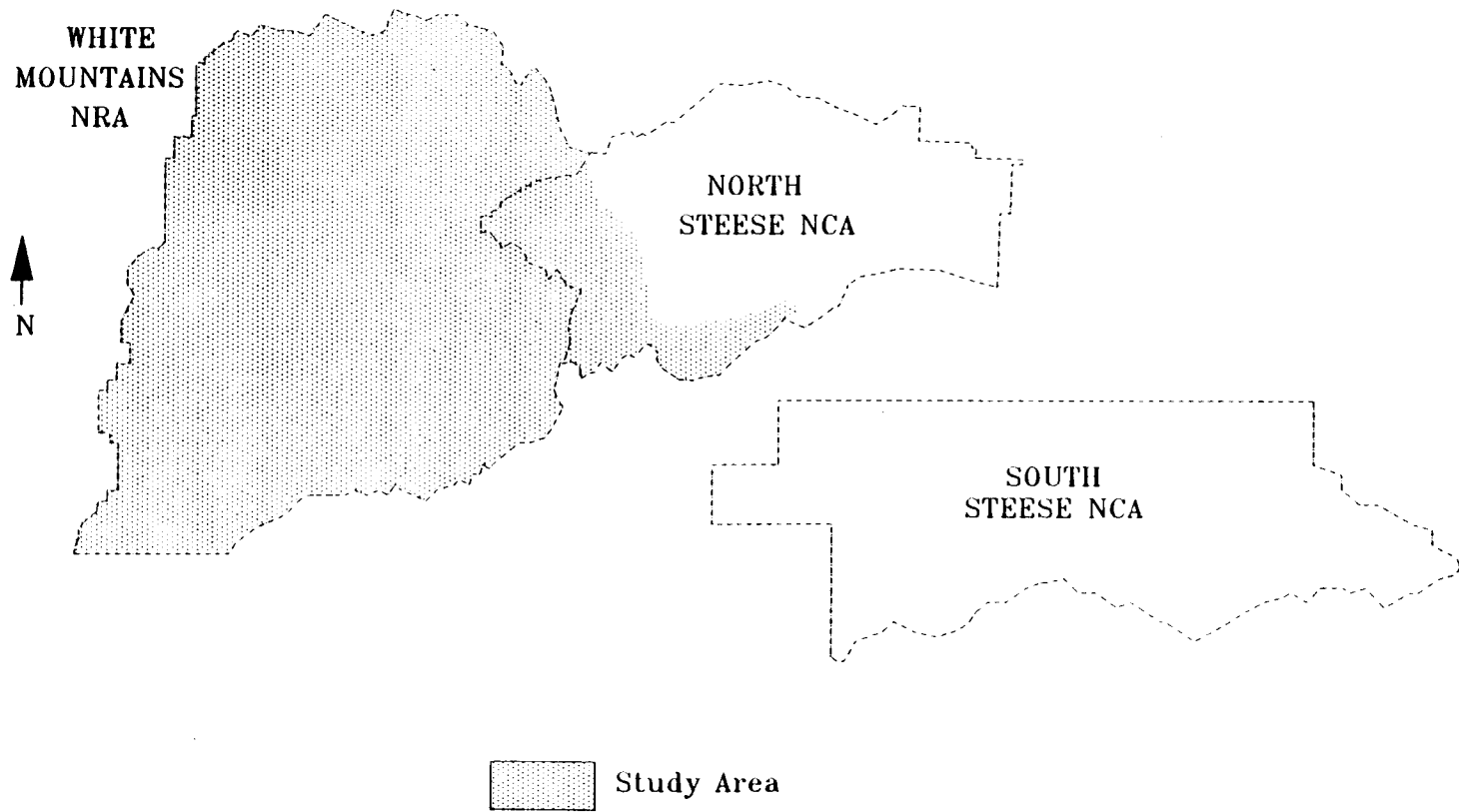
Study Objective

The study objective is to provide quantitative estimates of the area's potential mineral supply from three perspectives:

- (1) A baseline analysis which assumes all lands are open to mineral entry;
- (2) An analysis of the mineral values of only those lands closed to mineral entry by the current RMPs; and
- (3) A baseline analysis of the potential supply of minerals from eleven prospective mineral activity areas within the study area, delineated by the BLM on the basis of the preliminary study results.

¹Record of Decision Resource Management Plan for the Steese National Conservation Area and Record of Decision Resource Management Plan for the White Mountains National Recreation Area. Bureau of Land Management, Fairbanks District Office, February 6, 1986.

Figure 2. Study Area Within the White Mountains
NRA and The Steese NCA



For the purposes of this study, potential mineral supply is defined as the quantity and value of metal(s) that could be produced from undiscovered deposits which may exist in the study area under stated economic and technological conditions. The study assumes that the deposits would be discovered if access were permitted, and that currently available technology would be used. The estimated quantities and values of the potentially recoverable minerals in the second case above are measures of the mineral supply and economic consequences of the mineral access restrictions which currently apply to the area. The activity area analysis illustrates the type of information which could be provided earlier in the planning process, and which could improve the effectiveness of decisions on those lands which may contain economically recoverable mineral resources.

Methodology and Its Application

The procedures used to evaluate the mineral supply potential of the WMNRA/SNCA study area consist of five major activities (fig. 3): (1) a geologic analysis; 2) an engineering analysis; 3) the specification of a set of economic and policy analysis assumptions and metal price scenarios; 4) the development of a Potential Supply Analysis Computer Model (PSACM); and (5) estimation of the potential regional economic impacts of mineral development. The PSACM statistically estimates the quantities and values of the potentially recoverable mineral resources within the area based on the products of the first three activities. A detailed description of the potential supply analysis methodology, the results of the geologic analysis, the results of the engineering analysis, the structure and execution of the PSACM, and the regional economic impact analysis are provided in Appendices A,B,C, D and G, respectively.

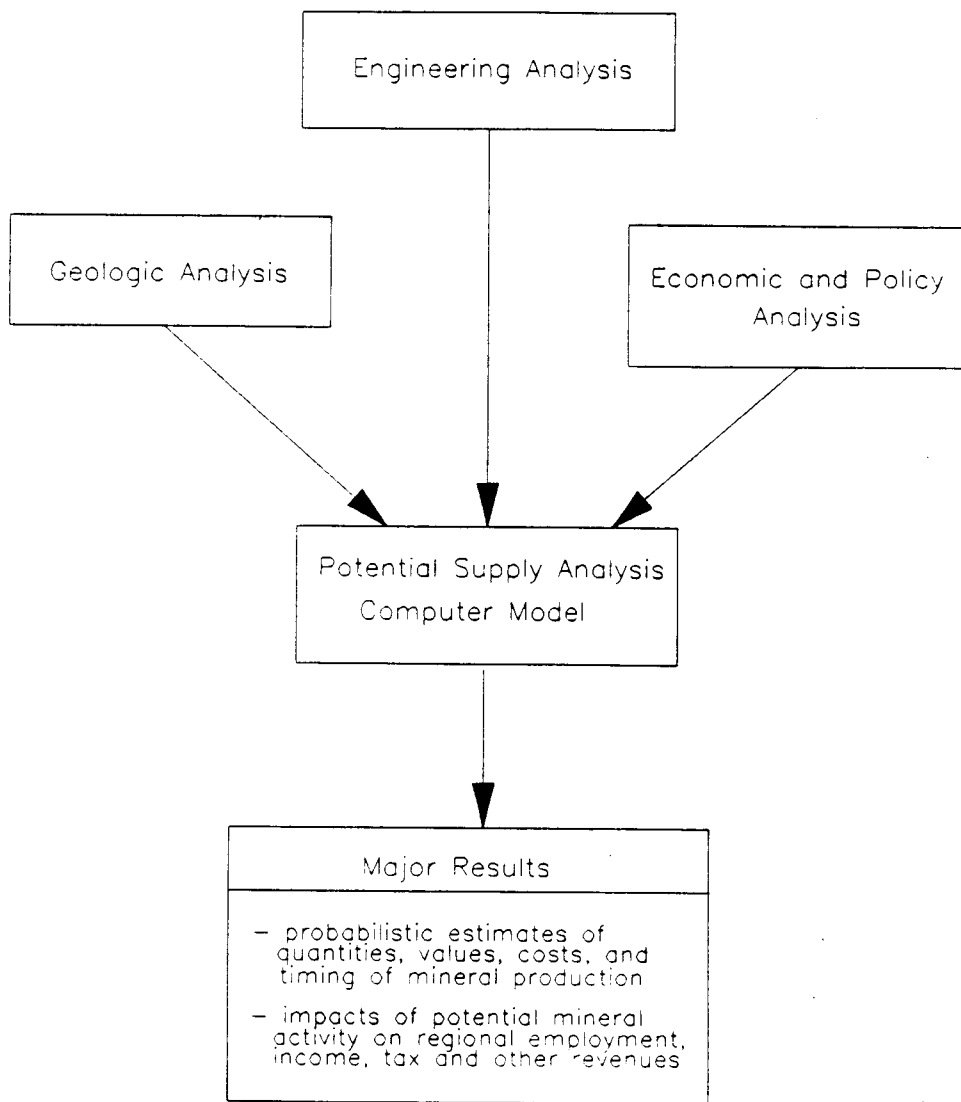


Figure 3. The Potential Supply Analysis System

The evaluation was a joint effort by the Alaska Division of Geological and Geophysical Surveys (ADGGS), the U.S. Bureau of Mines (BOM), and the U.S. Geological Survey (USGS). Its results reflect the current understanding of the study area's geology by these three agencies and are based on: 1) quantitative estimates of the area's mineral resource characteristics; 2) BOM capital and operating cost estimates for developing and producing the types of mineral deposits which might exist within the area; and 3) the use of a discounted cash flow analysis to determine whether prospective deposits would be economically recoverable if discovered.

Chapter 1

MINERAL ENDOWMENT OF THE STUDY AREA

As a first step in the potential supply analysis, geologists from the ADGGS, the BOM and the USGS identified those tracts of land within the study area which they considered to be geologically favorable for the occurrence of specific types of undiscovered mineral deposits (mineral terranes). Selected tracts were then assessed to determine: (1) the likelihood that they contain one or more undiscovered deposits; and (2) the number, size, metal grade(s) and depth of those deposits, should they exist. The assessed mineral resource characteristics associated with each of the selected tracts are found in Appendix B.

The delineated tracts and the estimates of their associated mineral resource characteristics reflect the current understanding of the geology of the area and are based on literature search and field studies which include detailed geologic mapping, geochemical and geophysical studies, and examination of known mineral occurrences (Weber et al, 1987; Smith et al, 1987; Fechner et al, 1988; Warner et al, 1988). Since there is uncertainty regarding the characteristics of undiscovered deposits which might exist in the area, the numbers, sizes and grades of prospective deposits were expressed as probability distributions.

These geologic data enable estimates to be made of the quantities of metals which may constitute the mineral endowment of the study area, and provide the information necessary for an evaluation of the economic recoverability of those metals. The mineral endowment of the study area

is defined as the total physical quantity of each metal or mineral which could be contained in prospective undiscovered deposits which exceed minimum tonnage and metal grade conditions established by the geologists.

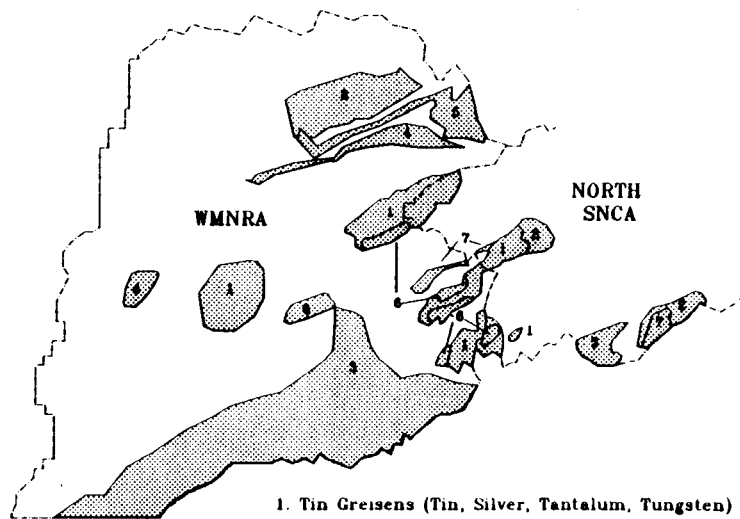
Location of Mineralized Lands

Figures 4a and 4b show the location of those lands within the study area identified as geologically favorable for the occurrence of undiscovered mineral deposits. Lands favorable for selected types of non-placer mineral deposits are located primarily in the southern portion of the WMNRA, and along a mineralized zone which extends from the northeastern quadrant of the WMNRA downward and to the southeast along the geographic boundary separating the WMNRA and the North SNCA (fig. 4a). Several of the delineated mineral terranes overlap the boundary between the two areas (fig. 1). Although this mineralized zone has had relatively little exploration to date, numerous tin prospects have been identified in the vicinity of Mount Prindle, Lime Peak, and in northwest portions of the North SNCA; rare earth occurrences (associated with thorium or uranium) exist in the Mount Prindle area (fig. 2); and lead and zinc occurrences have been found in the northeastern portion of the WMNRA.^{2,3} Placer gold has been recovered from the area since the turn of the century and numerous sediment samples taken suggest that the potential for undiscovered placer gold deposits also exists in streambeds throughout the area, but concentrated in the southern WMNRA (fig. 4b).

²Proposed Resource Management Plan/Final Environmental Impact Statement for the Steese National Conservation Area, Bureau of Land Management, Fairbanks District Office, November 2, 1984.

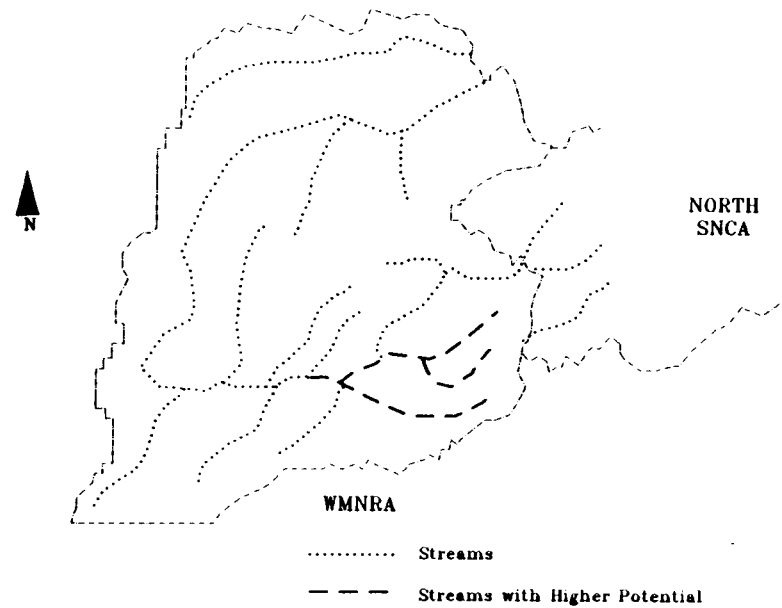
³Proposed Resource Management Plan/Final Environmental Impact Statement for the White Mountains National Recreation Area, Bureau of Land Management, Fairbanks District Office, November 2, 1984.

Figure 4a. Location of Lands Favorable for Various Types of Non-Placer Mineral Deposits



1. Tin Greisens (Tin, Silver, Tantalum, Tungsten)
2. Tungsten Skarns (Tungsten, Tin, Silver)
3. Vein Gold (Gold)
4. Polymetallic Veins (Lead, Zinc, Silver)
5. Sediment Hosted Lead-Zinc (Lead, Zinc, Silver)
6. Rare Earths (Uranium, Thorium, REO's)
7. Alkalic-associated Gold (Gold, Silver)

Figure 4b. Location of Streams Tested for Gold Placer Potential



- WMNRA
- Streams
 - - - Streams with Higher Potential

Prospective Types and Numbers of Undiscovered Deposits

Based on the geological evaluation, the mineralized lands outlined in figures 4a and 4b have the potential to contain eight major types of mineral deposits: 1) alkalic-associated gold deposits, 2) gold placers, 3) gold veins, 4) polymetallic veins, 5) sediment-hosted lead-zinc deposits, 6) tin greisens, 7) tungsten skarns, and 8) rare earth deposits.

The likelihood that undiscovered deposits of each type exist, and the minimum, maximum and average number of deposits which could be present, assuming that at least one exists, are presented in Table 1. Geologic indications are most favorable for the presence of gold placer deposits (100 percent chance - indicating that the geologists were virtually certain that there are undiscovered placer deposits in the area). The estimated number of undiscovered deposits of this type ranges from 1 to 20, with an average of 8 or 9. These deposits are most likely to exist in Beaver Creek, Nome Creek, and their tributaries which drain the southcentral WMNRA (the higher potential streams shown in fig. 4b).

Geologic indications are also extremely favorable for the presence of undiscovered tin greisen deposits (98 percent), tungsten skarns (98 percent chance), and alkalic-associated gold deposits (78 percent chance). Lands which could contain these types of deposits are primarily located along the mineralized belt that overlaps the boundary of the WMNRA and the SNCA and on the southwestern edge of the SNCA (fig. 4a).

For the study area as a whole, the results of the mineral assessment indicate that the total number of undiscovered deposits of all types which could exist ranges from 7 to 38, with an average number of 20. Assuming that deposits of all eight types do exist, gold placers, tin greisens and

Table 1. Likelihood and Number of Undiscovered Deposits
by Deposit Type

Deposit type	Probability undiscovered deposits exist	Conditional No. of Deposits		
		Average no.	Minimum no.	Maximum no.
Alkalic-associated gold	0.78	1 or 2	1	4
Gold placer	1.00	8 or 9	1	20
Gold vein	0.48	1	1	4
Polymetallic vein	0.50	1	1	2
Sediment-hosted Pb-Zn	0.10	1	1	1
Tin greisen	0.98	3 or 4	1	10
Tungsten skarn	0.98	4	1	15
Rare Earths	0.27	1	1	3
Aggregate ¹	1.00	20	7	38

¹For statistical reasons the values shown in each column cannot be added to derive the Aggregate values shown.

tungsten skarns are estimated to be present in the largest numbers, constituting on average approximately 60 percent of the area's undiscovered deposits.

Estimated Mineral Endowment

The eight prospective types of deposits typically contain varying quantities of gold (Au), silver (Ag), lead (Pb), rare earth oxides (REO), tin (Sn), tantalum (Ta), thorium (Th), uranium (U_3O_8), tungsten (W), and zinc (Zn). Some of these metals can be contained in more than one type of deposit (table 2). The gold endowment of the study area, for example, is the total quantity of gold which could be contained in prospective alkalic-associated gold deposits, gold placers, gold veins and tungsten skarns. Similarly, the silver endowment is the total quantity of silver that could be contained in prospective alkalic-associated gold, polymetallic vein, sediment-hosted lead-zinc, tin greisen, and tungsten skarn deposits.

Table 3 shows the average estimated endowment for each of the metals, as well as the 95, 50, and 5 percent exceedance chance quantities. The exceedance chance is the likelihood that the endowed quantity of each metal is equal to or greater than the amount shown in the table. For example, it is estimated that there is a 95 percent chance that more than 83,000 ounces of gold could be present within the study area; a 50 percent chance that more than 720,000 ounces of gold could be present; and a 5 percent chance that more than 6.8 million ounces could be present. Five of the metals—lead, tantalum, tin, tungsten, and zinc—are classified as critical and strategic minerals according to the 1987 Strategic and Critical Materials Stockpiling Act (P.L. 96-41).

Table 2. Metals Contained in the Prospective Types of Deposits

Deposit Type	Contained Metals									
	Ag	Au	Pb	REO	Sn	Ta	Th	U ₃ O ₈	W	Zn
Alkalic-associated gold	X	X								
Gold placer		X								
Gold vein		X								
Polymetallic vein	X		X							X
Sediment-hosted Pb-Zn	X		X							X
Tin greisen	X				X	X				
Tungsten skarn	X	X			X				X	
Rare Earths				X			X	X		

Table 3. Metal Endowment of the WMNRA/SNCA Study Area

Metal	Average	Exceedance Chance*		
		95%	50%	5%
Gold.....(10 ³ oz)	2,157.6	83.0	720.0	6,800.0
Lead.....(10 ³ st)	180.7	0.0	0.1	610.0
REO.....(10 ³ st)	6.3	0.0	0.0	35.0
Silver.....(10 ³ oz)	18,109.2	73.0	6,300.0	59,000.0
Tantalum.....(10 ³ st)	0.5	0.0	0.0	2.8
Thorium.....(10 ³ st)	3.6	0.0	0.0	16.0
Tin.....(10 ³ st)	220.8	6.2	160.0	640.0
Tungsten.....(10 ³ st)	48.5	2.5	26.0	190.0
Uranium.....(10 ³ st)	1.0	0.0	0.0	4.4
Zinc.....(10 ³ st)	256.9	0.0	0.0	1,100.0

*The chance that the amount of metal in the endowment exceeds the quantity shown. For example, there is a 95% chance that the gold endowment of the study area exceeds 83,000 ounces, a 50% chance that the endowment exceeds 720,000 ounces and a 5% chance that it exceeds 6.8 million ounces. Alternatively, it can be said that there is a 90% chance (95%-5%) that the gold endowment is between 83,000 and 6.8 million ounces.

Chapter 2

BASELINE POTENTIAL SUPPLY ANALYSIS

Whether or not a prospective deposit is expected to contain economically recoverable resources is, to a large extent, a function of geologic attributes and the prices of the commodities contained in the deposit. Each of the prospective types of deposits within the study area has a different set of endowment characteristics. Some deposits will be more likely than others to contain economically recoverable resources at a given metals price level.

A large number of possible geologic endowment scenarios were developed based on the assessed resource characteristics for each prospective deposit type. The economic recoverability of each deposit in each scenario was determined by calculating and evaluating its net present value (NPV), the total discounted revenues minus the total discounted costs of mining and milling. If the computed net present value for a simulated deposit was equal to or greater than zero, it was assumed to contain potentially economic resources.⁴ Estimates of the costs of developing and producing each deposit were based on the use of appropriate current mining and milling technologies (Appendix C).

The following analysis presents estimates of the quantities of metals which could be recovered, their NPV and value of production, the locations

⁴The resources could be produced at stated prices and show a positive net present value after covering all production costs, including a 15 pct return on capital investment.

of associated favorable areas, and examples of the regional economic impacts which could result from the development of specific deposits. Estimates of the potential supply of minerals were developed at current price levels (1987 average annual prices) and at twice 1987 prices. Because there is uncertainty concerning the existence of each type of deposit, and because those deposits that do exist might not be profitable to produce, the estimates are presented as probability distributions.

Baseline Results at Current Prices

At current commodity prices, prospective undiscovered deposits within the study area contain an estimated average of 1 million ounces of economically recoverable gold and over 150,000 ounces of recoverable silver (table 4). The average market value of the two metals is approximately \$450 million. There is a 50% chance that the market value of recoverable resources will exceed \$3.5 million, and a 5% (or 1 in 20) chance that the value will exceed \$2.1 billion. Only three of the eight prospective types of deposits are estimated to be potentially economically recoverable at current prices: 1) alkalic-associated gold deposits, 2) gold placer deposits, and 3) gold vein deposits. As a result, gold and silver are the only commodities likely to be economically recoverable from the area.

Likelihood and Number of Potentially Economic Deposits. Overall, there is a 64 percent chance that economic gold-bearing deposits exist within the study area at current prices (table 5). The total number of economic deposits is estimated to range from 1 to 5, with 1 or 2 on average. At current prices undiscovered gold placer deposits have the greatest chance

Table 4. Potential Mineral Supply at Current Prices
Baseline Analysis

Commodity	Quantities				Commodity	Market Value, \$10 ⁶			
	Aver- age	Exceedance Chance*				Aver- age	Exceedance Chance*		
		95%	50%	5%			95%	50%	5%
Gold.....(10 ³ oz)	1,010.7	0.0	7.9	4,800.0	Gold (\$444.00/oz)..	448.8	0.0	3.5	2,131.2
Silver.....(10 ³ oz)	156.9	0.0	0.0	130.0	Silver (\$7.20/oz)..	1.0	0.0	0.0	0.8

*The probability that the quantity or market value of the commodity exceeds the value shown. For example, there is a 50% chance that the market value of the gold production will exceed \$3.5 million.

Table 5. Likelihood and Number of Economic Deposits
at Current Prices - Baseline Analysis

Deposit type	Probability economic deposits exist	Conditional No. of Deposits		
		Average no.	Minimum no.	Maximum no.
Alkalic-associated gold	0.04	1	1	1
Gold placer	0.60	1 or 2	1	5
Gold vein	0.08	1	1	2
Polymetallic vein	0.0			
Sediment-hosted Pb-Zn	0.0			
Tin greisen	0.0			
Tungsten skarn	0.0			
Rare Earths	0.0			
Aggregate*	0.64	1 or 2	1	5

*For statistical reasons the values shown in each column cannot be added to derive the Aggregate values shown.

of containing economically recoverable resources. There is a 60 percent chance that from 1 to 5 economic deposits of this type exist.

Net Present Value of Prospective Deposits. Assuming current prices, the prospective deposits with the largest Net Present Value (NPV) within the study area are the undiscovered gold vein deposits (table 6). Prospective deposits of this type have an average NPV of \$38 million, and there is a 5 percent chance that NPV will exceed \$93 million. Their \$38 million average accounts for 90 percent of the average total NPV for all types of deposits in the study area (fig. 5).

Location of Potentially Economic Resources. Figure 6 shows the location of the tracts of land within the study area which could contain economic alkalic-associated gold deposits and gold vein deposits. The tracts vary in size and are located primarily in the southern part of the study area. The economic viability of each favorable area is a function of its degree of geologic favorability, the geologic features of its prospective deposits and the size of the favorable area itself. Therefore, some of the tracts identified as geologically favorable for a given type of deposit (e.g. vein gold deposit) may have a greater chance than others of containing economic deposits (Appendix E). The geologically favorable tracts located in the southwest portion of the study area are more likely to contain economically recoverable resources (between a 1 percent and a 10 percent chance) than those located in the WMNRA (less than a 1 percent chance).

Potentially economic undiscovered gold placer deposits could occur in streambeds throughout the study area. However, they are more likely to

Table 6. Net Present Value of Prospective Types of Deposits at Current Prices - Baseline Analysis
(Net Present Value in millions of dollars)

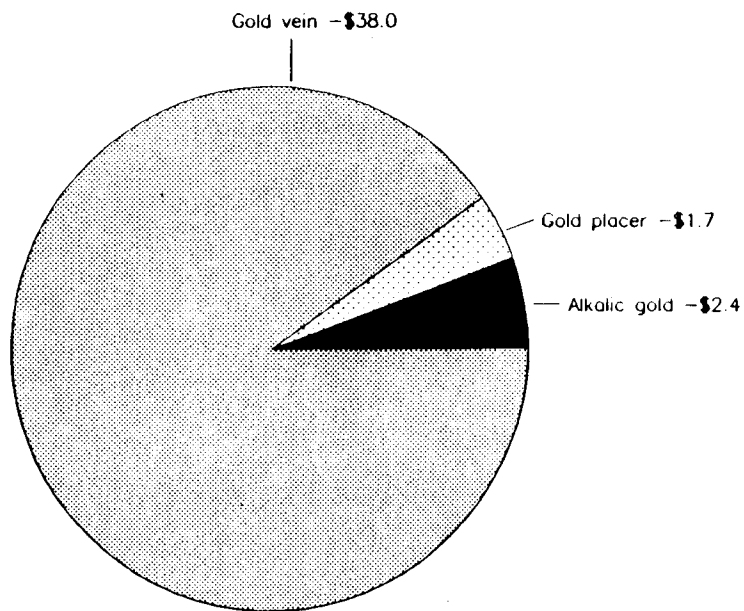
Deposit Type	Net Present Value			
	Average	Exceedance Chance*		
		95%	50%	5%
Alkalic-associated gold	2.4	0.0	0.0	0.0
Gold placer	1.7	0.0	0.14	9.9
Gold vein	38.0	0.0	0.0	93.0
Polymetallic vein	0.0	0.0	0.0	0.0
Sediment-hosted Pb-Zn	0.0	0.0	0.0	0.0
Tin greisen	0.0	0.0	0.0	0.0
Tungsten skarn	0.0	0.0	0.0	0.0
Rare Earths	0.0	0.0	0.0	0.0
Aggregate**	42.1	0.0	0.25	120.0

*The probability that the Net Present Value exceeds the value shown.

**For statistical reasons the values shown under the "Average" column can be added together to arrive at the Aggregate average but the values shown under the "Exceedance Chance" columns cannot be added together to arrive at the Aggregate values.

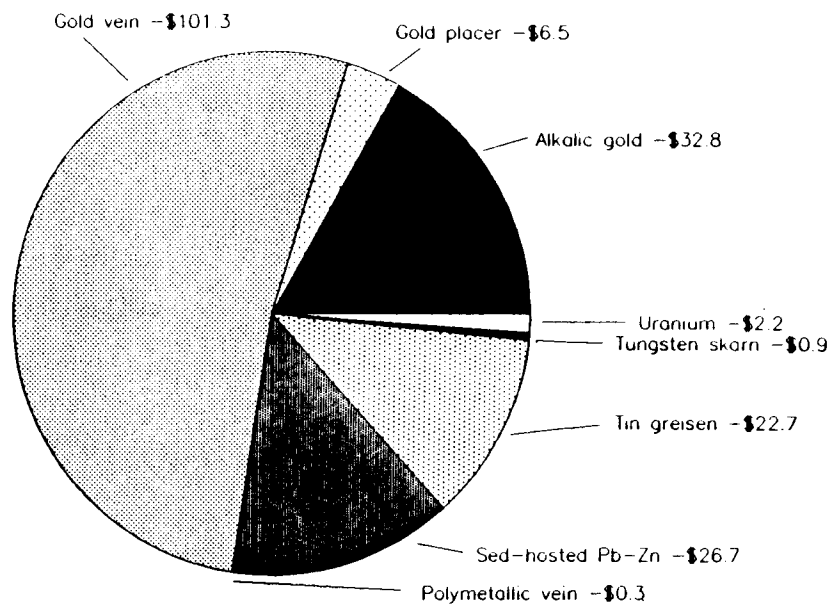
Figure 5. Average Net Present Value of Mineral Resources
in Prospective Deposit Types

(\$ in Millions)



At Current Prices

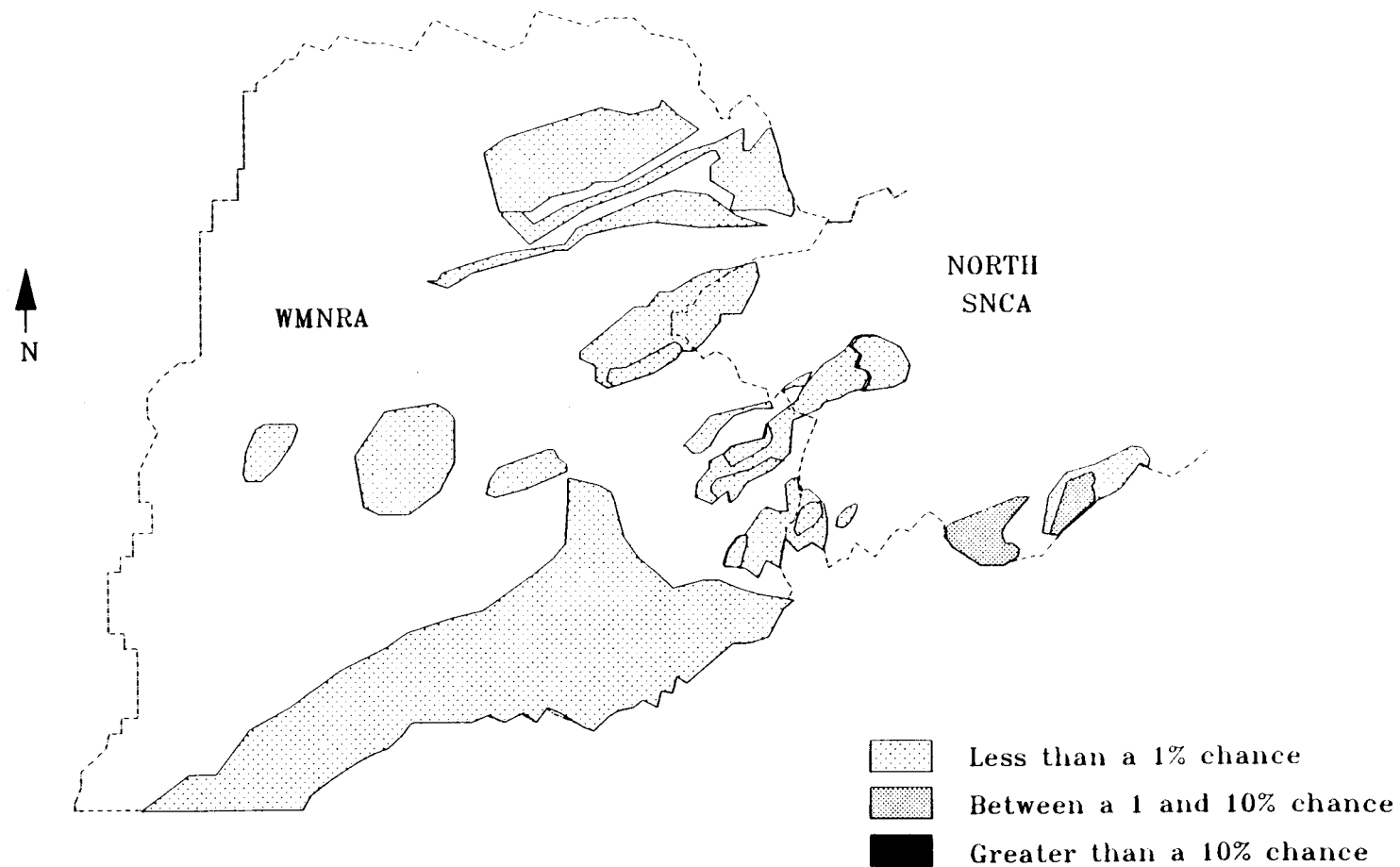
Total: \$42.1



At Two-times Current Prices

Total: \$193.4

Figure 6. Location of Lands which Could Contain Economically Recoverable Resources at Current Prices



occur in Beaver and Nome Creeks and their tributaries in the southern part of the WMNRA than in the drainages in the rest of the study area. To date, production of placer gold from Nome Creek and its tributaries within the WMNRA is estimated to be approximately 29,000 oz, with a value of \$13 million based on current gold prices. Although ANILCA permanently closed the WMNRA to the filing of mining claims under the 1872 Mining Law, properly located and maintained claims filed prior to the Area's designation can be developed. Only a few placer gold claims in the Nome Creek area are currently being mined (BLM, 1984).

Potential Supply of Minerals. Table 4 shows the quantities and market values of the gold and silver estimated to be economically recoverable from the study area at current prices. Gold could be recovered from three potentially economic deposit types (alkalic-associated gold, gold placer and gold vein); silver could be recovered as a co-product of the gold from economic alkalic-associated gold deposits. On average, the potential supply of gold at this price level is estimated to be approximately 1 million ounces having a market value of about \$450 million, and the potential supply of silver approximately 150 thousand ounces worth about \$1 million. There is a 5 percent chance that the potential production of gold could exceed 4.8 million ounces and be worth more than \$2.1 billion.

Regional Economic Impacts from Mineral Development. If the study area does, in fact, turn out to contain alkalic-associated gold, gold placer and/or gold vein deposits which are profitable to produce (64 percent chance), the associated mining activity could have important direct and indirect economic benefits to the Fairbanks economy.

At current prices, new jobs and income in the area could be generated by up to 5 new placer mines, one or two gold lode operations and/or one bulk-mineable gold operation. Site-specific operations could also include either heap leaching or Carbon-In-Pulp (CIP) processing facilities, depending on the type of deposit being developed and the grade of the gold ore. See table 10 for examples of the economic impact of the development of various types of deposits.

Baseline Results At Twice Current Metal Prices

At twice current metal prices the potential for production of metals from the study area can be significantly larger than that estimated at current prices. In response to a doubling of commodity prices, the estimated average value of production from all types of deposits increases from \$450 million to over \$2.8 billion (table 7) or over 6 times. There is a 50% chance that the value of recoverable gold alone will exceed \$57 million, and a 5% chance that the production of gold, tin or zinc will exceed \$1 billion. At this higher price level, the results also indicate that economically recoverable resources could be present in prospective deposits of all eight types (table 8).

Likelihood and Number of Potentially Economic Deposits. With a doubling of current prices, the likelihood that the study area as a whole contains economic deposits increases from 64 percent to 96 percent (table 8). At this higher price level a total of from 1 to 12 economic deposits could be present within the study area, with 3 or 4 on average. The likelihood that economic gold placer deposits exist increases from a 60 percent chance to 94 percent, making this type of deposit still the most likely to contain economically recoverable resources.

Table 7. Potential Mineral Supply at Twice Current Prices
Baseline Analysis

Quantities					Market Value, \$10 ⁶				
Commodity	Average	Exceedance Chance*			Commodity	Average	Exceedance Chance*		
		95%	50%	5%			95%	50%	5%
Gold.....(10 ³ oz)	1,463.5	0.4	65.0	5,600.0	Gold (\$888.00/oz)...	1,299.6	0.4	57.7	4,972.8
Lead**.....(10 ³ st)	159.2	0.0	0.0	540.0	Lead (\$0.72/lb).....	229.2	0.0	0.0	777.6
REO.....(10 ³ st)	0.7	0.0	0.0	0.0	REO (\$2.00/lb).....	2.8	0.0	0.0	0.0
Silver.....(10 ³ oz)	8,388.0	0.0	0.0	35,000.0	Silver (\$14.40/oz).	120.8	0.0	0.0	504.0
Tantalum**.(10 ³ st)	0.1	0.0	0.0	0.0	Tantalum (\$44.00/lb)	8.8	0.0	0.0	0.0
Tin**.....(10 ³ st)	49.7	0.0	0.0	300.0	Tin (\$8.36/lb).....	831.0	0.0	0.0	5,016.0
Tungsten**.(10 ³ st)	0.8	0.0	0.0	0.0	Tungsten (\$5.74/lb).	9.2	0.0	0.0	0.0
U ₃ O ₈(10 ³ st)	0.5	0.0	0.0	0.0	U ₃ O ₈ (\$33.10/lb)	33.1	0.0	0.0	0.0
Zinc**.....(10 ³ st)	200.2	0.0	0.0	890.0	Zinc (\$0.84/lb).....	336.3	0.0	0.0	1,495.2

*The probability that the quantity or market value of the commodity exceeds the value shown.
For example, there is a 50% chance that the market value of the gold production will exceed \$57.7 million.

**Designated critical and strategic mineral.

Table 8. Likelihood and Number of Economic Deposits at
Twice Current Prices - Baseline Analysis

Deposit type	Probability economic deposits exist	Conditional No. of Deposits		
		Average no.	Minimum no.	Maximum no.
Alkalic-associated gold	0.20	1	1	3
Gold placer	0.94	2 or 3	1	9
Gold vein	0.17	1	1	2
Polymetallic vein	0.02	1	1	1
Sediment-hosted Pb-Zn	0.07	1	1	1
Tin greisen	0.20	1	1	3
Tungsten skarn	0.03	1	1	1
Rare Earths	0.02	1	1	1
Aggregate*	0.96	3 or 4	1	12

*For statistical reasons the values shown in each column cannot be added to derive the Aggregate values shown.

Net Present Value of Prospective Deposits. A doubling of the prices used in the analysis results in an increase from \$42 million to \$193 million in the average NPV for all deposit types in the study area (table 9). There is a 5% chance that the NPV for the study area will exceed \$780 million. At twice current prices, gold veins remain the potentially most valuable type of deposits (as measured by NPV) within the study area. Prospective deposits of this type have a 5 percent chance of being worth at least \$360 million. The next most valuable deposit type is the tin greisens (5 percent chance of exceeding \$270 million) followed by the alkalic-associated gold deposits (5 percent chance of exceeding \$220 million).

Location of Potentially Economic Resources. The lands most likely to contain economic deposits at this price level are located along the mineralized zone which extends from the sediment-hosted lead-zinc terrane down along the boundary of the WMNRA and the SNCA and along the southwestern edge of the study area (fig. 7). Economic gold placer deposits are still most likely to be present in the Beaver Creek and Nome Creek areas in the south WMNRA.

Potential Mineral Supply. At twice current prices, gold continues to be the commodity most likely to be recovered from the study area (table 9). However, with a doubling of metal prices, there is a 5 percent chance that at least 540 thousand short tons of lead, 35 million ounces of silver, 300 thousand short tons of tin and 890 thousand short tons of zinc in addition to 5.6 million ounces of gold will be economically recoverable.

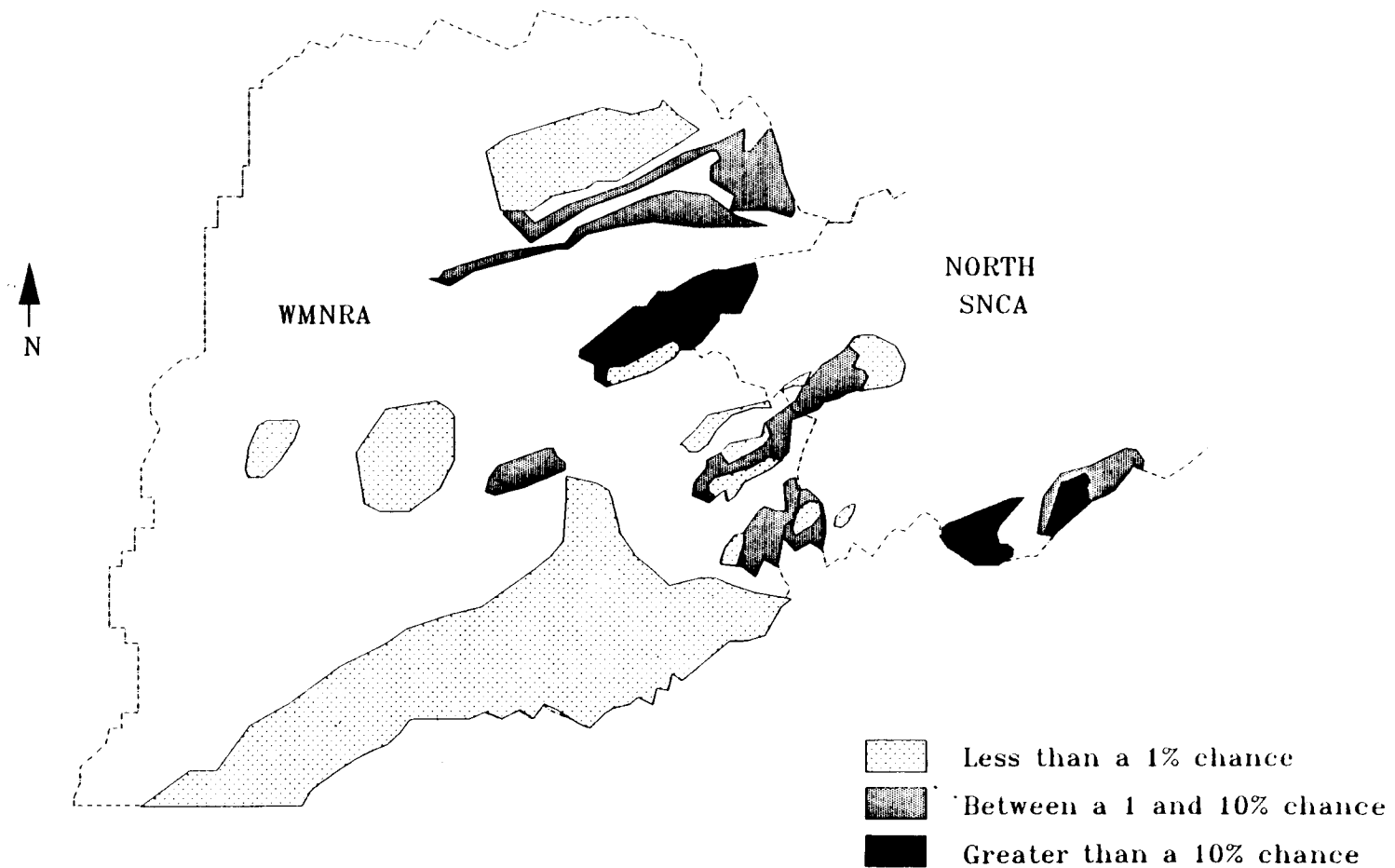
Table 9. Net Present Value of Prospective Types of Deposits
at Twice Current Prices - Baseline Analysis
(Net Present Value in millions of dollars)

Deposit Type	Net Present Value			
	Average	Exceedance Chance*		
		95%	50%	5%
Alkalic-associated gold	32.8	0.0	0.0	220.0
Gold placer	6.5	0.0	3.3	25.0
Gold vein	101.3	0.0	0.0	360.0
Polymetallic vein	0.3	0.0	0.0	0.0
Sediment-hosted Pb-Zn	26.7	0.0	0.0	87.0
Tin greisen	22.7	0.0	0.0	270.0
Tungsten skarn	0.9	0.0	0.0	0.0
Rare Earths	2.2	0.0	0.0	0.0
Aggregate**	193.4	0.2	25.0	780.0

*The likelihood that the Net Present Value exceeds the value shown.

**For statistical reasons the values shown under the "Average" column can be added together to arrive at the Aggregate average but the values shown under the "Exceedance Chance" columns cannot be added together to arrive at the Aggregate values.

Figure 7. Location of Lands which Could Contain Economically Recoverable Resources at Two Times Current Prices



Regional Economic Impacts from Mineral Development. At twice current metal prices, it is almost certain (96 percent) that the study area contains undiscovered economic deposits. Given the higher likelihood that economic deposits exist, and the larger proportion of such deposits which could be developed, the potential direct and indirect economic benefits from mining activity to the Fairbanks economy are much larger than those estimated at current prices.

Assuming that the area was fully explored, the total number of potential mining operations is estimated to range from 1 to 12, with 3 or 4 on average. Because of the larger number and variety of deposits which could be economic to produce at this price level, mining activity within the study area could consist of a larger number and variety of mining and milling operations — placer, vertical crater retreat, open-pit, cut-and-fill, and/or room-and-pillar mines in association with appropriately sized flotation, gravity, CIP or heap leach facilities. Again, the type of mining activity most likely to occur is placer mining.

Table 10 shows the estimated employment, earnings and output impacts on the Fairbanks region resulting from the development of various types and sizes of deposits in the study area (see Appendix G for descriptions of the sizes and grades of the deposits). In table 10, the first column contains estimates of the average annual number of workers employed in mining activities. The next shows estimates that include workers employed in support industries. The Cumulative Earnings columns refer to total wages received by workers in mining activities (direct), and by workers in mining and support industries (total). Cumulative Output refers to total expenditures by the mining industry (direct) and by the mining and support industries (total). These expenditures include moneys spent on labor, equipment, fuel, steel, food, chemicals, transportation, services, materials, etc., over the life of the mine.

Table 10. Potential Direct and Total* Regional Economic Impacts
from Various Types of Mineral Development
(all values in 1982 dollars)

a. Small Mine Impacts

Deposit Type	Avg. Annual Employment		Cumulative Earnings (\$10 ⁶)		Cumulative Output (\$10 ⁶)	
	Direct	Total	Direct	Total	Direct	Total
Alkalic-gold	259	712	365	554	1094	1651
Placer gold	3	4	1	1	2	2
Sediment-hosted lead-zinc	294	666	270	410	848	1262
Tin Greisen	553	1176	746	1144	2469	3642

b. Large Mine Impacts

Deposit Type	Avg. Annual Employment		Cumulative Earnings (\$10 ⁶)		Cumulative Output (\$10 ⁶)	
	Direct	Total	Direct	Total	Direct	Total
Alkalic-gold	561	1559	1134	1723	3599	5348
Placer gold	7	11	2	3	6	8
Sediment-hosted lead-zinc	500	1014	421	654	1648	2340
Tin Greisen	773	1727	1240	1896	4177	6114

*Total impacts equal direct plus indirect impacts.

For example, the development of a "small" sedimentary lead-zinc deposit would result in the direct employment of 294 workers, and 372 additional workers in support industries. A large tin greisen mine would generate almost \$1.9 billion in total wages over the life of the mine, and a small alkalic gold mine would generate expenditures of over \$1.6 billion over the life of the mine. (Appendix G provides estimates of annual employment, earnings and output impacts for various types and sizes of deposits.

Chapter 3

OPPORTUNITY COSTS OF CURRENT RESOURCE MANAGEMENT PLANS

The approved Resource Management Plans (RMPs) developed by BLM for the WMNRA/SNCA restrict, in varying degrees, access to the mineral resources within the study area. Classifications in the RMPs which apply to lands within the study area include: Primitive, Semi-Primitive, and Research Natural Areas (fig. 8). The units identified as Primitive, Research Natural Areas, as well as the Beaver Creek National Wild and Scenic River Corridor, are closed to all mineral entry. Lands within the WMNRA which are classified Semi-Primitive are open to hardrock mineral leasing, but placer gold activity is limited to existing claims only. Lands within the SNCA which are classified Semi-Primitive remain open to all mineral entry under the 1872 Mining Laws.

As a result of their designations, lands favorable for seven of the eight prospective types of deposits within the study area have been closed to mineral entry. Approximately 44% of the lands identified as geologically favorable for non-placer mineral deposits of various types have been closed (fig. 9), and placer activity is now prohibited throughout most of the study area, except on valid existing claims. The non-placer closures include all of the lands favorable for undiscovered polymetallic vein and sediment-hosted lead-zinc deposits; all of the lands favorable for undiscovered tin greisen deposits in the vicinity of Lime Peak (or Rocky Mountain) and Cache Mountain and portions of the lands favorable for this type of deposit in the Quartz Creek and Mt. Prindle

Figure 8. Administrative Land Use Designations
Within The WMNRA/SNCA Study Area

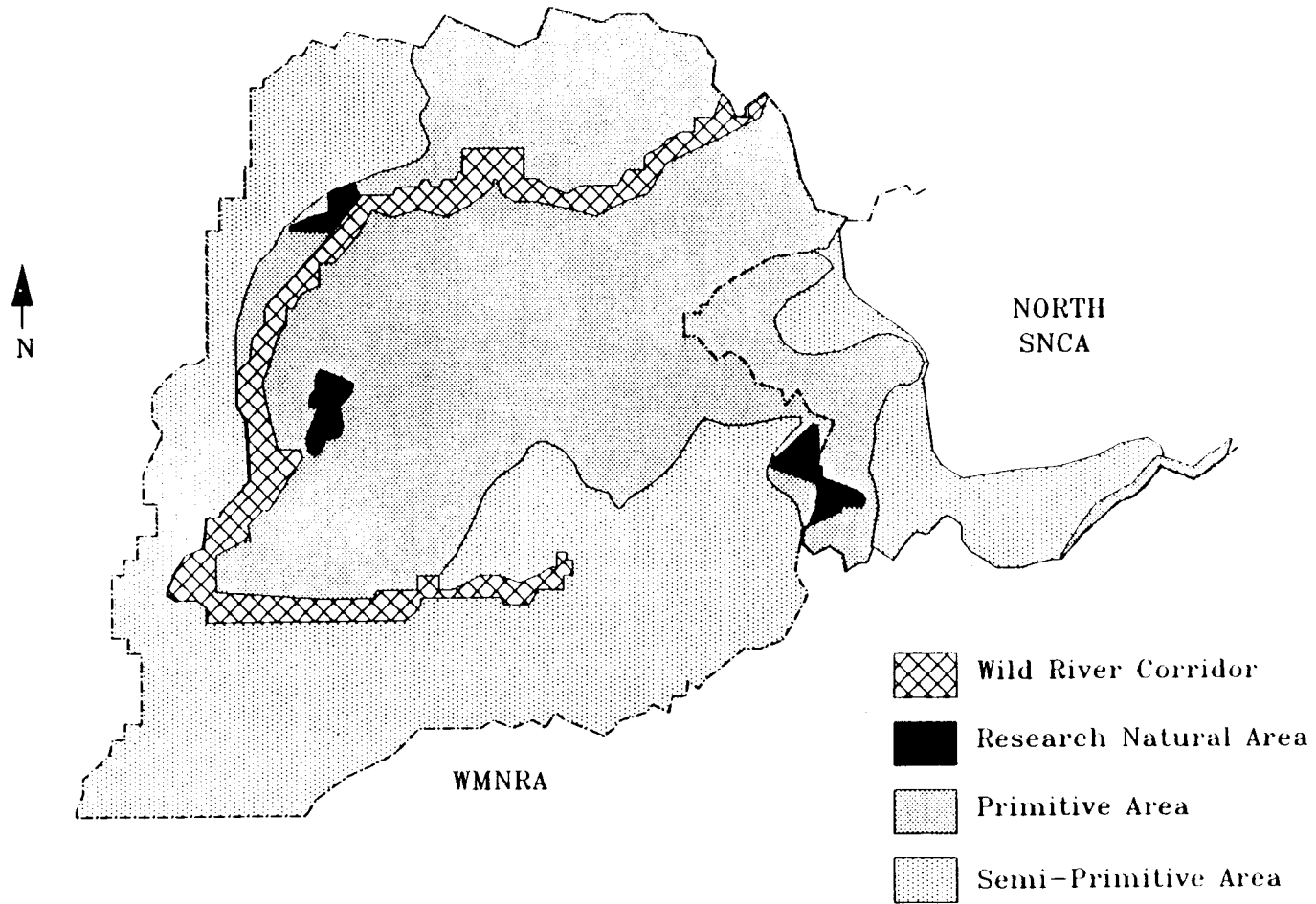
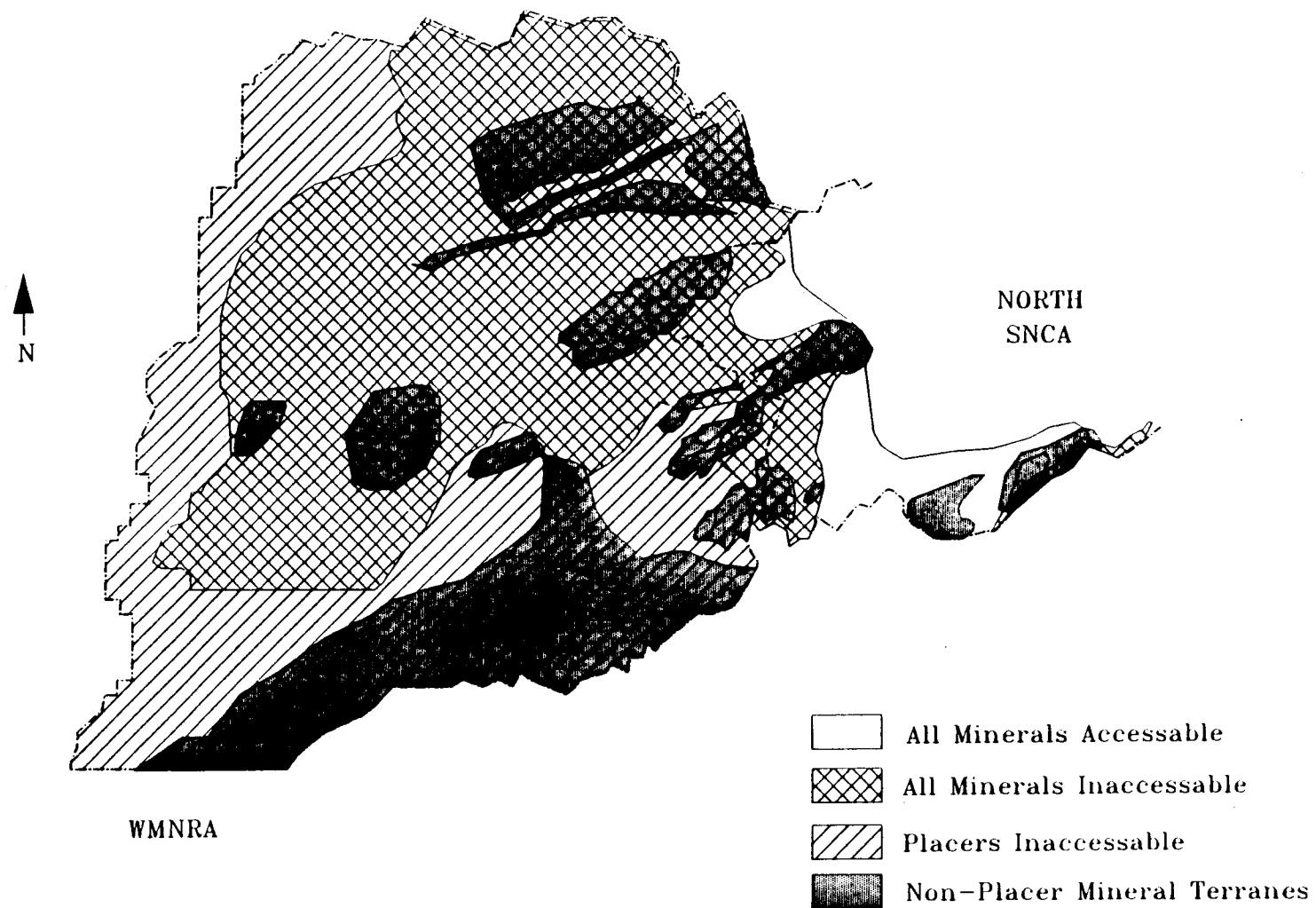


Figure 9. Accessibility to Mineralized Lands In The Study Area
As A Result of Land Use Designations In WMNRA/SNCA



areas. Most of the lands favorable for tungsten skarn deposits have also been closed to mineral entry, as well as some of the lands favorable for alkalic-associated gold and rare earth deposits. Access to those lands identified as geologically favorable for gold vein deposits has not been restricted by the RMPs and all lands within the study area favorable for deposits of this type remain open to mineral entry.

The PSACM was used to estimate the opportunity costs of the mineral access restrictions within the study area at current and twice current metal prices. These opportunity costs are the metal quantities and values foregone as the result of the restrictions, as well as the jobs and income which the foregone mineral activity could have generated for the state and local economy.

Opportunity Costs at Current Prices

At current prices, an estimated average of 112,000 ounces of economically recoverable gold are made inaccessible by the RMPs (table 11). There is a 5% chance that over 200,000 ounces, with a market value of \$88 million, have been made inaccessible. The average estimated total NPV of prospective undiscovered deposits that remain accessible decreases from \$42.1 million prior to the adoption of the RMPs (the baseline estimate) to \$39.1 million when the RMP imposed restrictions are taken into account. Since the baseline analysis indicates that only prospective gold-bearing deposits within the study area are likely to be economic at current prices, the opportunity costs of mineral closures at this price level result from the inability to access lands that are geologically favorable for alkalic-associated gold deposits and gold placer deposits.

Table 11. Potential Mineral Supply from Lands Closed to Mineral Entry
at Current Prices

Quantities					Market Value, \$10 ⁶				
Commodity	Aver- age	Exceedance Chance*			Commodity	Aver- age	Exceedance Chance*		
		95%	50%	5%			95%	50%	5%
Gold.....(10 ³ oz)	112.4	0.0	5.2	200.0	Gold (\$444.00/oz)..	49.9	0.0	2.3	88.8

*The probability that the quantity or market value of the commodity exceeds the value shown.

Likelihood and Number of Economic Deposits Made Inaccessible. At current prices, the gold placers which may exist on lands closed to mineral entry are the mostly likely type of deposit to contain economically recoverable resources (table 12). There is a 60 percent chance that from 1 to 5 economic deposits of this type have been made inaccessible, with 1 or 2 on average.

Net Present Value of Inaccessible Deposits. The average estimated NPV of the gold-bearing deposits which may have been made inaccessible is \$3 million (table 13) at current prices. There is a 90 percent chance that the total NPV is between \$0 and \$12 million. The most valuable inaccessible deposits, at this price level, are the undiscovered gold placer deposits which have a 5% chance of being worth more than \$9 million.⁵

Location of Inaccessible Potentially Economic Resources. Lands which have been closed to mineral entry, and which could contain economic alkalic-associated gold deposits, are located in the Quartz Creek area, which is in the southcentral part of the mineral belt, and in the vicinity of Table Mountain, which is at the southeastern edge of the study area. Economic gold placer deposits are more likely to be present in Beaver Creek, Nome Creek and their tributaries which drain the southern part of the WMRA than in drainages in the rest of the area.

⁵Estimates of the value of placer deposits which have been made inaccessible do not take account of the possibility that some of those resources might be located on valid existing claims.

Table 12. Likelihood and Number of Economic Deposits on Lands Closed to Mineral Entry at Current Prices

Deposit type	Probability economic deposits exist	Conditional No. of Deposits		
		Average no.	Minimum no.	Maximum no.
Alkalic-associated gold	0.02	1	1	1
Gold placer	0.60	1 or 2	1	5
Gold vein	0.0			
Polymetallic vein	0.0			
Sediment-hosted Pb-Zn	0.0			
Tin greisen	0.0			
Tungsten skarn	0.0			
Rare Earths	0.0			
Aggregate*	0.60	1 or 2	1	5

*For statistical reasons the values shown in each column cannot be added to derive the Aggregate values shown.

Table 13. Net Present Value of Prospective Types of Deposits
on Lands Closed to Mineral Entry at Current Prices
(Net Present Value in millions of dollars)

Deposit Type	Net Present Value			
	Average	Exceedance Chance*		
		95%	50%	5%
Alkalic-associated gold	1.3	0.0	0.0	0.0
Gold placer	1.7	0.0	0.14	9.9
Gold vein	0.0	0.0	0.0	0.0
Polymetallic vein	0.0	0.0	0.0	0.0
Sediment-hosted Pb-Zn	0.0	0.0	0.0	0.0
Tin greisen	0.0	0.0	0.0	0.0
Tungsten skarn	0.0	0.0	0.0	0.0
Rare Earths	0.0	0.0	0.0	0.0
Aggregate**	3.0	0.0	0.15	12.0

*The likelihood that the Net Present Value exceeds the value shown.

**For statistical reasons the values shown under the "Average" column can be added together to arrive at the Aggregate average but the values shown under the "Exceedance Chance" columns cannot be added together to arrive at the Aggregate values.

Foregone Mineral Supplies. At current prices, gold is the only commodity likely to be economically recoverable from lands which have been closed to mineral entry by the RMPs. On average, approximately 112,000 ounces of gold, or about 10 percent of the gold estimated to be potentially recoverable from the study area under the baseline analysis, has been made inaccessible. There is a 5% chance, however, that more than 200 thousand ounces of economically recoverable gold, with a market value in excess of \$88 million at current prices, has been foregone.

Foregone Job and Income Benefits. If the gold-bearing lands within the study area which have been closed to mineral access do, in fact, contain alkalic-associated gold and placer gold deposits which would have been profitable to produce, the foregone mineral development means a loss in the direct and indirect economic benefits which would have otherwise accrued to the state and local economies.

Opportunity Costs at Twice Current Prices

At twice current prices, the effect of the RMP imposed restrictions is much larger. On average, the estimated potential production of metals is reduced by 14% (rare earths) to 100% (lead and zinc). The market value of lost metal production increases from \$50 million to almost \$1.8 billion (table 14). The average estimated NPV of the remaining accessible resources is \$122.6 million (fig. 10). This is approximately \$72 million, or 37 percent, less than the baseline estimate at this price level. The total estimated NPV of the mineral resources made inaccessible by the RMPs has increased from approximately \$3 million to \$72 million, on

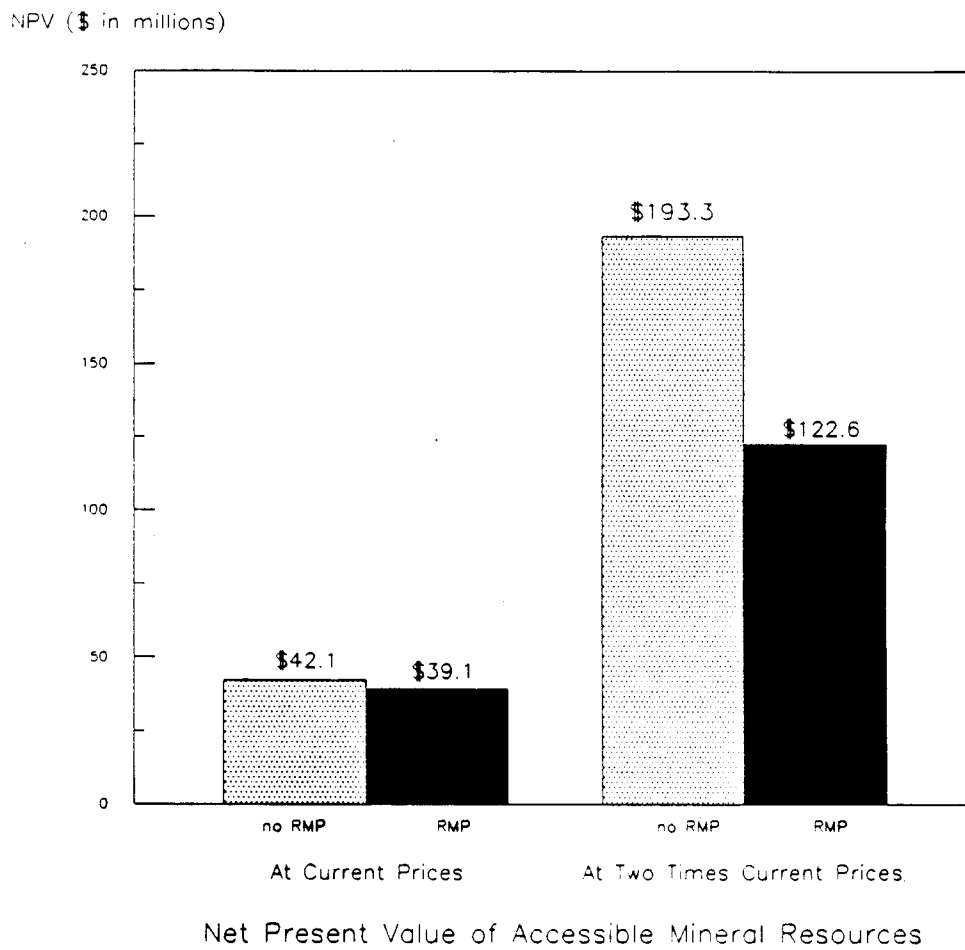
Table 14. Potential Supply of Minerals from Lands Closed to Mineral Entry at Twice Current Prices

Quantities					Market Value, \$10 ⁶				
Commodity	Average	Exceedance Chance*			Commodity	Average	Exceedance Chance*		
		95%	50%	5%			95%	50%	5%
Gold.....(10 ³ oz)	320.6	0.0	37.0	2,200.0	Gold (\$888.00/oz)..	284.7	0.0	32.9	1,953.6
Lead**.....(10 ³ st)	159.2	0.0	0.0	540.0	Lead (\$0.72/lb)....	229.2	0.0	0.0	777.6
REO.....(10 ³ st)	0.1	0.0	0.0	0.4	REO (\$2.00/lb).....	0.4	0.0	0.0	1.6
Silver.....(10 ³ oz)	8,062.7	0.0	0.0	33,000.0	Silver (\$14.40/oz)..	116.1	0.0	0.0	475.2
Tantalum**.(10 ³ st)	0.1	0.0	0.0	0.0	Tantalum (\$44.00/lb)	8.8	0.0	0.0	0.0
Tin**.....(10 ³ st)	46.7	0.0	0.0	290.0	Tin (\$8.36/lb).....	780.8	0.0	0.0	4,848.8
Tungsten**.(10 ³ st)	0.2	0.0	0.0	0.0	Tungsten (\$5.74/lb).	2.3	0.0	0.0	0.0
U ₃ O ₈(10 ³ st)	0.1	0.0	0.0	0.0	U ₃ O ₈ (\$33.10/lb)	6.6	0.0	0.0	0.0
Zinc**.....(10 ³ st)	200.2	0.0	0.0	890.0	Zinc (\$0.84/lb).....	336.3	0.0	0.0	1,495.2

*The probability that the quantity or market value of the commodity exceeds the value shown.

**Designated critical and strategic mineral.

Figure 10. Comparison of Average Net Present Value of Mineral Resources in Study Area in "no RMP" and "RMP" Cases



average, with a doubling of prices. Access to lands favorable for gold vein deposits within the study area and, therefore, to potentially economic deposits of this type was not impeded by the RMPs, but the plans have restricted access to lands within the study area which are geologically favorable for the other seven prospective deposit types determined by the baseline potential supply analysis to be potentially economic at this price level.

Likelihood and Number of Economic Deposits Made Inaccessible. In response to a doubling of prices, the likelihood that economic deposits exist on lands closed to mineral entry increases from 60 percent to 96 percent. At this price level a total of from 1 to 9 potentially economic deposits, with 3 or 4 on average, may be inaccessible (table 15). The likelihoods that economic deposits exist on lands now closed to mineral entry range from 94 percent for gold placers to less than 1 percent for tungsten skarns and uranium deposits. There is a 19 percent chance that from 1 to 3 potentially economic tin greisen deposits exist within geologically favorable areas which have been closed, in whole or in part, to mineral entry; a 12 percent chance that 1 or 2 economic alkalic-associated deposits have been made inaccessible; and a 7 percent chance that an economic sediment-hosted lead-zinc deposit has been made inaccessible.

Net Present Value of Inaccessible Deposits. There is a 90 percent chance that the total NPV of deposits which have been made inaccessible is between \$0.1 million and \$310 million (table 16). The potentially most valuable deposits, at this price level, are estimated to be the undiscovered tin greisen deposits which have a 5 percent chance of being

Table 15. Likelihood and Number of Economic Deposits on Lands
Closed to Mineral Entry at Twice Current Prices

Deposit type	Probability economic deposits exist	Conditional No. of Deposits		
		Average no.	Minimum no.	Maximum no.
Alkalic-associated gold	0.12	1	1	2
Gold placer	0.94	2 or 3	1	9
Gold vein	0.0			
Polymetallic vein	0.02	1	1	1
Sediment-hosted Pb-Zn	0.07	1	1	1
Tin greisen	0.19	1	1	3
Tungsten skarn	< 0.01	1	1	1
Rare Earths	< 0.01	1	1	1
Aggregate*	0.96	3 or 4	1	9

*For statistical reasons the values shown in each column cannot be added to derive the Aggregate values shown.

Table 16. Net Present Value of Prospective Types of Deposits
on Lands Closed to Mineral Entry at Twice Current Prices
(Net Present Value in millions of dollars)

Deposit Type	Net Present Value			
	Average	Exceedance Chance*		
		95%	50%	5%
Alkalic-associated gold	16.0	0.0	0.0	100.0
Gold placer	6.5	0.0	3.3	27.0
Gold vein	0.0	0.0	0.0	0.0
Polymetallic vein	0.3	0.0	0.0	0.0
Sediment-hosted Pb-Zn	26.7	0.0	0.0	87.0
Tin greisen	21.3	0.0	0.0	160.0
Tungsten skarn	0.2	0.0	0.0	0.0
Rare Earths	1.0	0.0	0.0	0.0
Aggregate**	72.0	0.1	7.9	310.0

*The likelihood that the Net Present Value exceeds the value shown.

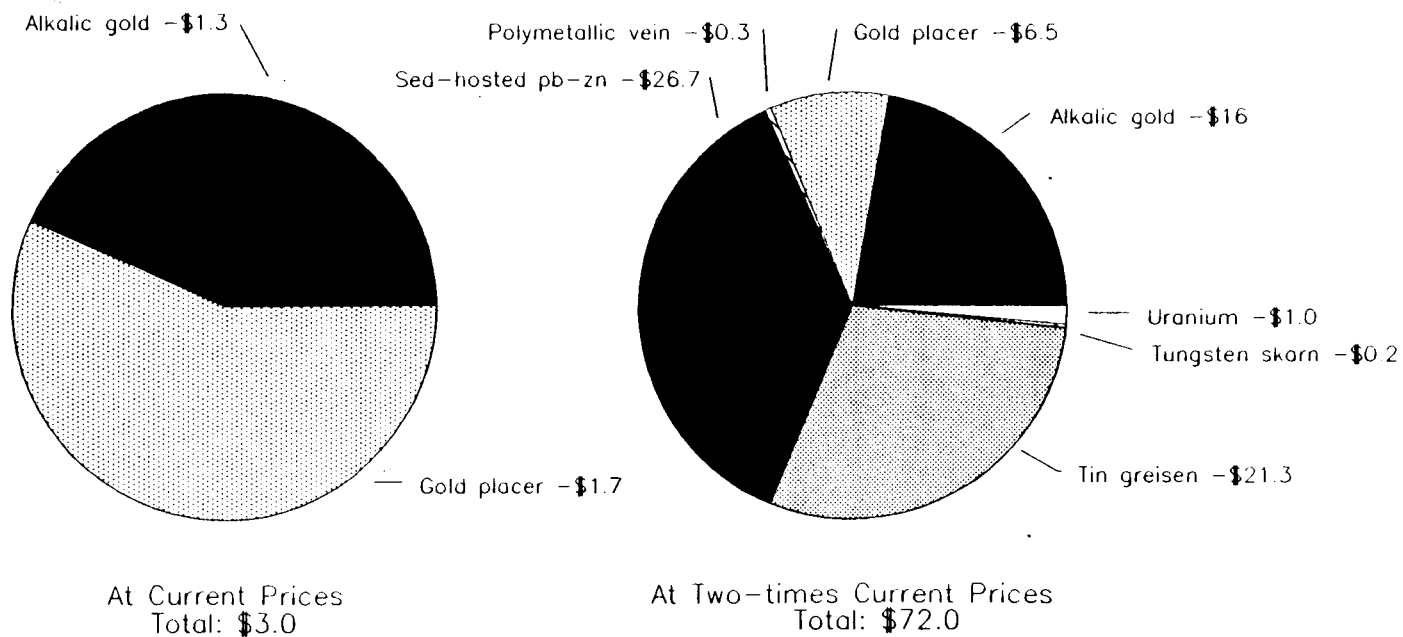
**For statistical reasons the values shown under the "Average" column can be added together to arrive at the Aggregate average but the values shown under the "Exceedance Chance" columns cannot be added together to arrive at the Aggregate values.

worth more than \$160 million, followed by the alkalic-associated gold deposits (5 percent chance of being worth more than \$100 million), the sediment-hosted lead-zinc deposits (5 percent chance of being worth more than \$87 million) and the gold placers (5 percent chance of being worth more than \$27 million). On average, prospective deposits of these four types account for over 98 percent of the total NPV of the mineral resources which have been made inaccessible (fig. 11).

Location of Inaccessible Potentially Economic Resources. The areas which have been closed to mineral entry and which are most most likely to contain economic deposits at twice current prices are located along the mineralized zone which overlaps the boundary of the WMNRA and the SNCA and along the southeastern edge of the study area (fig. 9). At twice current gold prices, potentially economic gold placer deposits which are inaccessible could be present in streambeds throughout the study area.

Foregone Mineral Supplies. At twice current prices, quantities of gold, lead, REO, silver, tantalum, tin, tungsten, uranium and zinc are estimated to be economically recoverable from lands which have been closed to mineral entry (table 15). Gold is still the commodity most likely to be foregone as a result of the RMPs. However, there is a 5 percent chance that 540 thousand tons of lead, 4000 tons of REO, 33 million ounces of silver, 290 thousand tons of tin, and 890 thousand tons of zinc will also be foregone. On average, at twice current prices, the RMPs have reduced the baseline supply potential of the study area by approximately 22 percent for gold, 100 percent for lead, 14 percent for REO, 96 percent for silver, 100 percent for tantalum, 94 percent for tin, 25 percent for tungsten, 20 percent for uranium, and 100 percent for zinc.

Figure 11. Average Net Present Value of Mineral Resources on
Lands Closed to Mineral Entry by Deposit Type
(\$ in Millions)



The average estimated market value of the potential metal production which has been lost as a result of mineral access constraints increases from approximately \$50 million at current metal prices to almost \$1.8 billion at two times current prices, or over thirty-six times. At current prices all of the foregone metal values are attributed to the inability to produce gold within the area. At two times current prices, however, almost 50 percent of the total foregone metal values are, on average, attributed to lost tin production.

Foregone Job and Income Benefits. At twice current metal prices, it is almost certain that lands closed to mineral entry within the study area contain deposits which would be profitable to produce if discovered (96 percent). If the lands closed to mineral entry do, in fact, contain deposits which would be profitable to produce, the foregone mineral development means a loss in the associated direct and indirect economic benefits which could have accrued to the state and local economies.

The total number of profitable mining operations which may have been precluded is estimated to range from 1 to 9, with 3 or 4 on average. Table 10 (presented in the baseline analysis in Chapter 2) provides examples of the employment, earnings and output benefits which may have been forgone due to the mineral closures.

Chapter 4

ANALYSIS OF ELEVEN PROSPECTIVE MINERAL ACTIVITY AREAS

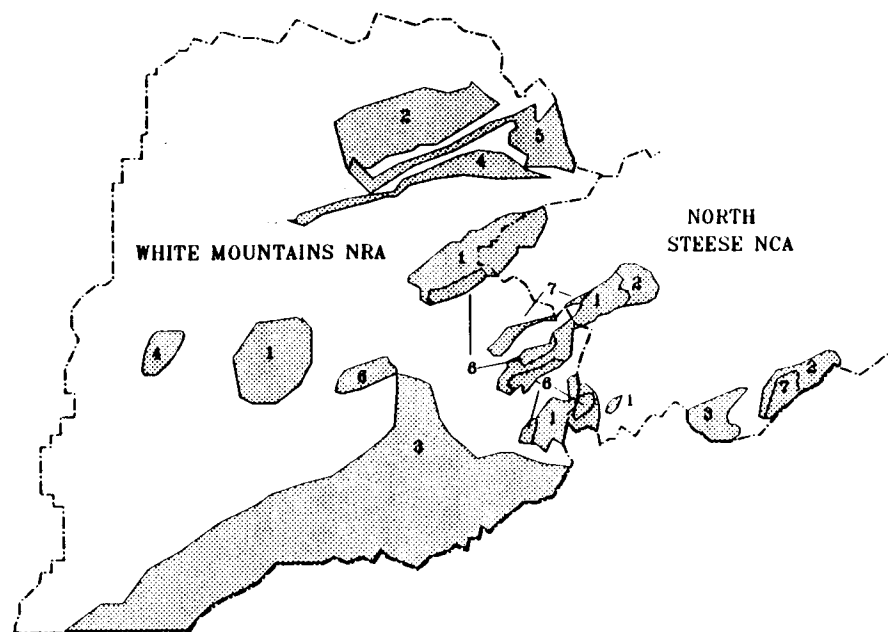
Following a preliminary analysis and presentation of the impacts of the SNCA and WMNRA resource management plans on the potential supply of minerals from the study area, the Steese-White Mountains BLM District Manager requested an additional assessment based on a grouping of mineral terranes into eleven prospective mineral activity areas. At the request of BLM, mineral deposits were evaluated at prices up to three times current prices as well as at current prices. A primary purpose of this analysis is to provide information which can be used in evaluating the impacts of potential modifications to RMP's.

The activity areas specified by BLM are shown in Figure 12 (for reference, the mineral terrane map is reproduced in the same figure). Generally, the activity areas are geographically distinct, and contain contiguous or overlapping mineral terranes, regardless of type. An exception, Activity Area 11, addresses gold placer potential throughout the study area. Table 17 lists the activity areas, the types of mineral deposits that may be present, and the potentially recoverable metals.

The methodology and assumptions used in this analysis are the same as those employed in prior chapters, although lower likelihood results (i.e. probabilities less than .01) are included. Results are summarized in Table 18, and additional results for each of the activity areas are provided in Appendix F.

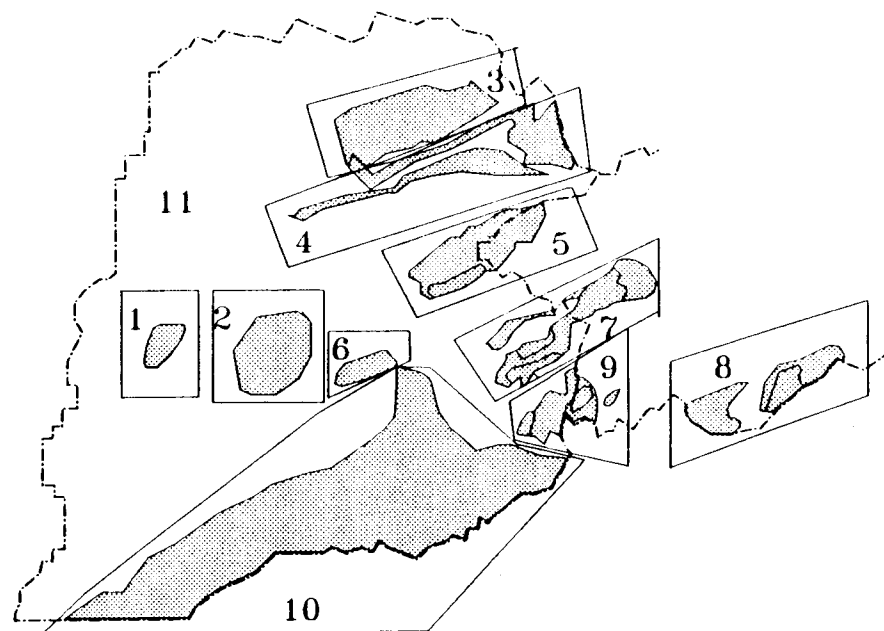
Figure 12. Location of Mineral Terranes and Delineation of Activity Areas in the WMNRA/SNCA Study Area

Mineral Terranes



1. Tin Greisens (Tin, Silver, Tantalum, Tungsten)
2. Tungsten Skarns (Tungsten, Tin, Silver)
3. Vein Gold (Gold)
4. Polymetallic Veins (Lead, Zinc, Silver)
5. Sediment Hosted Lead-Zinc (Lead, Zinc, Silver)
6. Rare Earths (Uranium, Thorium, REO's)
7. Alkalic-associated Gold (Gold, Silver)
8. Gold Placer Deposits Throughout the Study Area (Gold)

Activity Areas



- Area 1: Polymetallic Vein
- Area 2: Tin Greisen
- Area 3: Tungsten Skarn
- Area 4: Sediment Hosted Pb-Zn and Polymetallic Vein
- Area 5: Tin Greisen and Rare Earths
- Area 6: Rare Earths
- Area 7: Tin Greisen, Tungsten Skarn, Rare Earths and Alkalic-associated Gold
- Area 8: Tungsten Sharn, Vein Gold and Alkalic-associated Gold
- Area 9: Tin Geisen and Rare Earths
- Area 10: Vein Gold
- Area 11: Gold Placer

Table 17. Activity Areas and Component Mineral Terranes

Activity Area	Deposit Types	Potentially Recoverable Metals
1	Polymetallic Vein	Lead, Zinc and Silver
2	Tin Greisen	Tin
3	Tungsten Skarn	Tungsten
4	Sediment-hosted Polymetallic Vein	Lead, Zinc and Silver Lead, Zinc and Silver
5	Tin Greisen Igneous Uranium	Tin, Silver and Tantalum Uranium and Rare Earths
6	Uranium	Uranium and Rare Earths
7	Tin Greisen Tungsten Skarn Alkalic-associated Gold Igneous Uranium	Tin, Silver and Tantalum Tungsten and Tin Gold Uranium and Rare Earths
8	Tungsten Skarn Vein Gold Alkalic-associated Gold	Tungsten and Gold Gold and Silver Gold
9	Tin Greisen Igneous Uranium	Tin, Silver and Tantalum Uranium and Rare Earths
10	Vein Gold	Gold
11	Gold Placer	Gold

Table 18. Mineral Deposit Probabilities and Average Net Present Value of Economic Deposits In Eleven Activity Areas in the White Mountains National Recreation Area and the Steese National Conservation Area.

Activity Areas	Probability of Deposits	At Current Prices		At Three Times Current Prices ¹	
		Probability of Economic Deposits	Average NPV \$10 ⁶ (Conditional)	Probability of Economic Deposits	Average NPV \$10 ⁶ (Conditional)
1	0.110	0.002	8	.012	20
2	0.100	0.000	0	.000	0
3	0.010	0.000	0	.006	30
4	0.460	0.005	66	.131	482
5	0.940	0.001	267	.424	171
6	0.190	0.003	27	.034	81
7	0.560	0.008	63	.137	181
8	0.990	0.108	347	.521	338
9	0.320	0.002	34	.076	177
10	0.090	0.002	597	.013	464
11	1.000	0.595	3	.984	13

The probabilities that one or more deposits exist, that one or more economically recoverable deposits exist at current prices, and that one or more economically recoverable deposits exist at high prices are compared in Figure 13. As can be seen by the third bar in each group, activity areas 5, 8 and 11 are the most likely to contain one or more undiscovered deposits (probabilities between 0.9 and 1.0). Activity areas 4, 7 and 9 (probabilities between 0.3 and 0.6) make up the next most likely group, followed by 1, 2, 6 and 10 (probabilities between 0.1 and 0.2). Activity area 3 is the least likely to contain deposits with a probability less than 0.1.

Without additional information, these probabilities identify the most attractive targets for mineral exploration. However, the objective of exploration is to discover deposits that can be profitably developed. Based on economic criteria and current prices, area 11 ranked highest (probability of 0.6), followed by area 8 (probability of 0.1). For all other activity areas, the probability of an economic deposit at current prices is less than 0.01. Using the higher price assumption, the likelihood of an economically recoverable deposit is, again, highest for activity area 11; better than one in ten for areas 4, 5, 7 and 8; and less than one in ten in activity areas 1, 2, 3, 6, 9 and 10.

A second perspective is provided by Figure 14, which shows the expected value of metals that could be economically recovered from the eleven activity areas. These values are one measure of the potential importance of mining activity to the local and regional economies and, using the quantities of metal from which these values are derived (provided in the individual summaries), a measure of the importance of the potential mineral supply to the nation. From this perspective, activity

Figure 13. Comparative Probabilities for Eleven Activity Areas

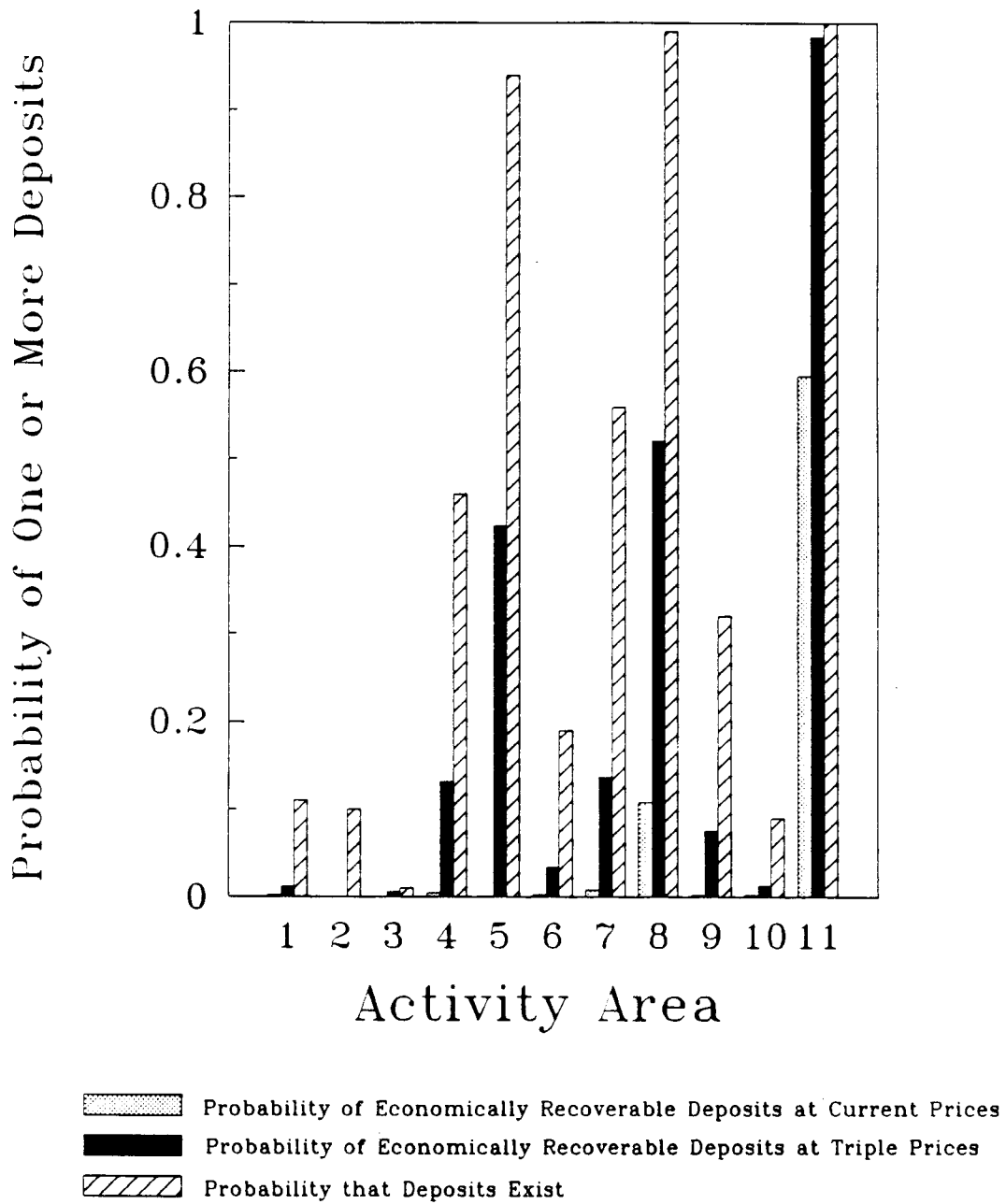
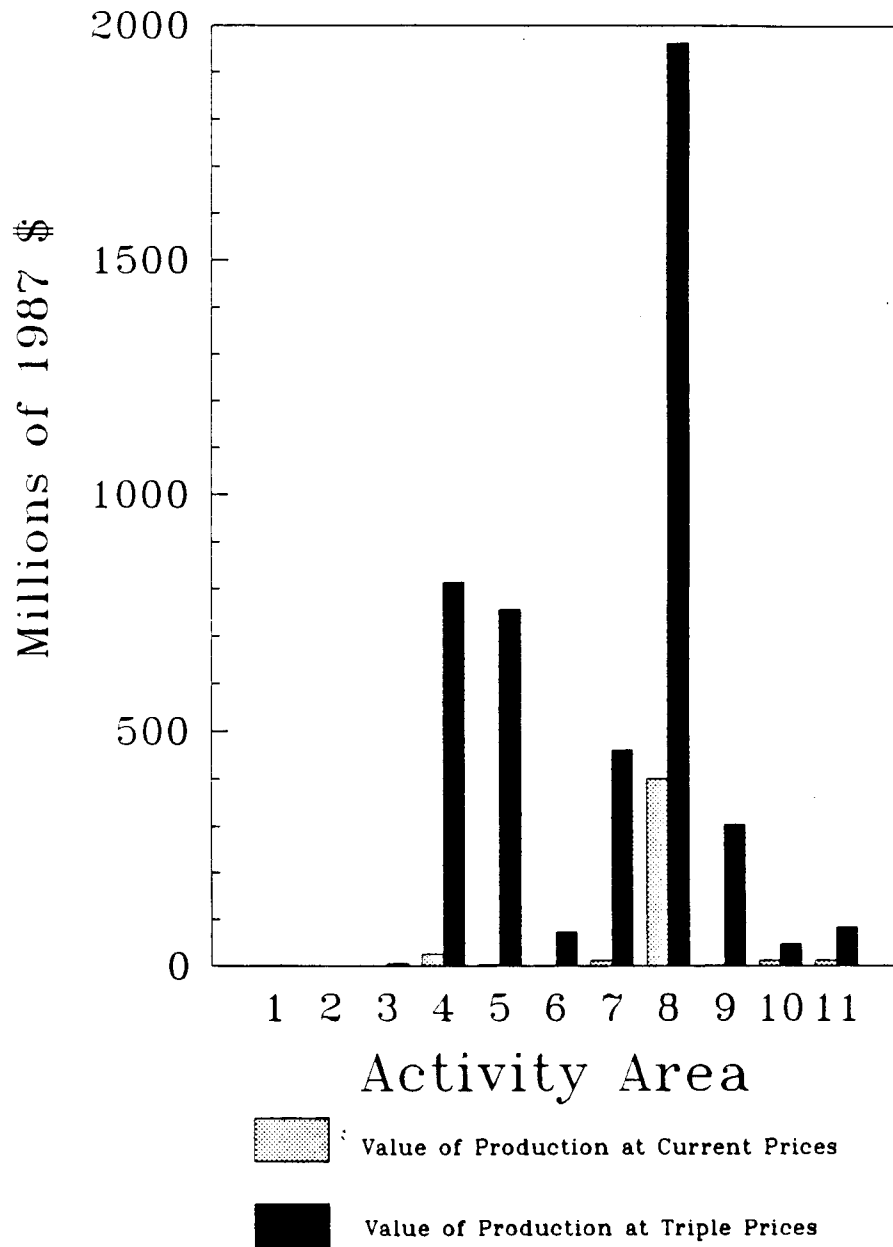


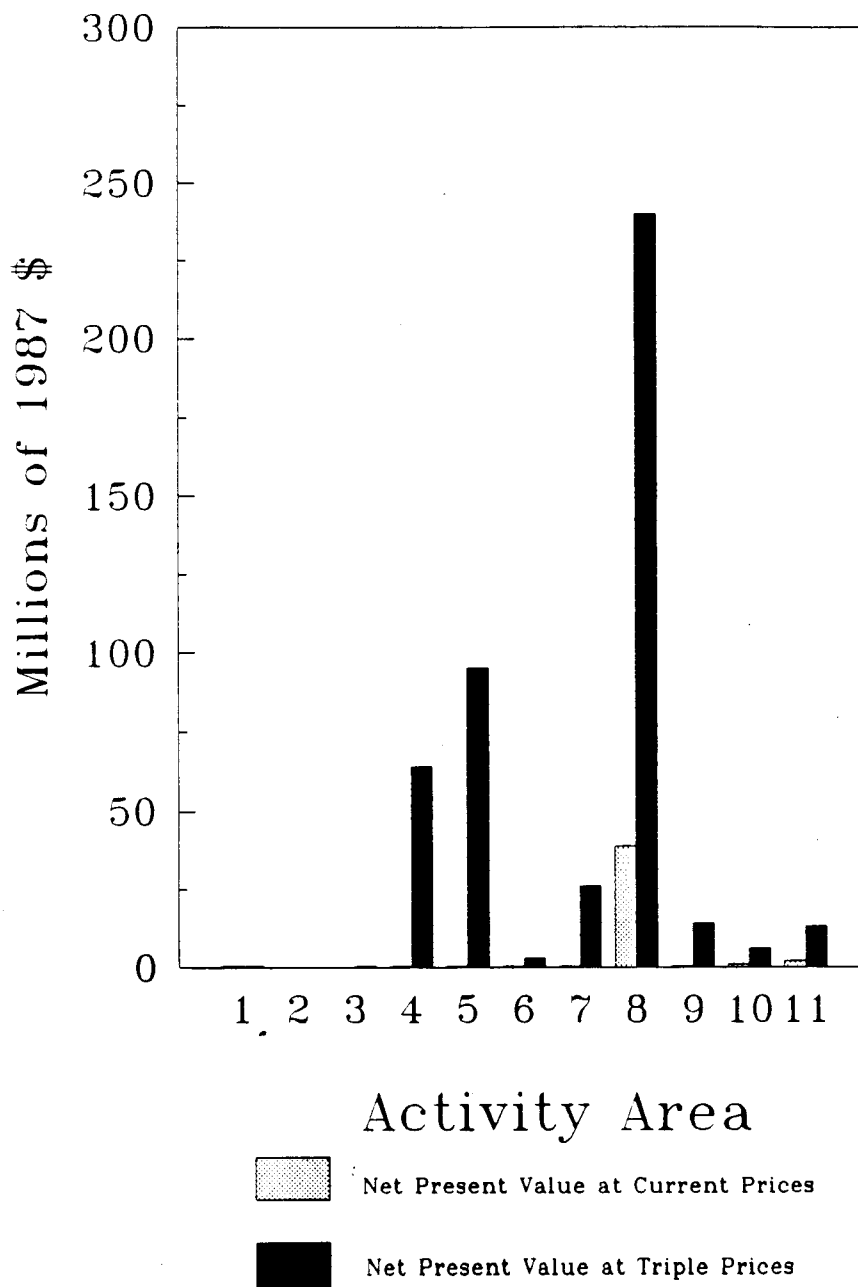
Figure 14. Expected Value of Production from Eleven Activity Areas



area 8 is clearly the most significant, at any price level. At current prices, the expected value of production is less than \$30 million for all other areas. At higher prices, areas 4, 5, 7 and 9 generate values in the \$200 to \$800 million range, areas 6, 10 and 11 between \$50 and \$100 million, and areas 1, 2, and 3 less than \$5 million.

A third viewpoint is that of the firms that would develop and operate mining and beneficiation facilities in the activity areas. Their objective is to generate the largest profits for owners and shareholders. Figure 15 illustrates this viewpoint using Net Present Value (NPV, defined as discounted revenues minus discounted costs) for each of the eleven activity areas. Again, area 8 is clearly the most attractive with an expected NPV of almost \$40 million at current prices, and \$240 million using the higher price assumption. At current prices activity area 11 is the second most attractive at \$2 million, while all others generate an NPV of \$1 million or less. At higher prices, areas 4 and 5 rank second (\$50 to \$100 million), followed by areas 6, 7 and 9 through 11, with NPV's between \$3 and \$25 million. Areas 1, 2, and 3 are ranked last with NPV's less than \$1 million.

Figure 15. Expected Net Present Value from Eleven Activity Areas



CONCLUSION

Approximately 44 percent of the lands which were identified within the study area as favorable for various types of undiscovered non-placer mineral deposits have been excluded from mineral access by land-use designations assigned by the WMNRA and SNCA RMPs. In addition, placer activity is also now largely prohibited throughout the study area. The results of the potential supply analysis estimate that, at the 90 percent confidence level, the total NPV of foregone resources that are potentially economically recoverable ranges from \$0 to \$12 million at current prices and ranges from \$100 thousand to \$320 million at two times those prices. On average, at the assumed price levels, from 7 to 37 percent of the total NPV of the mineral resources within the study area has been lost as a result of the mineral access constraints imposed by the WMNRA and SNCA RMPs.

Gold placer mining is the type of mining activity which is most likely to occur within the study area, if permitted. At the higher prices, the potentially most significant types of undiscovered deposits which have been made inaccessible, in terms of expected NPV, are the prospective tin greisens, sediment-hosted lead-zinc deposits, alkalic-associated gold deposits and gold placer deposits.

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