

5. Replacement costs of assets are computed by compounding the original cost of the assets at the annual escalation rate of 5%.

6. Assets that attract declining balance depreciation are not replaced.

From these assumptions, the initial capital expenditure is computed below based on the Assets acquisition file for 1990. (Appendix 3) This includes capital expenditure incurred for the expansion project.

Table 4.5: Initial Capital Expenditure (in Z\$)

Asset	Book Value	Annual Depreciation
Land and Mining Title	866678	-
Industrial and Commercial Buildings	779422	Declining Balance
Resident and Amenities Buildings	5428329	-do-
Shafts Mine and Civils	2037784	-do-
Plant and Machinery: Mining	1584919	191037
Plant and Machinery: Concentrator	2394910	399872
Plant and Machinery: Industry and Manufacture.	1622256	441280
Mobile Plant and Motor Vehicles	1057443	226718
Furniture/Fittings/Tools /Instruments	233791	33131
Development and Exploration	5047944	Declining balance
TOTAL	21053476	

Replacement

The annual escalation rate of equipment costs are estimated by the suppliers in Zimbabwe to be about 5% annually. Based on the above assumptions, the replacement costs are computed below.

Table 4.6: Computation of Replacement Costs (in Z\$)

Asset Class	<u>Age**</u>	*Original Value \$	*Economic Life	+Year Re-placed	Replacem-ent value.
Plant and Machinery: Industry/ Manufacture	8	53077075	12	4th	9530741
Mobile Plant and Motor Vehicles	5	19999597	9	5th	3102031
Plant and Machinery: Concentrator	6	4809873	12	6th	8637841
Furniture/ Fittings/Tools/ Instruments	6	430640	13	7th	812036
Plant and Machinery:	4	2307259	12	8th	4143506

* Economic Life = Original Value

Annual Depreciation

The economic lives of some asset classes are greater than their useful lives because assets of different useful lives and acquired at different times are consolidated into the same class according to the R.T.Z depreciation schedule.

** Age = Total Depreciation
Current Depreciation

+ Year replaced = Economic Life - Age

4.7 OPERATING COST ESTIMATION

Operating costs are defined as those ongoing, recurring costs incurred during normal functioning of the project. In general total project operating costs can be divided into three primary classifications - direct, indirect, and general (overhead).

Direct or variable, costs are considered prime costs and can be traced directly to the product being produced. Direct costs primarily consist of labour and material charges. Indirect or fixed, costs are expenditures which are independent of throughput. Although these costs often vary with the level of production, they do not vary directly with product throughput. General, or overhead, expenses may or may not be considered part of operating costs. They however, contribute and are assignable to total product cost even though they typically represent off-site charges.

Several methods are available for estimating operating costs for feasibility studies. These methods are similar to capital cost estimating methods and include:

- 1) Similar project method
- 2) Cost-capacity Relationship method
- 3) Component cost method
- 4) Detailed cost Breakdown method

The method used to estimate operating costs is the Detailed cost breakdown method and is discussed below.

4.7.1 Detailed Cost Breakdown Method

In this method of operating cost estimation, the major cost items of the mine are broken down into units. Estimates on powder factors; meterage drilled per bit, gallons of fuel consumed per operating hour per machine, quantity of detonating cord, primers, and delays per blast; and numerous other variables must be made in order to develop a detailed operating estimate.

A checklist of each job function is prepared and broken down into the materials, labour etc. needed for each job. Costs are developed for these elements. The total cost for the job is the total of these elemental jobs. The elemental costs are developed from time and work studies and current costs data based on final mine design and drawings are used.

4.7.2 Estimation of Renco Expansion Project's Operating Cost.

Operating costs are estimated during the annual budgeting process using historical data and measured costs. Indirect, or fixed, costs are estimated by compounding the past costs by the annual inflation factor.

Direct, or variable, costs are estimated using developed elemental costs of unit operations such as stoping, development etc. and the latest prices of high cost items. Wages and salaries are computed from the current wage rates and applying a factor for anticipated wage rises. Appendix 4 is a summary of unit costs and mine standards. For this project the annual operating cost are estimated using the 1990 operating cost budget as basis. The budget was prepared as a fixed and variable cost model. Each department is divided into five main cost centres: Stores, Salaries: Grade II+, Salaries: 1-10, Contract and Manufacture, Sundries. Each cost centre has a fixed and variable cost element.

Future costs are computed by compounding the current operating costs by an escalation factor of 10% annually. Wages and Salaries are compounded at 8.5% annually.

Some costs are not classified as operating costs or capital costs. These are divisional costs and training school costs. Divisional costs are expenditure on headquarters staff salaries, smelter and transport charges, insurance payment etc. Training school costs are expenditure on training of mining personnel. These are estimated

by compounding the current costs by 18% and 18.5% annually respectively.

TABLE 4.7: Summary of Renco Mine Fixed and Variable Cost Model: 1990

Department	Variable Cost	Fixed Cost	Total Cost	Unit Variable Cost
	Z\$ x 10 ³	Z\$ x 10 ³	Z\$ x 10 ³	Z\$ x 10 ³
Admini- stration	550	2,525	3075	2.23
Personnel	0	1,709	1709	0
Mining* :				
Stopping	2993	253	3246	12.12
Development	2919	144	3063	11.82
Tramming	699	19	718	2.83
Support	998	0	998	4.04
Shaft Maint.	88	466	554	0.36
Mine General	101	819	920	0.41
Rock Drill	242	39	282	0.98
Mining Engi- neering	555	556	1111	2.25
Mining Loaders	83	0	83	0.34
Mining Services	18	771	789	0.07
Power	783	1175	1958	3.17
Engin- eering	257	2930	3187	1.04
Mill	5734	870	6604	23.21
Stock Variance	0	0	0	0
TOTAL	16020	12276	28297	64.86

*Development includes driving ,cross cutting and raising while stoping consists of breaking ground in stopes only.

4.8 Depreciation

Depreciation is defined as a deduction allowed for computing taxable income which reflects exhaustion, wear and tear, and obsolescence of property used in trade or business. In general, property with useful life greater than one year can

be depreciated with one or more of several methods.

In order to calculate the annual depreciation deduction for an asset, it is necessary to determine:

- 1) the basis for depreciation
- 2) the useful life of the asset.

The basis in the property to be depreciated is the amount from which depreciation will be deducted. The basis is generally considered to be the total cost associated with placing an asset in service.

The useful life of the asset is estimated by the tax payer and is generally shorter than the assets physical life.

The salvage value is the value of the property at the end of its useful life. It represents that amount which might be obtained from the sale or disposal of the asset after it can no longer be used productively in one's trade or business.

4.8.1 Methods of Depreciation

Several methods are available for computing depreciation allowances on an asset and any method can be chosen by the tax payer provided it is consistent. The four methods which are most commonly used in the minerals industry are:

- (i) Unit of production (UOP) Method
- (ii) Straight Line (SL) Method
- (iii) Declining Balance (DB) Method

(iv) Sum of Years digits (SYD) Method.

Renco Mine uses the SL and DB methods and those are discussed in detail below.

1. The Straight-Line (SL) Method of Depreciation

The depreciation deduction is the same for each year with this method. The total amount of depreciation which may be deducted over the asset's life is equal to the basis minus estimated salvage value. This amount (adjusted basis) is divided by the number of years of useful life. Notationally,

If D_n = Depreciation in year n
 B = Depreciable basis
 S = Salvage Value
 N = Life of asset
 n = Year (1 - N)
 P_n = Units produced in Year n
 R = Total production in units
 T = Times straight line rate

SL depreciation D_n is,

$$D_n = \frac{1}{N} \times (B - S)$$

2. Declining-Balance (DB) Method

The declining-balance method is an accelerated depreciation method in that it provides for larger depreciation deductions in earlier years and lesser ones later years. With the declining-balance method the rate of depreciation is related to the normal straight-line rate which is divided by the number of years of useful life. The D.B. rate can be 1½, 1¼ or 2

depending on certain restrictions. When the rate is 2 it is called Double-declining balance (DDB). Using the notation above, the declining balance depreciation D_n is computed as:

$$D_n = \frac{T}{N} \times (B - \sum_{x=1}^{n-1} D_x)$$

where,

$$(B - \sum_{x=1}^{n-1} D_x) \geq S$$

4.8.2 Systems of Depreciation

Many systems of depreciation accounting are available from which the taxpayer can choose as many as he wishes to establish his accounts.

The major depreciation systems are:

- i) Single Item Accounts
- ii) Component Accounts
- iii) Multiple Asset Accounts

Renco mine uses the Multiple Asset Accounts System and this system is discussed in detail below.

i. The Multiple Asset Accounts System of Depreciation

Multiple asset accounts are generally broken into group, classified and composite accounts. The rates are determined differently for multiple

asset accounts, depending on the type of account established.

- a) Group Accounts: These accounts contain assets similar in kind with approximately the same useful lives. The group rate of depreciation is determined from the average of the useful lives of the assets in the account.
- b) Classified Accounts: These consist of assets classified according to use without regard to useful life, such as machinery and equipment, furniture and fixtures, or transport equipment.
- c) Composite Accounts: These accounts include assets without regard to their character or useful life. For classified and composite accounts the applicable rate is generally determined by computing the depreciation for one year for each item or each group of similar items, and dividing the total depreciation thus obtained by the total cost or other basis of the assets.

4.9 Estimating Renco Mine Depreciation

Renco mine depreciation allowances are deducted annually using the Group Accounts System. Assets are grouped according to their useful lives and/or kind. The rate of depreciation is determined from the average of the useful

lives of the assets. Straight line method of depreciation is used for all assets except for immovable property. Exploration and development are classified as immovable assets and depreciated by the declining balance method. Thus the depreciation schedule applied at Renco is:

Asset	Useful Life (Year)	Method	Salvage Value
Plant and Equipment	12	Straight Line	0
Furniture and Fittings	12	- do -	0
Vehicles	4	- do -	0
Immovable Property	7	Declining Balance	0

Based on the above depreciation Policy, the total project depreciation using the Assets acquisition file Appendix 5 and the replacement costs calculated above, the following annual depreciation deductions are applicable.

Declining Balance Depreciation

Assets that qualify under this method are:

Industrial and Commercial buildings	=	Z\$ 779422
Residential and Amenities	=	Z\$ 5428329
Shafts, Mine, and Civil works	=	Z\$ 2037784
Development and Exploration	=	<u>Z\$ 5047944</u>
TOTAL	=	<u>Z\$ 13293479</u>

Year	Adjusted Basis(Z\$)	Depreciation(Z\$)
1	13293479	1899068
2	11394411	1627773
3	97566638	1395234
4	8371404	1195915
5	7175489	1025070
6	6150419	878631
7	5271788	753113
8	4518675	645525
9	3873150	553307

Straight Line depreciation

Capital items that are depreciated on straight line basis as listed in the capital acquisition file (appendix5) give a total annual depreciation of \$ 1291038 for the first four years. After the 4th year, assets that have useful lives of 4 years are replaced as stated above and attract a new depreciation deduction. These deductions are also done for other assets that are retired in the 5th, 6th, 7th and 8th years respectively. The Table 4.8 below shows the straight line depreciation deductions for initial capital expenditure and replacement assets.

Table 4.8: Calculation of Straight Line Depreciation (in Z\$)

Yr.	Asset Acquired in 3rd Year	Asset Acquired in 4th Year	Asset Acquired in 5th Year	Asset Acquired in 6th Year	Acquired in 7th Yr.	Acquired in 8th Yr.	Total ST. Line
1	1291038						
2	1291038						1291038
3	1291038						1291038
4	1291038						1291038
5	849758	794229					1291038
6	623040	794229	775508				1643987
7	191037	794229	775508	719820			2192777
8	191037	794229	775508	719820	67670		2581395
9	0	794229	775508	719820	67670	345292	2893556
							2702519

Total Annual Depreciation

<u>Year</u>	<u>Total Annual Depreciation in Z\$ x 10³</u>
1	
2	3190
3	2919
4	2686
5	2487
6	2669
7	3071
8	3335
9	3539
	3256

4.9 Project Evaluation Criteria

Any satisfactory evaluation criterion used to distinguish between acceptable and unacceptable projects in a consistent manner and to rank projects under consideration in order of importance must respect two basic principles (Quirin, 1967)(28).

- 1) Bigger benefits are preferable to smaller benefits
- 2) Early benefits are preferable to later benefits.

In addition to those principles, the evaluation criterion of a mining project should:

- 1) be consistent with the firms primary object
- 2) be conformable and realistic

Numerous investment criteria are available for the evaluation of mining properties. These are:

- 1) Accounting Rate of Return
- 2) Payback (Payout) period
- 3) Present, Future and Annual value
- 4) Benefit/Cost Ratio
- 5) Internal Rate of Return
- 6) External Rate of Return
- 7) Wealth Growth Rate
- 8) Growth Rate of Return
- 9) Hoskold's Method

In this study the criterion used is the Present Value method.

4.9.1 The Present Value Method

In investment analysis we are more interested in the Net Present Value (NPV) which is simply the difference between the sum of the present value of all cash inflows and the sum of the present value of all cash

outflows. NPV is expressed as:

$NPV = \sum PV \text{ cash benefits} - \sum PV \text{ cash costs}$. An acceptable project proposal has a positive NPV (i.e. $NPV > 0$).

The present value technique offers the following advantages:

- 1) It takes into account the time value of money
- 2) It provides a single number, or cash equivalent, which can be used as an index for comparison at a specific point in time ($t = 0$)
- 3) The value of the present value amount is always a unique quantity for a given interest rate.

The method assumes that the investment will be borrowed and re-invested at the required rate of return specified by the company. It has drawbacks when comparing projects with different lives, even though it is the most valid method for such comparisons. Another disadvantage is that the magnitude of the project is not indicated and large or small NPV can result from either large or small investments.

4.9.2 The Internal Rate of Return

This method, also called the Discounted Cash Flow Rate of Return (DCFROR) method utilises the present value concept but seeks to avoid the arbitrary choice of a discount rate when evaluating the investment. It is defined as that interest rate which equates the sum of the present values of the cash inflows with the sum of the present values of the cash outflows for a project. It is the interest rate that satisfies the following expressions:

$$NPV = 0$$

$$PI = 0$$

$$\sum PV \text{ cash inflows} - \sum \text{cash outflows} = 0$$

PI is the profitability Index

$$\text{i.e. } \frac{CF_1}{(1+r)} - \frac{CF_2}{(1+r)^2} + \dots + \frac{CF_n}{(1+r)^n} = 0 \quad \dots \dots \dots (1)$$

The Internal Rate of Return has the following advantages.

- 1) It considers the time value of money
- 2) It gives the truest measure of profitability

Its disadvantages are:

1. The magnitude of the project is not indicated
2. Large or small investments give large or small IRR.

Since the NPV and the IRR methods are used in this study, both methods are compared below.

4.9.3 IRR versus NPV

Both methods provide identical accept/reject for a single investment proposal but can give contradictory results when comparing mutually exclusive projects. The difference between these two criteria is the result of different implied assumptions for reinvestment rates for funds generated by the project. The IRR method assumes that funds are reinvested at the IRR over the remaining life of the project while the NPV method assumes reinvestment at a rate equal to the required rate of return used at the discount rate.

In ranking projects, the NPV method is preferred since the assumption of reinvestment at the minimum return on opportunities available to the firm is the same for all proposals and presents some consistency since it is applied to all proposals.

4.10 DISCOUNT RATE

The appropriate discount rate (or hurdle rate) to use in evaluation of capital projects is the cost of capital which represents the bridge between investment policy and the firms primary objective. Van Horne (1974)⁽²⁹⁾ defined the cost of capital as the rate of return on a project that leaves unchanged the market price of its common stock. The cost of capital of a firm is a function of the explicit costs associated with specific sources of financing available to

the firm. The after tax costs of financing new investment through the use of debt, preferred stock and equity capital are calculated to establish an appropriate cost of capital for evaluation purposes. An appropriate way of combining these specific financing costs will be the weighted averages method.

The discount rate used in this project is 25% representing R.T.Z. cost of capital.

4.11 INFLATION IN MINE INVESTMENT ANALYSIS

4.11.1 Definition and Measurement of Inflation

Inflation is the general decline in the value of money measured by what it can buy and escalation is the price change of individual goods. The rate of inflation varies with the particular currency under consideration as well as the types of goods and services being purchased.

Inflation is usually measured by a dimensionless index which measures average price trends over a wide variety of goods and services. The indices most widely used to measure inflation are: the Consumer Price Index (CPI), the Producer Price Index (PPI) and the gross National Product Implicit Price Deflator (GNPIPD). Factor Cost Indices and Project Cost Indices are used to measure escalation.

4.11.2 Effects of Inflation on Investment Analysis

In investment analysis we are often confronted with escalation and income tax deduction, so inflation in general has to be properly handled to avoid errors in an investment analysis. These errors arise in:

1) Depreciation: Declining tax shelters

Depreciation deductions in appraising capital investment projects is to reduce the tax base of the investor. However due to inflation there is general rise in costs and prices while the amount of depreciation is tied to the original purchase price of the asset and thus becomes less effective tax shelter over time under inflationary conditions.

2) Working Capital Drain

Normally in the appraisal of capital projects, working capital is provided for at the beginning of the project. However under high inflationary conditions, prices of goods and services rise so high that expected revenues are not enough to cover this thus necessitating infusion of further working capital.

3) Capital Gains Taxation

Assets such as land, are not tax deductible due to the assumption that they do not lose value and can be resold at any time, to recover the initial investment. However if there is an increase, in constant money unit terms, the seller must pay taxes on the account of the apparent increase usually at the capital gains rate.

4) Discount Rate Adjustment

In most capital investment analyses, the market determined cost of capital is used as the minimum acceptable rate of return. This rate usually contains a component for inflation and should be used only when revenues and costs are also adjusted for inflation. If constant money unit analysis is used, then the discount rate should not contain a component for inflation.

An Inflation-Adjusted Required Rate of Return

The relationship used to adjust the rate of return for inflation during investment analysis is as follows:

Let i_c = constant money units rate of return

i_i = rate of inflation

i_e = effective interest rate, or inflation adjusted RRR.

Then if the cash flow are expressed in constant money units:

$$NPV = CF_0 + \frac{CF_1}{(1+i_c)} + \frac{CF_2}{(1+i_c)^2} + \dots + \frac{CF_n}{(1+i_c)^n} \dots \quad (2)$$

However, if the cash flows are in inflated (current) money units

$$NPV = CF_0 + \frac{CF_1}{(1+i_1)(1+i_c)} + \frac{CF_2}{(1+i_1)^2(1+i_c)^2} + \dots + \frac{CF_n}{(1+i_1)^n(1+i_c)^n} \dots \quad (3)$$

therefore, $(1 + i_e) = (1 + i_1)(1 + i_c)$

$$\underline{i_e = i_1 + i_c + i_c i_1} \quad (4)$$

Due to the perculiar characteristic of mining projects, they are highly vulnerable to the ravages of inflation therefore in Mine capital investment analyses inflation must be handled property to quantify its impact on the feasibility of such projects.

4.11.3 Handling Inflation in Investment Studies

In the generation of project cash flows two general approaches are used to handle inflation.

- 1) Uniform inflation with or without taxation.

2) Differential inflation (escalation) with income tax.

In the first approach it is assumed that all costs will increase at the same general rate of inflation. In the second approach it is recognised that the cost of individual inputs rarely if ever rise at the same rate. This assumption is true in the short run where market forces often amplify or dampen price sways caused by general inflation. The escalation rate of different cost items are determined and used to estimate the future cost with the present (year 0) values as basis.

Calculation of annual cash flows is done in two ways:

- escalated money units:- this refers to actual money units of revenue or cost that will be realised or incurred at specified future periods.
- constant money units:- refers to a hypothetical constant purchasing power money units that reflect average purchasing power of money at an arbitrary point in time chosen by the evaluator which normally is the time

that corresponds to the beginning of a project. The economic conclusions that are reached are always identical with either method provided consistency is maintained in the analysis.

In this project the escalated money units approach is used to compute cash flows taking into account the escalation rate of major cost items.

4.12 PRODUCTION OPTIMIZATION

The open-ended dynamic programming model of Elbrond et al (1982) is used to compute the optimum annual production schedule for Renco mine based on its expansion programme and the reserves, economic and technical parameters pertaining at the mine during the period of data collection.

4.12.1 Input Data

1. Ore Reserves

At the time of data collection the total ore reserves of the mine were:

Proved Reserves	32140 t
Probable reserves	273251 t
Reclamation reserves	73754 t
Sub total	668,413 t
Indicated Reserves	854770 t
Total	1523183 t

Production planning is based on the total reserves available. In chapter 2 of this

report the grade distribution of the entire deposit has been done based on global geostatistical parameters developed by Renco.

2) Technical Parameters

These parameters were extracted from the complete data on the mine performance statistics.

Mill Call factor = Mill recovery = 89%

Tonnage factor = $\frac{\text{Tonnage milled}}{\text{Run of mine tonnage}} = 95\%$

Grade factor = $\frac{\text{Mill Head grade}}{\text{Run of mine grade}} = 81\%$

Optimum working days per annum = 302 days.

3) Economic Parameters

Economic parameters such as capital expenditures, replacements, and depreciation have been calculated in earlier sections of this chapter. The price of gold has also been estimated for the life of the project.

Costs

The annual fixed and variable costs are developed for the life of the project based on Renco estimated annual escalation rates. The 1990 operating cost is used as basis.

The rates used are:-

Labour costs escalated at 8.5% annually
 Divisional costs escalated at 18% annually
 Training costs escalated at 18.5% annually
 All other costs escalated at 17.0% annually.
 Annual operating costs used in the project
 are listed in Appendix 6.

Table 4.9 Mining and Milling Variable costs in Thousands of Z\$

	<u>Mining</u>		<u>MILLING</u>	
	Labour	Other	Labour	Other costs
Administration	-	275	-	275
Stopes	-	-	-	1817
Development	1138	1781	1176	-
Training	-	-	-	95
Support	-	-	604	750
Shaft Maint.	-	44	248	44
Mine Gen.	-	50.5	-	50.5
Rock Drill	-	117	-	125
Mining Engg.	12	256	13	274
Loaders	-	40	-	43
Mining Services	13	5	-	-
Power	-	392	-	391
Engineering	112	12	-	13
Mill	-	-	120	-
	<u>1275</u>	<u>2972.5</u>	<u>2161</u>	<u>5734</u>
				<u>9611</u>

This is a breakdown of the fixed and Variable Cost model of Renco Mine (Table 4.7) Based on economic models of Taylor(30) and Lane(34).

Table 4.10: Unit Cost Calculation: Mining

Year	<u>Labour Cost (Z\$)</u>	<u>Other Cost (Z\$)</u>	<u>Total Cost (Z\$)</u>	<u>Unit Cost Z\$/t</u>
0	1275	2972.5	4248	17.20
1	1383	3269	4653	18.84
2	1501	3597	5098	20.64
3	1629	3956	5585	22.61
4	1767	4352	6119	24.77
5	1917	4787	6704	27.14
6	2080	526	7346	29.74
7	2257	5793	8049	32.59
8	2449	6372	8821	35.71
9	2657	12212	14869	60.19

* Labour cost is escalated at 8.5% annually.

Other costs are escalated at 10% annually.

Table 4.11: Unit Cost Calculation: Milling

Year	<u>Labour Cost</u>	<u>Other Costs</u>	<u>Total Costs</u>	<u>Unit Cost Z\$/t</u>
0	2161	9611	11773	47.66
1	2345	10513	12917	52.30
2	2544	11630	14174	57.38
3	2760	12793	15553	62.97
4	2995	14072	17067	69.10
5	3249	15479	18729	75.83
6	3527	17027	20553	83.21

7	3825	18730	22555	91.32
8	4150	20603	24754	100.22
9	4503	39488	43991	178.10

* Labour cost is escalated at 8.5% annually.

Other costs are escalated at 10% annually.

4.12.2 Decision Variables

1. Mining Rates

Three mining rates are possible and they can be determined from the following:

- a) The maximum hoisting capacity of the skip which is about 1000 t/day.
- b) The current daily milling rate of 750 tonnes.
- c) A minimum production of 550 t/day is possible since the current breakeven production is around 520 t/day.

The ore loss factor of the mine defined as:

$$\begin{aligned} \text{Ore loss factor} &= \frac{\text{Ore Milled}}{\text{Ore Mined}} \\ &= 90 \% \end{aligned}$$

The possible mining rates can be computed to the nearest hundred as: 1000, 800, and 600 tonnes per day.

2) Cutoff grades

Three mill feed grades are possible and can be determined from management policies and production statistics.

These are:

- a) The targeted grade of 6.9 g/t for the expansion project.
- b) The average grade of 6.49g/t for the orebody developed from orebody modelling in chapter 2.
- c) The current mill feed grade of 5.5 g/t.

On applying the grade factor defined as

$$\begin{aligned} \text{Grade factor} &= \frac{\text{mill feed grade}}{\text{Run of Mine (ROM) grade}} \\ &= 81\% \end{aligned}$$

The ROM grades associated with the three possible mill feed grades are 8.52, 6.86 and 6.79 g/t respectively.

From the grade tonnage curve, figure 2.1, the cutoff grades are read as 6.60, 6.00 and 4.00 g/t respectively. At these cutoff grades, 41%, 81% and 91% respectively of the total ore reserves can be sent to the mill to

obtain the average ROM grades envisaged.

To conclude, three mining rates and three cut off grades are possible: resulting in nine possible grade and tonnage combinations.

The problem objective therefore is to determine the annual production rates and cutoff grade that will maximise the projects total discounted cash flows (or the Net Present Value).

4.12.3 Cash flows

Cash flows are developed for each of the nine production combinations and discounted to year zero (0) at 25% discount rate representing Renco mine's Cost of Capital.

The project life (based on the ore reserves available) is about 8 years, hence eight cash flows are calculated, one for each year. (Table 4.13- 4.20)

4.12.4 Optimization of Production Variables

(i) States and Stages:

The maximum stages are computed as:

$$\text{Maximum stages} = \frac{\text{Total Ore Reserves}}{\text{minimum annual production rate}}$$

$$= \frac{1523183}{600 \times 302} = 8 \text{ years}$$

The maximum stages = life of the project = 8 yrs.

$$\text{The possible states} = \frac{\text{Total Reserves}}{\text{possible production increments}}$$

The three possible production rates differ from each other by increments of 200 t/day.

$$\text{Therefore the possible states} = \frac{1523183}{200 \times 302}$$

$$= 25.$$

However only 15 states will be used since after this state, the ore left is not enough to be mined in a year (unless further exploration discovers more ore).

Optimum Cutoff Grade

The optimum cutoff grade for each production rate is determined as the cutoff grade that results in a maximum discounted cash flow for that production rate. An analysis of the cash flow shows that for each production rate throughout the project life the 4.00 g/t cutoff grade gave the maximum discounted cash flow. Hence the cutoff grade for the expansion project is 4.00 g/t.

Optimum Production Rate

The optimum was determined using the open-ended dynamic programming algorithm of equation 3.7. The input into the model is the discounted cash flow associated with each production rate. The initial investment i.e. the value at stage 0 and state 0 ($F_0(0)$) is the starting point for computing the state-stage (decision point) values. The model was executed by writing a program in Lotus 1.2.3 using the flowchart of figure 4.1. The state-stage values are shown in figure 4.2.

The optimum production plan is shown as a bold line in the figure. The optimum plan yielded a Net Present Value of $\$7215 \times 10^3$ and a DCFROR of 35%. Table 4.14 shows the daily production rates and the cut off grades for the optimum plan.

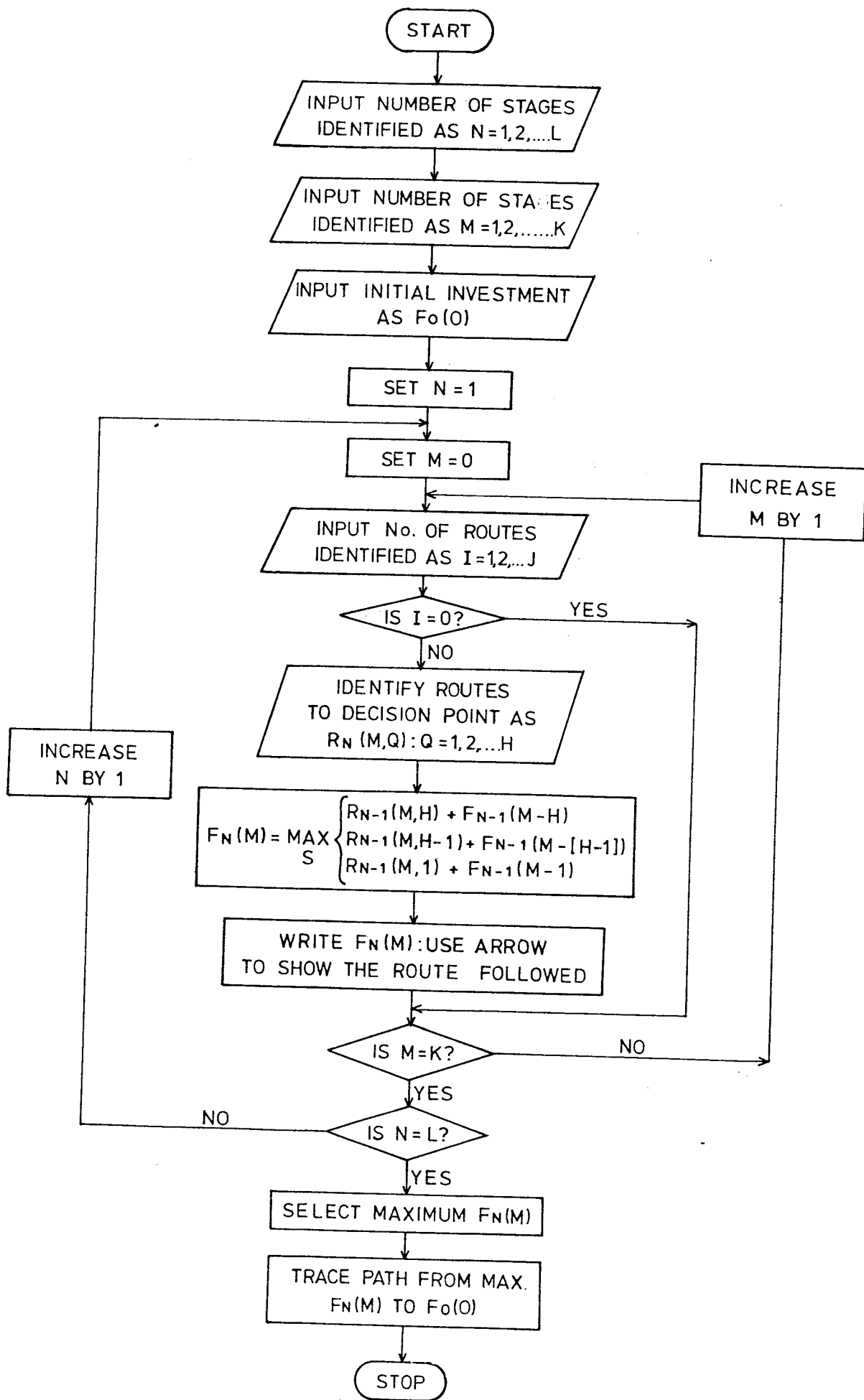


Fig. 4.1. FLOWCHART OF OPEN ENDED DYNAMIC PROGRAMMING MODEL

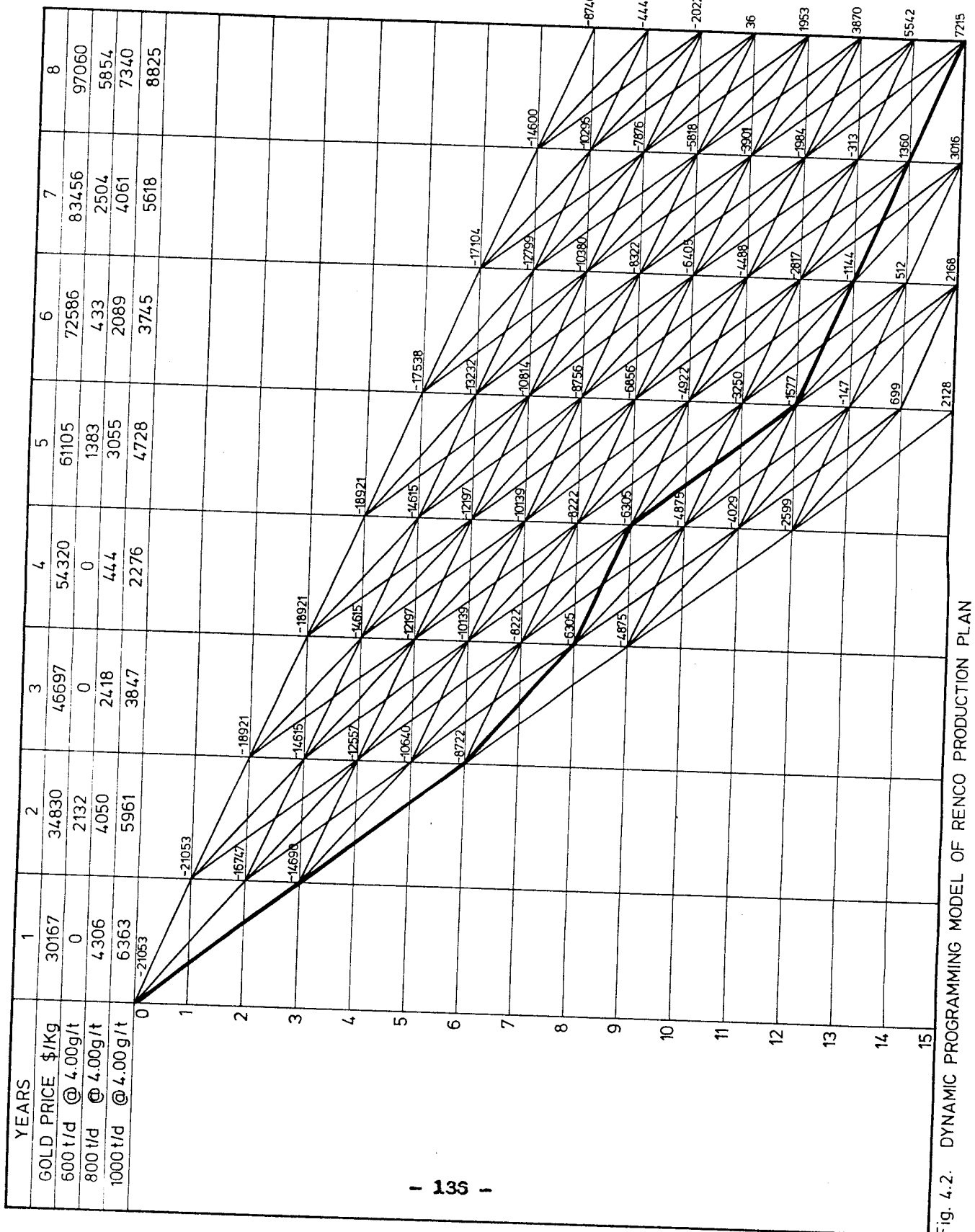


Fig. 4.2. DYNAMIC PROGRAMMING MODEL OF RENCO PRODUCTION PLAN

OPTIMUM SOLUTION			
YEAR	MINING RATE TONNES / DAY	CUTOFF GRADE GRAMS / TONNE	DISCOUNTED CASH FLOW \$ × 10 ³
1	1000	4.00	6363
2	1000	"	5967
3	800	"	2418
4	600	"	0
5	1000	"	4728
6	600	"	433
7	600	"	2508
8	600	"	5854
TOTAL D.C.F. (OR NPV) = \$ 7215 × 10 ³			
D.C.F.R. OR = 35%			

Table 4.21 STANDARD OPTIMIZATION

4.13 Generating Project Stoping and Development Schedules.

The stoping and development schedules for the project can be generated using the Mine Potentialities Concept. Since the annual production rates are known from the previous sections, the number of stoping blocks and development ends to maintain to achieve these targets can be calculated from equations (9) - (13) of chapter 3.

The calculations were done by writing a program in Lotus 1-2-3 using the flowchart of figure 4.3.

Appendix 5 shows the print out of the Schedule Generator. This program can be used to develop stoping and production schedules for any mining system if the optimum production plan and the basic technical and operational parameters are known. When the number of stopes and the number of development ends are known it is now possible to divide the mine into sections based on the labour and supervisors available, compute the production expected from each section and calculate the efficiencies of all mining operations. It is also possible to schedule blocks according to their starting and finishing times.

Table 4.21 below shows the results of the execution of the generator for the Renco project using the optimum production rates developed earlier in this chapter as basis.

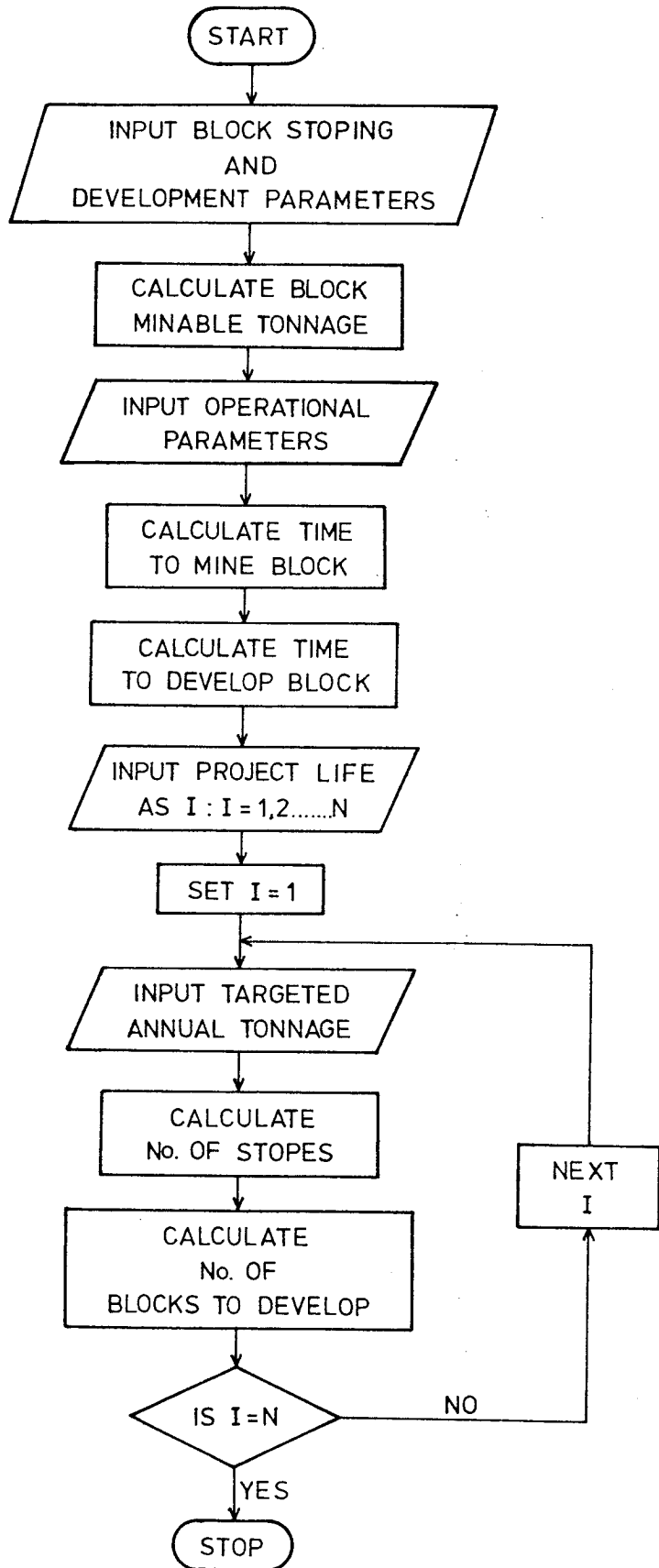


Fig. 4.3. FLOW CHART OF PROGRAMME FOR GENERATING, STOPPING AND DEVELOPMENT REQUIREMENTS

Table 4.22 Results of Stopping and Development Generator.

Year	Prod. Rate (t/d)	No. of Mining Blocks	No. of Dev. Blocks
1	1000	13	8
2	1000	13	8
3	800	10	6
4	600	8	5
5	1000	13	8
6	600	8	5
7	600	8	5
8	600	8	5

5. SENSITIVITY ANALYSIS

5.1 Risk and Uncertainty in Mine Investment Analysis

Mining projects are characterised by high risks and uncertainty. In decision theory, an analysis involves risk if the probabilities of future outcomes are known. Risk may be considered to be the dispersion of the probability distribution of the variable under consideration. (31)

An analysis is characterised by uncertainty if the frequency distribution of the possible outcomes are not known. In other words, uncertainty is the degree of lack of confidence that the estimated probability distribution is correct.

Two main types of risk are encountered in mine investment analyses. These are financial risks and business risk. (32)

5.2.1 Financial Risk

This refers to the uncertainty in earnings from investments due to the firms capital structure. A firms financial risk is a function of its capital structure which is reflected in the cost of capital.

5.1.2 Business Risk

This is defined by the type of business a firm is engaged in and is reflected in the fluctuation or variation of net earnings before interest charges and income taxation. Mining businesses are high risk ventures reflected in the previous low levels of debt financing for mining projects.

5.2 Accounting for Risk and Uncertainty

There are many approaches to evaluating the problem of risk and uncertainty.⁽³²⁾ These are:-

- (i) Intuitive judgement
- (ii) Certainty equivalent estimates
- (iii) Conservative adjustments
- (iv) Optimistic-pessimistic adjustments
- (v) Risk adjusted discount rate
- (vi) Break even analysis
- (vii) Three level estimates
- (viii) Sensitivity analysis
- (ix) Risk-adjusted payback period

In this project, Uncertainty is handled by carrying out a sensitivity analysis.

5.3 Sensitivity Analysis

Sensitivity analysis is a means of evaluating uncertainty on a capital investment project. This is done by varying some parameters and evaluating how the profitability of the project varies while other parameters remain constant.

If the probabilities of occurrence are associated with the levels of investment parameters, the sensitivity analysis becomes probabilistic.

The parameters to vary are chosen intuitively and they are usually those economic and/or technical parameters that most affect the viability of the project. For most mining projects, the most sensitive parameters are price, operating cost (affected by the inflation rate), capital investment, salvage value, project life and grade.

5.4 Sensitivity Analysis of Renco Expansion Project

The cash flows generated in the previous chapter were based on predicted gold price increments of 4% per annum, annual cost escalation rate of 10% per annum and an annual equipment cost escalation of 5%. Using these parameters, the Revenue, the operating cost and the replacement costs were estimated.

A base case model yielded a production plan which gave a project Net Present Value (NPV) of Z\$7,215,000.

It is however necessary to carry out a sensitivity analysis on the project since the parameters mentioned above are not known with a certainty. The parameters chosen to be varied are:

- (a) Gold price increment rate
- (b) Cost escalation rate
- (c) Replacement Cost
- (d) Salvage value.

These are economic parameters. No technical parameter was considered since these were determined from the execution of the dynamic program.

The objectives of the sensitivity analysis are to:

- i) investigate the viability of the project when the estimated parameters are varied within a certain range.
- ii) investigate the changes in the production model when the parameters are varied.
- iii) determine and investigate the parameters that can cause significant changes in the profitability of the expansion project.

A single parameter sensitivity analysis was carried out by writing a computer program in Lotus 1-2-3 version 2.01. One parameter was taken at a time and varied in the ranges of $\pm 20\%$, $\pm 60\%$ and $\pm 100\%$ while all other parameters in the base case were held constant. The maximum Discounted Cash flows

generated at each level of variation were input into the dynamic program to generate the optimum production plan at that level. The procedure employed is detailed in the flowchart of figure 5.1.

5.5 Results of the Analysis

The results of the analysis for each of the parameters are tabulated in tables 5.1 to 5.4. and displayed graphically in figures 5.2 and 5.3.

5.5.1 Price Increase Rate

The rate at which the price of gold increases, determines the level of the project revenue. In the analysis small changes in the price increase rates result in large percentage variation in the NPV. These variations are very significant. When the price is assumed not to change, the project becomes unviable with an NPV of $-Z\$11314 \times 10^3$ due to the fact that costs are increasing annually. This parameter is therefore very sensitive in the development of the production plan and must be estimated with a high degree of accuracy.

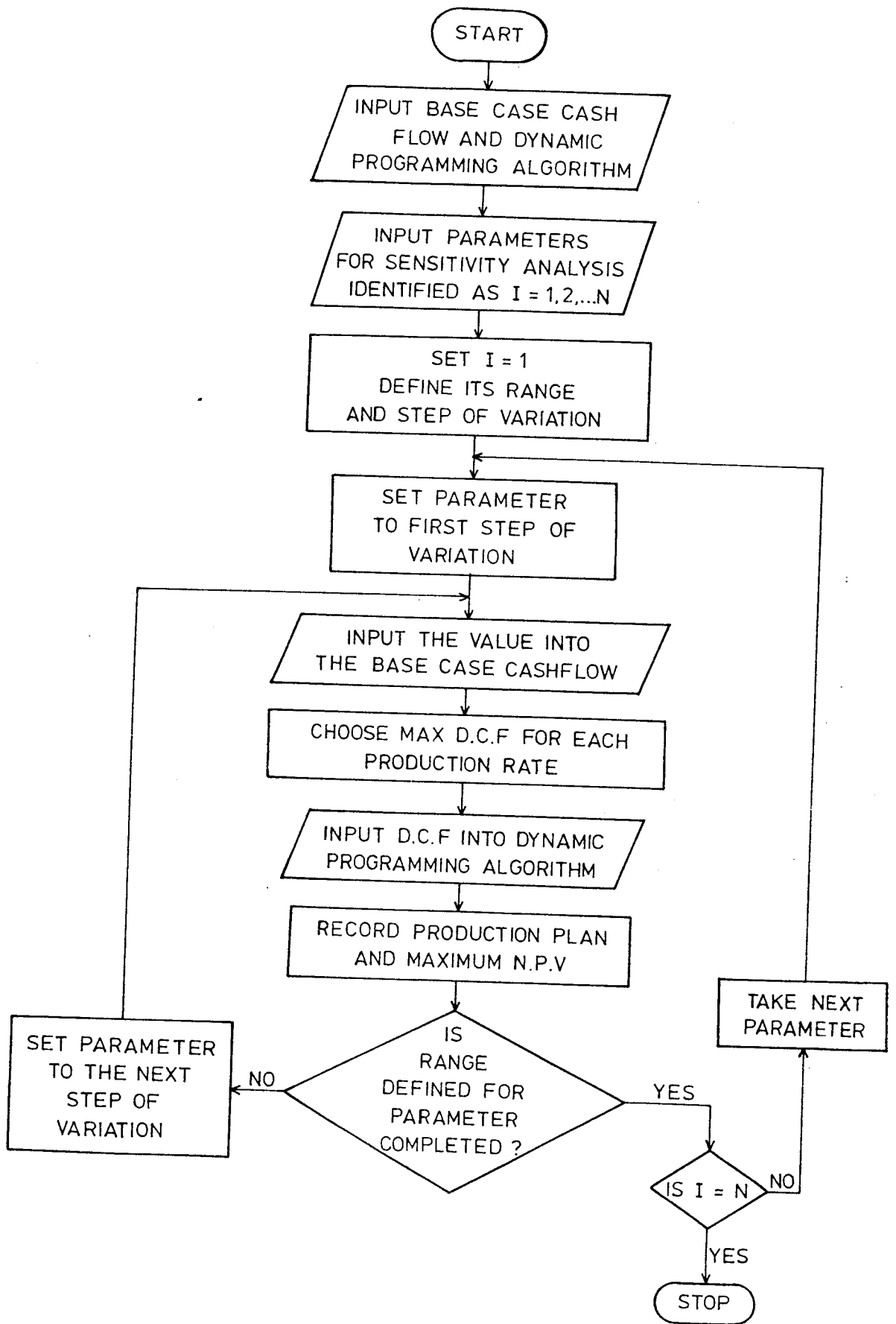


Fig. 5.1. FLOWCHART MODEL FOR SENSITIVITY ANALYSIS

		0%		1.6%		3.2%		DCF	
Tonnage	Grade	g/t	DCF	Tonnage	Grade	g/t	DCF	Tonnage	Grade
t/d			\$ x 1000	t/d			\$ x 1000	t/d	
1	4.00	1000	3946	1000	4.00	1000	5933	1000	4.00
2	4.00	1000	2079	1000	4.00	1000	5210	1000	4.00
3	4.00	600	0	1000	4.00	1000	5188	1000	4.00
4	4.00	600	0	800	4.00	800	0	800	4.00
5	4.00	600	0	600	4.00	600	532	600	4.00
6	4.00	600	0	600	4.00	600	0	600	4.00
7	4.00	600	0	600	4.00	600	1486	600	4.00
8	4.00	600	3714	600	4.00	600	4781	600	4.00
TOTAL DCF			-11314	TOTAL DCF			3485	TOTAL DCF	
%age Var			-256.8	%age Var			-51.7	%age Var	
								5675	
								-21.3	

		4.0%		4.8%		6.4%		8.0%	
Tonnage	Grade	g/t	DCF	Tonnage	Grade	g/t	DCF	Tonnage	Grade
t/d			\$ x 1000	t/d			\$ x 1000	t/d	
1000	4.00	6363	1000	4.00	4.00	4.00	6780	600	4.00
1000	4.00	5967	1000	4.00	4.00	1000	6717	600	4.00
800	4.00	2418	1000	4.00	4.00	1000	7330	1000	4.00
600	4.00	0	600	4.00	4.00	600	0	1000	4.00
1000	4.00	4728	800	4.00	4.00	800	4311	1000	4.00
600	4.00	433	600	4.00	4.00	600	1524	600	4.00
600	4.00	2504	600	4.00	4.00	600	3685	1000	4.00
600	4.00	5854	600	4.00	4.00	600	7120	800	4.00
TOTAL DCF			7215	TOTAL DCF			16452	TOTAL DCF	
%age Var			0	%age Var			128	%age Var	
								21963	
								204.4	

YEAR

PRODUCTION PLAN AT VARIOUS COST ESCALATION RATES

	0%		4%		8%		
Tonnage t/d	Grade g/t	DCF \$ x 1000	Tonnage t/d	Grade g/t \$ x 1000	Tonnage t/d	Grade g/t \$ x 1000	
1	4.00	7098	1000	4.00	1000	4.00	
2	4.00	7204	1000	4.00	1000	4.00	
3	4.00	2080	600	4.00	800	4.00	
4	4.00	4024	600	4.00	1000	4.00	
5	4.00	4620	1000	4.00	600	4.00	
6	4.00	1737	800	4.00	600	4.00	
7	4.00	3786	600	4.00	600	4.00	
8	4.00	7091	600	4.00	600	4.00	
TOTAL DCF		16587	TOTAL DCF		13202	TOTAL DCF	
%age Var		130	%age Var		83	%age Var	
						9670	
						34	

	10%		12%		16%		8.0%	
Tonnage t/d	Grade g/t \$ x 1000	DCF Tonnage t/d	Grade g/t \$ x 1000	DCF Tonnage t/d	Grade g/t \$ x 1000	DCF Tonnage t/d	Grade g/t \$ x 1000	
1000	6363	1000	4.00	6216	1000	5922	4.00	
1000	5967	1000	4.00	5706	1000	5170	4.00	
800	2418	800	4.00	2121	800	1497	4.00	
600	0	600	4.00	0	600	0	4.00	
1000	4728	1000	4.00	4271	1000	3252	4.00	
600	433	600	4.00	92	600	0	4.00	
600	2504	600	4.00	2150	600	1318	4.00	
600	5854	600	4.00	5495	600	4627	4.00	
TOTAL DCF		7215	TOTAL DCF		4998	TOTAL DCF		
%age Var		0	%age Var		-31	%age Var		
						733		
						-90		
						3634		
						-150		
						3714		
						2083		
						1970		
						4614		
						1380		

Table 5.3: Replacement Cost Sensitivity Analysis

PRODUCTION PLAN FOR DIFFERENT REPLACEMENT COSTS

YEAR	-100%		-60%		-20%		TOTAL DCF	%age Var			
	Tonnage t/d	Grade g/t	DCF \$ x 1000	Tonnage t/d	Grade g/t	DCF \$ x 1000			Tonnage t/d	Grade g/t	DCF \$ x 1000
1	1000	4.00	6363	1000	4.00	6363	1000	4.00	6363		
2	1000	4.00	5967	1000	4.00	5967	1000	4.00	5967		
3	800	4.00	2418	800	4.00	2418	800	4.00	2418		
4	1000	4.00	6180	800	4.00	2786	600	4.00	0		
5	600	4.00	2400	800	4.00	4072	1000	4.00	4930		
6	600	4.00	2698	600	4.00	1792	600	4.00	886		
7	600	4.00	2674	600	4.00	2606	600	4.00	2538		
8	600	4.00	5854	600	4.00	5854	600	4.00	5854		
							TOTAL DCF		TOTAL DCF		
							%age Var	87	%age Var	7904	
										%age Var	9.5

Tonnage t/d	0%		+20%		60%		100%		TOTAL DCF	%age Var		
	Grade g/t	DCF \$ x 1000	Tonnage t/d	Grade g/t	DCF \$ x 1000	Tonnage t/d	Grade g/t	DCF \$ x 1000				
1000	4.00	6363	1000	4.00	6363	1000	4.00	6363	1000	4.00	6363	
1000	4.00	5967	1000	4.00	5967	1000	4.00	5967	1000	4.00	5967	
800	4.00	2418	800	4.00	2418	800	4.00	2418	800	4.00	2418	
600	4.00	0	600	4.00	0	600	4.00	0	600	4.00	0	
1000	4.00	4728	1000	4.00	4525	1000	4.00	4118	1000	4.00	367	
600	4.00	433	600	4.00	0	600	4.00	0	600	4.00	0	
600	4.00	2504	600	4.00	2470	600	4.00	2402	800	4.00	2334	
600	4.00	5854	600	4.00	5854	600	4.00	5854	600	4.00	5854	
							TOTAL DCF		TOTAL DCF		TOTAL DCF	
							%age Var	7215	%age Var	6069	%age Var	2248
												%age Var
												-69

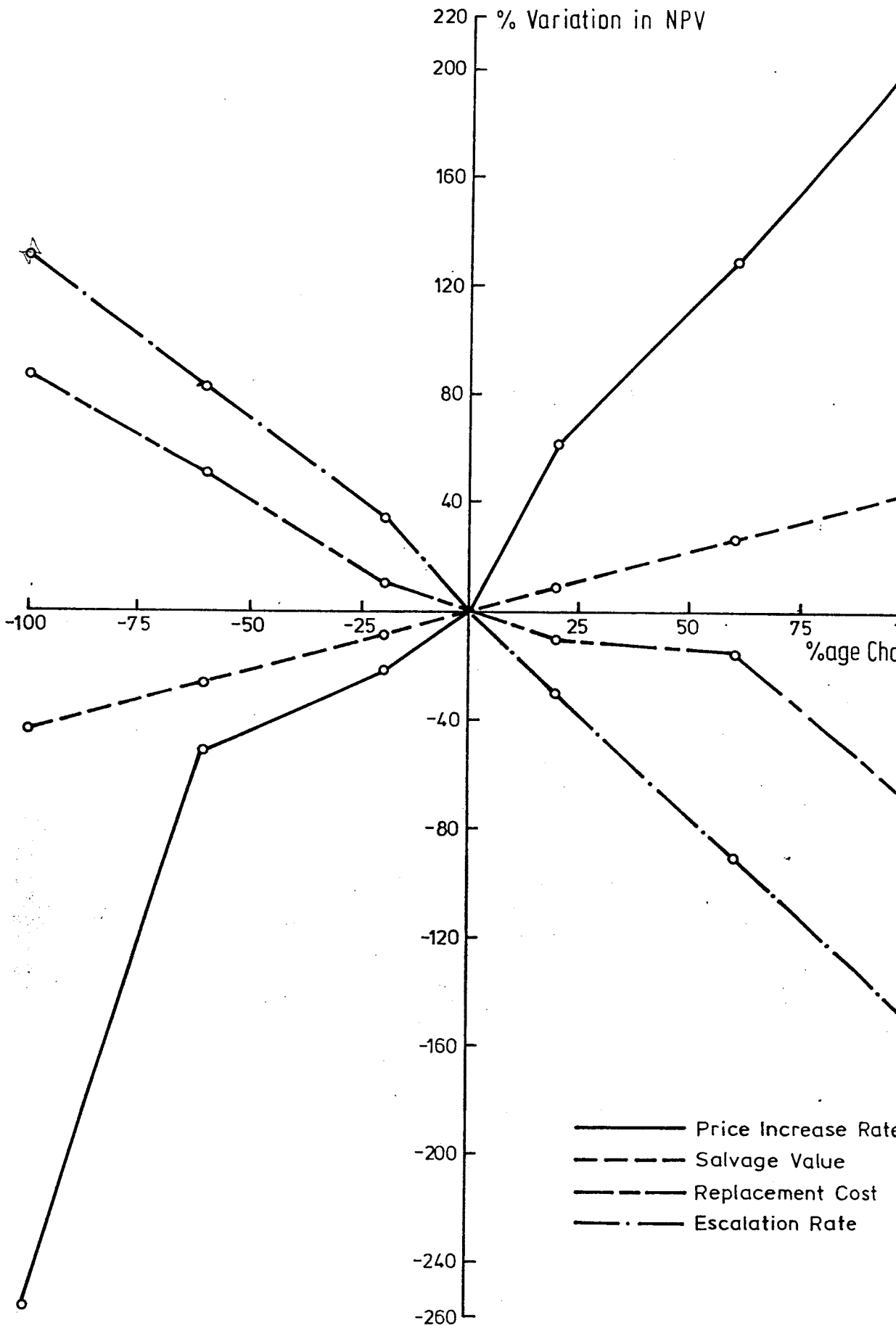


Fig. 5.2. PERCENTAGE VARIATION OF NPV WITH VARIATION IN SENSITIVE PARAMETERS

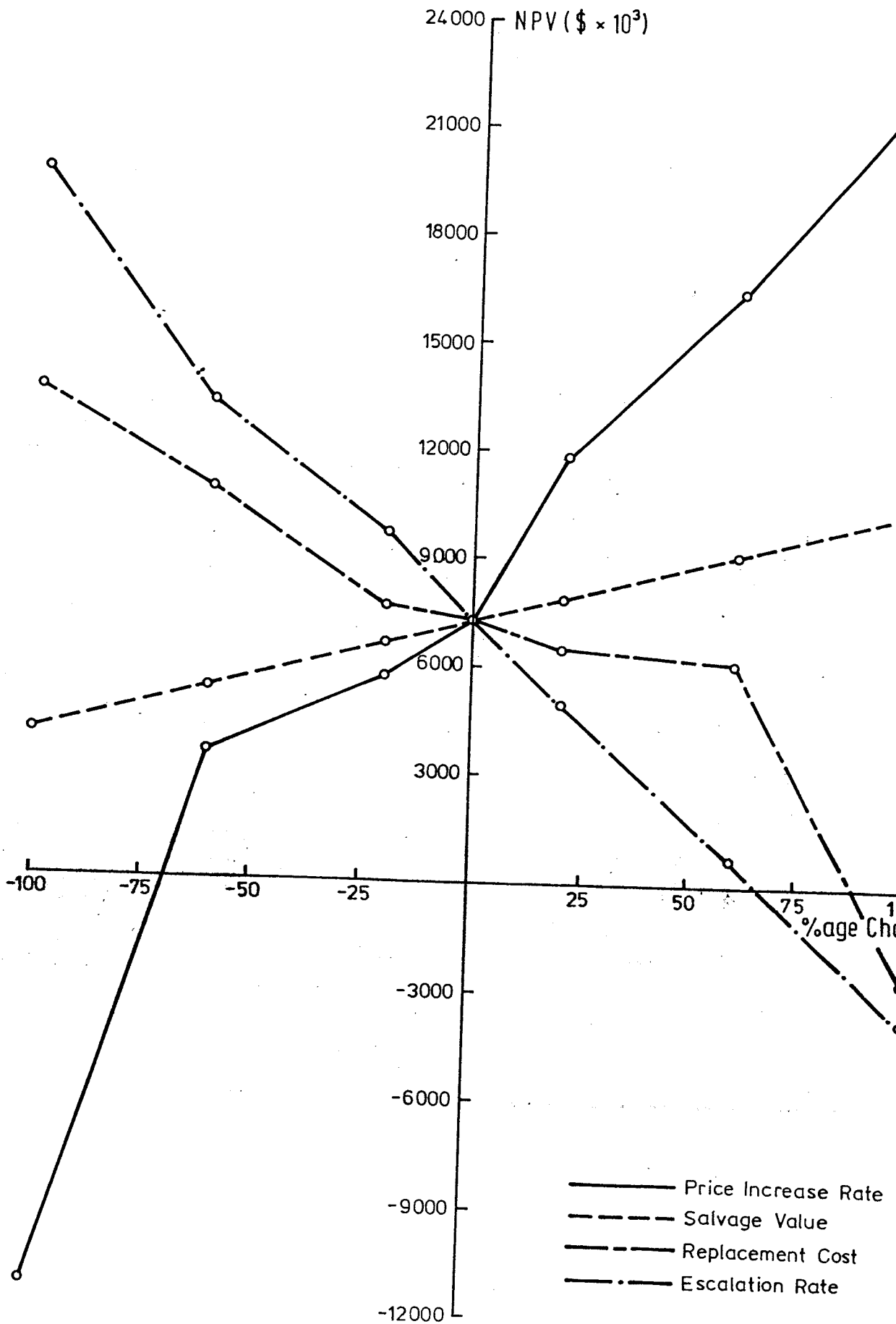


Fig. 5.3. VARIATION OF NPV WITH VARYING SENSITIVITY PARAMETERS

5.2.2 Cost Escalation Rate

The annual cost escalation rate affects the project's total operating cost. The analysis shows that the percentage variation in the NPV due to changes in the escalation rate is significant. The production plan also varies significantly from the base case.

When the escalation rate is doubled, the project is not viable.

5.5.3 Replacement Costs

When the annual price escalation rate for equipment and machinery changes, it affects the replacement cost. The replacement cost also affects the cash flows of the years in which they are incurred. The analysis showed that replacement as a cost does not cause as much a significant change in the NPV as the escalation rate. Nevertheless it is significant enough to affect the viability of the project at high levels of variation.

5.5.4 Salvage Value

Salvage value occurs far into the future of the project and when it changes, there is no significant percent variation the NPV. Even when

the salvage value decreases by 100% i.e. when there is no salvage value, the project is still viable. The production plan remains unchanged. Its accuracy is therefore not very important in determining either the viability of the project or the production plan.

DISCUSSIONS CONCLUSIONS AND RECOMMENDATIONS

A detailed structural analysis of the grade of the orebody was carried out in order to develop a grade-tonnage relationship for the mine.

This involved a statistical analysis of raw surface diamond drill borehole and underground development sampling data. The histograms obtained from these analysis were erratic and difficult to interpret. Probability plots of the data did not help much in the interpretation of the histograms.

The data was trimmed using suitable lower and upper cut off grades. The trimming was necessary to remove unreasonably low and high values which could have been due to sampling, assaying and other errors. Statistical analysis of the trimmed data produced right-hand skewed histograms suggesting log-normal behaviour. The data were further transformed by taking their natural logarithms. The histograms of the transformed values were normally distributed, a confirmation of the log-normal behaviour. Probability plots were straight lines which further confirmed that the grade is log-normally distributed.

The parameters developed for the surface diamond drill hole data were used for modelling the grade-tonnage relationship of the orebody. The underground data are normally used for detailed production scheduling.

The mean grade of the orebody was calculated by Koch and Link formula as 6.49g/t. The variance was found by the same formula as 48.88.

The second part of the structural analysis involved a variographic study of the data. Experimental variograms of the trimmed data were calculated since the variograms of the untrimmed data like the histograms were erratic and difficult to model.

The average variograms of both the underground and surface data could be modelled by spherical schemes. Some slight anisotropy was observed when the directional variograms were computed. This slight anisotropy could be due to the fact that the Renco orebody consists of several "geostatistically" different reef horizons

The variogram parameters were compared with the Renco mine values for the purpose of choosing suitable parameters for developing the grade-tonnage model. The Renco parameters were chosen due to the following reasons:-

- (i) Renco Mine used a larger volume of data.
- (ii) The computer software was custom designed after a preliminary study of the geology of the orebody was done.

The variogram parameters used were:

sill $c = 30.0$

nugget $C_0 = 17.0$

range $a = 30.0$

The grade-tonnage model was developed by the geostatistical approach. The simplified algorithm of Clark⁽¹⁰⁾ was used.

2. The optimum production plan was developed by using the open-ended dynamic programming algorithm. The objective was to find the production rates and the cut-off grades combinations that would yield a maximum Net present value (NPV) at the end of the project life.

Three daily production rates (600, 800 and 1000t/d) and three cut-off-grades (4.00, 6.00, 6.60g/t) were possible resulting in nine possible production rates and cutoff grades combinations. A maximum project life of eight years was calculated from the total ore inventory of 152 1383 tonnes at the time of data collection and a minimum mining rate of 600 tonnes per day.

Annual discounted cash flows were calculated for the nine possible combinations using economic parameters employed by Renco mine and technical parameters developed from this study and from Renco mine operational statistics. An analysis of the cash flows showed that those of the lower cut grade of 4.00g/t were bigger than those of the higher cut off grades for the same tonnage mined. This was due to the fact that at the lower cut off grade about 90% of the ore will be above cutoff grade and can thus be milled resulting in a higher bullion. Larger cash flows were also realised from the higher production rates.

From these analyses, the optimum cutoff grade for the project was found to be 4.00g/t since it yielded maximum Discounted Cash Flows (DCF's) for each production rate.

To execute the dynamic program, the number of states and stages were calculated from the ore reserves as 15 and 8 respectively. At each stage, three production rates represented as three DCF's were possible. The state-stage maximum DCF values were calculated using Roman's algorithm⁽¹²⁾. At the last stage, the state values are maximum total DCF's or Net Present Values (NPV's). The maximum NPV was found to be Z\$7215 x 10³ representing the optimum production plan for the 8 year period.

The total tonnage mined to realise this maximum NPV is 1872 400 tonnes which is higher than the total reserves of the mine during the time of data collection. In choosing this as a maximum production plan, it was anticipated that the ongoing exploration program at the mine will discover more ore.

However, if this were not possible, then the optimum production plan will have been 1000t/d for 5 years resulting in a maximum NPV of Z\$2,128,000 and a total tonnage of 11383 tonnes left unmined.

A production scheduling model was generated to determine the number of stoping blocks and development ends to maintain in order to achieve the planned production rates. This showed that it is possible to know the total number of stoping blocks as well as the number blocks to put under development when the optimum production plan is known from the economic view point. This scheduling generator can be used for any mining system to schedule mine operations as regards the timing of stoping and development operations. A single parameter sensitivity analysis was carried out on some of the economic parameters which were considered sensitive to the project. These were the annual gold price increment rate, the annual cost escalation rate, the capital replacement cost, and the salvage value. While one parameter was varied the others were kept constant as in the base case.

- (i) The gold price was predicted by Renco Mine to increase at about 4% annually with the 1990 predicted gold price of US\$375 per troy ounce being the base case. The analysis showed that the gold price is the most sensitive parameter since it determines the level of project revenue. The production plan will change drastically if the price of gold remains unchanged. In fact, if the same production plan is maintained, the NPV generated will be negative.

Below an annual increase of 1%, the production plan will have to be changed completely otherwise the project becomes non viable.

However, at the time of writing the project, the price of gold had actually fallen. The gold price generally does not vary by constant amounts. Table 6.1 shows the gold prices from 1984 to 1989.

TABLE 6.1 GOLD PRICES 1984-1989

	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1989</u>
LONDON FIXING am US\$/troy oz Real Dec. 1989 Prices	380.3	317.4	367.8	447.1	381.7
	392.1	344.0	414.1	489.6	384.8

Source: Metal Statistics 1990: The purchasing Guide of the Metals Industry AMM.

The table shows a wide fluctuation in the gold price. The expected 4% annual increase is therefore an over estimation which results in over estimated project revenues. Consequently it would be more appropriate to develop the optimum production plan based on the No-change model procedure of calculating mine revenues.

- (ii) The annual cost escalation rate affects the operating cost of the project. Renco mine assumed an annual cost escalation of 10% in

projecting future costs. The sensitivity analysis showed that the escalation rate is also a very sensitive parameter in determining the optimum production plan. When the escalation rate almost doubles, the plan has to be changed completely since the NPV will be negative. The escalation rate used is conservative since the trend in developing economies leans towards high inflation rates.

(iii) The annual escalation rate of machinery is reflected in the replacement cost. This parameter is not as sensitive as the first two. This is probably due to the fact that replacements costs are not incurred until the end of the fourth and fifth years.

(vi) The salvage value is insensitive to the production plan since it is incurred in the final year of the project. At all levels of salvage value, the NPV is positive.

Generally therefore, the gold price and the cost escalation rate must be as accurately determined as possible.

The current trend in gold price and inflation rates especially in developing countries has resulted in the closing down of some mines whilst others have embarked on

drastic cost saving measures just to break-even. It is therefore expedient that Renco mine takes a closer look at their economic forecasting methods and their planning and scheduling procedures in order to ensure the successful implementation of their expansion project.

Efforts should additionally be made to introduce comprehensive cost saving measures to offset the high inflation rates and low gold prices.

- (v) A study similar to this one and incorporating the first three recommendations should be undertaken to determine a more workable optimum production plan for the mine.

ix 1: Renco Mine Surface Diamond Drill Data

	metres					
	metres					
d.	metres					
	metres					
	g/t					
Wi.	Cm.					
0	686.00	-99.90	636.51	2.42	100	14
0	691.00	-99.90	601.75	16.40	117	15
0	720.00	-99.90	598.75	16.88	100	28
0	780.00	-99.90	636.70	3.48	100	34
0	795.00	879.91	626.44	1.99	188	35
0	825.00	-99.90	632.11	3.47	155	36
0	870.00	-99.90	648.31	0.75	182	37
0	910.00	-99.90	652.63	2.27	139	38
0	950.00	-99.90	654.68	5.26	322	42
0	1016.00	-99.90	653.30	6.12	100	43
0	885.00	-99.90	586.88	5.67	123	44
0	891.00	-99.90	639.44	14.29	356	45
0	917.00	-99.90	660.98	1.54	317	51
0	711.00	-99.90	538.31	1.79	160	52
0	836.00	850.82	586.91	20.74	176	54
0	787.00	793.58	559.74	16.82	232	55
0	739.00	-99.90	541.17	7.20	102	56
0	1083.00	-99.90	677.09	1.68	102	57
0	1035.00	1125.15	661.83	1.00	100	59
0	810.00	-99.90	574.31	1.32	152	61
0	683.00	744.15	524.68	2.14	145	62
0	866.00	-99.90	605.67	12.52	240	63
0	940.00	956.27	619.80	0.36	100	64
0	836.00	0.00	583.91	25.00	277	65
0	887.00	1111.21	590.60	0.22	100	66
0	937.00	-99.90	610.53	12.14	134	67
0	733.00	801.74	552.74	18.43	100	71
0	655.00	720.51	561.69	1.40	115	72
0	885.00	958.02	588.21	2.93	185	75
0	586.00	649.70	519.83	0.69	183	76
0	945.00	958.54	613.17	12.62	327	77
0	907.00	922.67	622.12	7.53	222	79
0	863.00	874.92	595.10	9.21	184	80
0	850.00	858.56	582.49	2.73	152	81
0	643.00	708.68	528.74	1.72	100	83
0	772.00	775.02	560.00	3.51	106	84
0	1224.00	1286.18	788.16	8.88	169	85
0	571.00	633.64	519.96	0.93	100	86
0	740.00	816.76	592.00	6.49	188	87
0	808.00	814.03	565.51	0.00	100	88
0	1188.00	1308.59	749.16	0.94	100	89
0	780.00	858.85	589.93	12.27	100	90
0	606.00	671.42	542.07	1.46	100	91
0	758.00	830.58	562.87	6.90	160	93
0	1156.00	1202.16	722.73	13.11	547	92
0	769.00	770.50	551.52	3.87	190	94
0	678.00	742.28	542.28	1.62	101	95
0	554.00	614.08	535.75	1.06	100	97
0	737.00	-99.90	542.39	5.75	150	99
0	838.00	846.76	584.16	1.48	237	100
0	632.00	-99.90	505.16	4.15	139	101
0	600.00	-99.90	511.26	1.08	100	102
0	1194.00	1246.53	748.99	9.01	100	103
0	707.00	-99.90	524.46	4.15	110	104

870.00	800.00	805.29	565.67	4.14	100	105
728.00	660.00	-99.90	516.04	0.81	113	106
940.00	802.00	807.92	577.05	9.20	127	107
953.00	890.00	901.59	599.28	8.37	129	110
995.00	943.00	1111.21	606.97	9.80	357	113
1005.00	1224.00	1274.78	752.64	11.77	409	116
943.00	972.00	986.67	620.32	11.65	141	120
1043.00	902.00	919.20	618.73	5.89	155	121
1122.00	840.00	860.94	613.25	7.87	100	126
1188.00	772.00	790.59	588.46	3.77	166	128
1263.00	693.00	-99.90	544.20	8.38	143	129
1212.00	1026.00	1062.18	645.26	12.51	101	130
1376.00	684.00	-99.90	563.86	0.41	100	132
1290.00	1240.00	1111.21	661.81	4.35	304	144
1070.00	1281.00	1333.87	761.00	12.83	206	146
1282.00	1353.00	1379.28	723.41	0.73	113	148
1246.00	1405.00	1111.21	765.57	0.22	362	149
1142.00	1355.00	1407.64	754.30	3.51	100	150
1195.00	1473.00	-99.90	773.49	2.58	106	151
1170.00	1498.00	-99.90	789.44	1.90	237	152
1302.00	1505.00	-99.90	787.64	0.50	130	153
1105.00	1292.00	-99.90	739.45	6.41	247	156
1183.00	1293.00	1333.46	714.68	2.25	222	158
1073.00	1396.00	-99.90	780.05	0.17	100	160
1324.00	800.00	-99.90	627.25	14.64	446	161
1081.00	1430.00	1111.21	757.48	1.84	100	162
1472.00	790.00	-99.90	621.50	7.56	100	163
1464.00	882.00	-99.90	551.77	3.67	100	164
1590.00	808.00	-99.90	630.00	0.00	100	165
1417.00	788.00	-99.90	626.30	1.60	100	166
1510.00	904.00	-99.90	635.58	8.86	100	167
1027.00	1067.00	1169.93	672.33	4.26	100	171
1357.00	1395.00	-99.90	719.03	0.10	100	172
1568.00	1432.00	1111.21	730.70	2.56	134	179
1310.00	1414.00	-99.90	734.05	0.10	100	183
1305.00	1369.00	-99.90	712.64	0.22	112	184
1293.00	1300.00	1323.73	688.72	0.60	100	188
1071.00	371.00	-99.90	308.50	0.42	100	190
1121.00	717.00	-99.90	533.46	2.86	189	191
1278.00	1271.00	-99.90	674.91	0.40	245	194
1100.00	536.00	-99.90	415.80	11.02	134	199
968.00	473.00	-99.90	378.84	13.85	158	202
600.00	529.00	-99.90	496.13	4.84	167	203
556.00	488.00	-99.90	467.85	0.37	100	204
589.00	450.00	489.44	337.38	0.13	184	204
916.00	638.00	-99.90	477.53	0.48	100	212
705.00	553.00	608.32	503.45	0.11	100	213
1060.00	637.00	-99.90	485.63	2.49	100	214
1236.00	1067.00	1086.01	652.57	1.08	100	215
1326.00	1259.00	-99.90	661.93	8.96	100	216
1222.00	803.00	816.45	618.03	23.71	268	217
990.00	556.00	-99.90	446.68	1.64	100	218
1305.00	731.00	-99.90	568.00	2.29	100	220
1270.00	765.00	768.53	598.98	0.93	100	220
1065.00	503.00	-99.90	392.99	10.00	100	221
1340.00	639.00	-99.90	523.29	6.32	100	222
1221.00	644.00	-99.90	500.19	8.77	123	224
1420.00	714.00	-99.90	583.06	0.43	105	225
1474.00	630.00	-99.90	545.69	6.83	153	226
1207.00	508.00	-99.90	422.22	5.00	100	227
1267.00	570.00	-99.90	455.30	3.53	100	228
1415.00	565.00	-99.90	499.17	4.61	100	229
1268.00	437.00	-99.90	380.10	0.04	299	230

1131.00	426.00	442.26	354.31	0.53	100	232
1584.00	565.00	-99.90	510.14	1.35	100	234
1353.00	527.00	-99.90	412.45	1.09	110	236
1704.00	553.00	-99.90	537.08	3.36	100	238
1690.00	698.00	-99.00	528.47	2.45	116	242
1471.00	504.00	-99.90	467.31	2.97	116	243
1345.00	355.00	-99.90	349.67	2.54	124	244
1412.00	422.00	-99.90	407.12	4.74	113	247
1469.00	343.00	-99.90	377.61	1.88	100	251
1524.00	401.00	-99.90	427.68	1.63	154	252
1604.00	486.00	-99.90	478.34	8.37	100	254
1626.00	354.00	-99.90	435.72	7.68	125	255
1696.00	425.00	-99.90	495.52	4.95	100	256
1767.00	496.00	-99.90	524.83	3.11	135	257
1845.00	570.00	-99.90	567.30	0.10	112	258
1918.00	643.00	-99.90	616.74	0.00	100	259
1556.00	283.00	-99.90	378.74	13.17	133	263
847.00	424.00	-99.90	363.96	0.16	100	290
778.00	356.00	-99.90	310.51	0.00	100	291
922.00	354.00	-99.90	317.91	5.52	131	292
1203.00	353.00	-99.90	308.48	19.42	100	294
1488.00	216.00	-99.90	279.78	1.66	100	295
1411.00	279.00	-99.90	335.18	1.82	100	296
1696.00	282.00	-99.90	378.91	1.36	100	297
1776.00	350.00	-99.90	449.13	4.86	100	298
1620.00	207.00	-99.90	347.34	1.15	100	299
1838.00	421.00	-99.90	524.41	1.69	104	300
1554.00	141.00	-99.90	287.66	0.46	100	301
1131.00	285.00	-99.90	259.82	2.96	100	303
1274.00	284.00	-99.90	267.44	0.31	100	304
637.00	349.00	-99.90	274.75	0.04	100	305
1627.00	72.14	-99.90	263.30	2.44	100	306
1481.00	110.00	-99.90	225.39	0.93	100	308
630.04	198.18	-99.90	206.21	7.98	160	309
1777.32	213.42	-99.90	311.82	0.04	138	310
1921.70	221.28	-99.90	584.53	0.00	100	312
2289.00	-17.14	-99.90	436.12	1.45	100	320
1061.00	211.00	-99.90	231.57	2.37	100	330
1911.00	-212.00	-99.90	220.91	0.48	100	331
1218.91	77.97	-99.90	97.00	0.02	100	333
345.00	582.00	-99.90	509.20	19.51	100	549
310.00	619.00	-99.90	511.10	2.77	115	540
409.00	546.00	-99.90	480.98	15.25	152	510
737.00	984.00	1067.92	644.01	7.14	233	6912
745.00	1023.00	1111.21	656.20	18.37	332	6905
1773.46	74.81	-99.90	303.23	2.87	100	314
1627.12	-72.42	-99.90	401.51	0.00	100	311
919.22	213.12	-99.90	224.27	9.14	100	334
491.54	202.14	-99.90	160.17	0.08	100	313
1764.86	-71.58	-99.90	469.26	12.99	100	332

Renco Mine Underground Development Data.

5

X Cord metres
 Y Cord metres
 Z Cord metres
 Grade g/t
 Stope Wi. metres

80661.75	-17621.50	762.00	9.00	1.50
80696.00	-17563.00	786.30	3.10	1.00
80695.00	-17562.00	786.70	3.70	1.20
80294.00	-17561.00	787.00	3.40	1.00
80693.00	-17560.00	787.30	1.70	1.00
80692.00	-17559.00	787.70	2.50	1.00
80691.00	-17558.00	788.00	5.80	1.00
80690.00	-17557.00	788.33	3.20	1.00
80689.00	-17556.00	788.70	4.30	1.00
80688.00	-17555.00	789.00	3.10	1.20
80663.75	-17630.83	754.00	14.40	1.00
80661.00	-17618.00	765.00	3.70	1.00
80607.45	-17640.04	754.00	12.30	1.00
80606.89	-17639.07	755.10	11.00	1.00
80606.34	-17638.11	756.20	7.20	1.00
80605.78	-17637.15	757.30	7.10	1.20
80605.22	-17636.19	758.40	3.90	1.50
80604.66	-17635.22	759.50	4.80	1.50
80604.11	-17634.26	760.60	9.50	1.20
80603.56	-17633.30	761.70	18.90	1.40
80603.00	-17632.33	762.80	6.60	1.20
80602.45	-17631.37	763.90	3.60	1.20
80601.89	-17630.41	765.00	3.30	1.40
80601.34	-17629.45	766.10	4.40	1.20
80600.78	-17628.48	767.20	12.50	1.40
80600.22	-17627.52	768.30	1.90	1.50
80599.66	-17626.55	769.40	0.50	1.00
80599.11	-17625.59	770.50	2.60	1.80
80598.56	-17624.63	771.60	3.10	1.50
80598.00	-17623.67	772.70	3.00	1.20
80597.45	-17622.70	773.80	3.50	1.80
80596.89	-17621.74	774.90	2.60	1.50
80596.34	-17620.78	776.00	9.70	1.50
80595.78	-17619.81	777.10	0.70	1.00
80595.22	-17618.85	778.20	4.00	1.00
80594.66	-17617.89	779.30	8.80	1.70
80594.11	-17616.93	780.40	1.30	1.20
80593.56	-17615.96	781.50	1.10	1.00
80593.00	-17615.00	783.00	1.80	1.00
80565.57	-17661.91	756.80	3.70	1.00
80565.14	-17660.83	757.70	1.70	1.00
80564.71	-17659.74	758.50	3.30	1.00
80564.29	-17658.66	759.40	4.40	1.00
80563.86	-17657.57	760.20	3.50	1.00
80563.43	-17656.49	761.10	5.20	1.00
80563.00	-17655.40	761.90	15.30	1.00
80562.57	-17654.31	762.80	12.20	1.00
80562.14	-17653.23	763.60	10.70	1.00
80561.71	-17652.14	764.50	17.60	1.00
80561.29	-17551.06	765.30	14.10	1.00
80559.57	-17546.71	768.80	6.60	1.80
80559.14	-17545.63	767.60	17.30	2.10
80558.71	-17644.54	768.50	15.90	2.10
80558.29	-17643.46	769.30	8.90	1.00
80557.86	-17642.37	770.20	1.90	1.00

80212.12	-17713.53	759.00	0.70	2.40
80210.41	-17714.35	759.00	0.60	1.30
80208.70	-17715.18	759.00	0.60	2.60
80207.00	-17716.00	759.00	3.10	1.00
80213.40	-17716.00	759.00	3.10	1.00
80211.80	-17716.00	759.00	0.30	1.00
80210.20	-17716.00	759.00	1.30	1.00
80208.60	-17716.00	759.00	1.70	1.40
80205.84	-17717.00	759.00	0.50	1.40
80204.66	-17718.00	759.00	0.00	1.10
80203.50	-17719.00	759.00	2.40	1.70
80202.34	-17720.00	759.00	1.10	1.00
80207.00	-17716.00	759.00	1.10	1.30
80201.16	-17721.00	759.00	1.80	1.00
80495.89	-17651.22	757.00	1.10	1.00
80494.78	-17651.45	757.00	2.80	1.00
80493.66	-17651.67	757.00	2.60	1.00
80492.56	-17651.89	757.00	0.40	1.00
80491.45	-17652.11	757.00	2.50	1.00
80427.43	-17699.57	728.00	0.20	1.50
80427.00	-17698.00	728.00	0.70	1.80
80426.66	-17697.20	728.00	0.70	1.80
80426.34	-17696.40	728.00	0.03	1.00
80425.66	-17694.80	728.00	0.30	1.70
80425.34	-17694.00	728.00	0.30	1.20
80876.72	-17525.00	723.00	0.00	1.00
80875.66	-17526.00	723.00	6.20	1.00
80425.00	-17693.20	728.00	0.00	1.00
80424.66	-17692.40	728.00	0.00	1.00
80424.34	-17691.60	728.00	1.90	1.50
80424.00	-17690.80	728.00	0.00	1.00
80423.66	-17690.00	728.00	0.00	1.00
80423.34	-17689.20	728.00	0.00	1.80
80423.00	-17688.40	728.00	0.20	1.80
80422.66	-17687.60	728.00	12.10	1.10
80422.34	-17686.80	728.00	1.20	1.50
80422.00	-17685.38	728.00	0.40	1.50
80418.00	-17684.75	728.00	0.20	1.00
80416.00	-17684.13	728.00	1.90	1.00
80414.00	-17683.50	728.00	0.40	1.00
80412.00	-17682.88	728.00	0.20	1.00
80410.00	-17682.25	728.00	1.00	1.00
80408.00	-17681.63	728.00	1.90	1.20
80405.00	-17681.13	729.00	0.30	1.00
80404.00	-17681.25	729.00	0.30	1.00
80403.00	-17681.38	729.00	0.00	1.00
80402.00	-17681.50	729.00	0.00	1.00
80400.00	-17681.75	729.00	0.00	1.00
80399.00	-17681.88	729.00	0.00	1.00
80398.00	-17682.00	729.00	0.20	1.00
80397.41	-17683.67	729.00	0.20	1.00
80396.84	-17685.33	729.00	0.20	1.00
80396.25	-17687.00	729.00	0.20	1.00
80802.34	-17685.00	724.00	4.40	1.00
80801.56	-17688.00	724.00	3.80	1.00
80800.78	-17689.00	724.00	7.10	1.00
80818.25	-17540.00	754.00	1.40	1.00
80817.50	-17541.20	754.00	2.40	1.00
80816.75	-17541.80	754.00	1.30	1.00
80816.00	-17542.50	754.00	2.50	1.00
80815.25	-17543.60	754.00	4.30	1.00
80814.50	-17544.80	754.00	5.80	1.00
80813.75	-17545.70	754.00	1.80	1.00

80813.00	-17546.50	754.00	2.70	1.20
80812.25	-17547.00	754.00	1.40	1.00
80811.50	-17547.50	754.00	1.90	1.00
80810.75	-17548.00	754.00	2.10	1.00
80800.00	-17548.00	754.00	1.40	1.00
80808.89	-17548.33	754.00	2.50	1.00
80807.78	-17548.67	754.00	2.50	1.00
80806.66	-17549.00	754.00	3.50	1.00
80805.56	-17549.33	754.00	4.40	1.40
80804.45	-17549.67	754.00	4.40	1.30
80803.34	-17550.00	723.00	2.80	1.00
80802.22	-17550.33	723.00	5.00	1.00
80801.11	-17550.67	723.00	7.30	1.00
80879.89	-17522.00	723.00	1.00	1.00
80878.84	-17523.00	723.00	1.80	1.00
80877.78	-17524.00	723.00	1.90	1.00

APPENDIX 3: RENCO MINE ASSETS ACQUISITION FILE

DATE : 12/31/79
 TIME : 08:11:27
 LOCATION : RENO MINE
 ASSET LIST TOTALS ONLY
 USER : AANBL

ASSET NUMBER	ASSET	DEPN	MTNS	STAT	MTNS	ORIGINAL	TOTAL	CURRENT	BOOK	DISPOSTN
CLASSIFICATION	00	LAND AND MINING TITLE	DEPRECIATION	VALUE	DEPRECIATION	VALUE	DEPRECIATION	VALUE	VALUE	VALUE
TOTAL FOR CLASS	00		*****		866678.00	0.00	0.00	866678.00	0.00	0.00
CLASSIFICATION	10	INDUSTRIAL COMMERCIAL BUILDING								
TOTAL FOR CLASS	10		*****		2042203.00	1262281	0.00	105074.00	779422.00	0.00
CLASSIFICATION	20	RESIDENT & AMENITIES BUILDINGS								
TOTAL FOR CLASS	20		*****		11219148.19	5780819	0.00	775476.00	5428329.19	0.00
CLASSIFICATION	30	SHAFTS MINE AND CIVILS								
TOTAL FOR CLASS	30		*****		4131330.00	2893541	0.00	291112.00	2037784.00	0.00
CLASSIFICATION	40	PLANT & MACHINERY : MINING								
TOTAL FOR CLASS	40		*****		2307239.00	722320	0.00	191037.00	1584919.00	0.00
CLASSIFICATION	50	PLANT & MACHINERY CONCENTRATE								
TOTAL FOR CLASS	50		*****		4609873.00	2414923	0.00	398872.00	2394910.00	0.00
CLASSIFICATION	60	P E M, INDUSTRY/MANUFACTURE.								
TOTAL FOR CLASS	60		*****		5307075.00	3684287	0.00	447280.00	1622256.00	0.00
CLASSIFICATION	70	MOBILE PLANT 7 MOTOR VEHICLES								
TOTAL FOR CLASS	70		*****		1999597.00	742154	0.00	226718.00	1457	

DATE : 12/01/90
 TIME : 08:16:03
 LOCATION : 38 RENCOS MINE
 ASSET LIST TOTALS ONLY
 PAGE : 2
 USER : AANBL

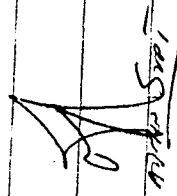
DEP NTHS ORIGINAL TOTAL CURRENT BOOK DISPOSTN
 STAT METH BASE VALUE DEPRECIATION VALUE VALUE VALUE
 CLASSIFICATION : 80 FURNITURE/FITTING/TOOLS/INST

TOTAL FOR CLASS 80 *****
 430640.00 0.00 33131.00 233791.00 0.00
 CLASSIFICATION : 90 DEVELOPMENT AND EXPLORATION

TOTAL FOR CLASS 90 *****
 1071926.00 567192 0.00 727811.00 5047944.00 0.00

TOTAL FOR LOCATION 18 *****
 43833709 884036423 0.00 3191411.00 21053476.19 0.00

REPORT TOTAL *****
 884036.23-20169459.96 3191411.00 21053476.19 0.00


 RENCOS MINE LTD.
 P. BAG 3005
 RENCOS

APPENDIX 4

COST CALCULATION AT RENCO MINE

Parameters for Cost Calculation are:

Current drill life = 127m/steel

Hole length = 1/5/shift

Ratio of raising to lateral development = 1:1

Length of 45lb rail = 9m

length of 30lb rail = 7.5m

Length of 16 ins. Ventilation Ducting = 4.6m

(1) Lateral Development Major Items Unit Costs

(i) Drill Steel: $\frac{40 \times 1.0}{12} \times \$73.64 + \frac{(40 \times 1.0)}{127} \times 96.49 \times \frac{1}{5}$
= \$37.72/m.

(ii) Explosives: $30 \times 1.8 \times 0.6 \times \frac{71.21}{25} \times \frac{1}{2.5} = \$61.63/m$

(iii) Fuse: $30 \times \frac{443.01}{450} \times \frac{1}{1.5} = \$19.68/m$

(iv) Ignitor Cord: $\frac{1}{4} \times 48.66 \times \frac{1}{1.5} = \$8.11/m$

(v) Pumping (air): 100mm Klambon
 $13.10 + \frac{16.22}{6m} = \15.80

(vi) Pumping (Water): 50mm Klambon
 $5.66 + \frac{7.48}{6} = \$6.91/m$

$$\text{Explosives} = \frac{65.01 \times 6}{200 \times 1.2} = \$1.62/t$$

$$\text{Fuse} = \frac{436.25}{500 \times 1.2} = \$0.73/t$$

$$\text{Stope Cord} = \frac{525.98 \times 1}{10 \times 40 \times 1.2} = \$0.60/t$$

$$\text{Total explosives} = \$2.95/t$$

$$\text{Scraper rope} = 0.13 \times 6.06 = \$0.79/t$$

$$\text{Stoping cost} = \$4.54/\text{tonne}$$

NB:

$$\text{No. of sticks of Explosives per hole} = 6$$

$$\text{No. of sticks per case} = 200$$

$$\text{Tonnes broken per hole} = 1.2 \text{ tonne}$$

$$\text{No. of holes per shift} = 40$$

(3) Jackhammer Maintenance costs

$$\begin{aligned} \text{Metres drilled in stoping} &= 40 \text{ holes} \times 301 \text{ days} \times 1.5 \text{ m} \times 16 \\ &= 288960\text{m} \end{aligned}$$

$$\begin{aligned} \text{Support meterage} &= 30 \times 1.8 \times 301 \times 6 \\ &= 370230\text{m} \end{aligned}$$

$$\begin{aligned} \text{Total drilling cost for Seco (23 m/cs)} \\ &= 370 \times 230\text{m} \times 5.76\text{C/m} = \underline{\$21,325,25} \end{aligned}$$

$$\begin{aligned} \text{Metres drilled in development (16 m/cs)} &= \underline{40 + 35} \text{ holes} \times \\ &301 \times 2.0 \times 16 = \underline{\$31713.36} \end{aligned}$$

Total Drilling Cost (Jackhammer Maintenance)

$$= \underline{\$53038.61}$$

Unit Drilling cost (Jackhammer Maintenance) = \$4.52 per day.

(4) Unit Cost for Underground Support:

6 support machines drilling 20 holes per machine shift.

Drill steel cost:

Holes per year = 6 x 20 x 301 = 36120 holes @ 1.8m

$$\begin{aligned} \text{Drilling Cost(1 machine)} &= \frac{(1 \times 73.64)}{127} + \frac{(0.8 \times 96.49)}{127} \times 1 \\ &= \$0.66/\text{m} \end{aligned}$$

For 2.7m holes:

$$\begin{aligned} \text{Unit drilling cost} &= \frac{(1 \times 73.64)}{127} + \frac{(1.7 \times 93.20)}{127} \times 1 \\ &= \$0.67 \end{aligned}$$

Cost of 1.8m rebar = \$3.63 each

Cost of 2.7m rebar = \$5.02 each

Defracting powder:

1 bag costs \$12,30

No. of capsules per bag = 28

No. of capsules per hole = 9

/ . . 1 bag will grout 3x1.8m holes and 2x2.7m holes.

Grout cost per hole(1.8m) = $\frac{12.30}{3}$ = \$4.1/hole.

Grout cost per hole (2.7m) = $\frac{12.30}{2}$ = \$6.15

Matt Packs:

Total call tonnage per stope = 240734 per year

Rock density = 2.8t/m³

$$\text{Volume to excavate} = \frac{240734}{2.9} = 83011$$

Assuming average stope width of 2m,

$$\text{Incline centres} = \frac{83011.7}{2} = 41505.9 \text{ m}^3$$

One matt pack will support an area of 5.2m x 5.2m

$$\therefore \text{No. of matt packs required} = \frac{41505.9}{5.2 \times 5.2} = 1535$$

$$\text{Packs per day} = \frac{1535}{301} = 5$$

i.e about 2 packs per crew.

One matt pack requires approximately 120 timbers.

Cost of 1 timber = \$2.75

$$\text{Cost per matt pack} = 120 \times 2.75 = \$330.$$

Average block width (m) = 1.5
 Tonnage per mach. shift = 47
 Development rate(m/sh.) = 1.5
 Number of stopes/Block = 2
 Block Length = 50
 Block Height(m) = 30
 Average dip (deg.) = 30
 assurance factor = 1.25
 Dev.ton : stope ton. = 0.0663
 Working Days /Year = 302
 No. of drill(mach) shifts/stope = 1
 No. of stopes/block = 2
 No. dev. mach. /block = 2
 No. of shifts/day = 1
 Average extraction = 0.9

 Calculations

Inclined length of block (m) = 60
 Total block meterage (m) = 220
 Time to dev. block(days) = 73
 total tonnage minable in Block(t) = 11745
 Coeff. Ko = 0.937822
 Time to mine block = 124.9468
 Years = 1
 Prodd.(t) = 1000
 No. of mining Blocks = 12.47
 No. of Dev Blocks = 7.32

	3	4	5	6	7	8
	800	600	1000	600	600	600
	9.98	7.48	12.47	7.48	7.48	7.48
	5.86	4.39	7.32	4.39	4.39	4.39

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