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For mining Costs

ASARCO

Rocky Mountain
Exploration Division

September 26, 1978

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EXPLORATION DEPARTMENT

TO: W. L. Kurtz

FROM: D. M. Smith, Jr.

Royalty Arrangements at Asarco's
Black Cloud and Groundhog Mines

The following information may be of interest to persons in the western U.S. who may be involved in negotiating leases for mining claims believed to hold potential for the discovery of limestone replacement ore deposits.

Black Cloud Mine, Lake County, Colorado

Twenty-year leases negotiated during the 1930's with extensions contracted at five-year intervals. Uniform agreement is held by all property owners. The leases are held via a "net return" arrangement calculated using this formula:

N.R. = Net Smelter Return - Distributed Milling Costs - Surface Transport

Royalty Payments consist of a percentage of the net return:

N.R. ≦	$10.00	Royalty = 4% of N.R.
	$10.01 - $ 20.00	6%
	$20.01 - $ 30.00	8%
	$30.01 - $ 50.00	10%
	$50.01 - $100.00	12%
	> $100.00	14%

Using the approximate figures for July 1978, the royalty would be calculated as follows:

N.S.R. = $77.00/ton
Distributed Milling Cost = $8.68/ton
Truck Transport = $1.60/wet ton of concentrate
Rail Transport = $20.71/wet ton of concentrate
= $4.14/wet ton of crude ore (calculated)
= $4.25/dry ton of crude ore (calculated)

N.R. = N.S.R. - D.M.C. - S.T.
N.R. = $77.00 - $8.68 - (0.08 + 4.14)
N.R. = $64.10 per dry ton of crude ore
N.R. = $50.01 to $100.00 Royalty = 12%
Royalty = 0.12 X $64.10 = $7.69/ton

Ground Hog Mine, Grant County, New Mexico

Separate arrangements have been devised for Black Hawk and Kennecott parts of the mine. Again, the leases date back many years and are so repressive under present economic conditions that no mining is currently done in either lessor's ground.

Black Hawk - Ore chutes are sampled in the mine and the assays are checked at the Deming smelter's laboratory. Royalties are calculated using the gross dollar value of a dry ton of ore:

Ore Value ≦	$10.00	Royalty = 4% of value
	$10.01 - $ 20.00	6%
	$20.01 - $ 30.00	8%
	$30.01 - $ 50.00	10%
	$50.01 - $100.00	12%
	>$100.00	14%

Kennecott - Hoistman is advised when he is hoisting K. C.C. ore and separates it by cars into 6-car lots. Lots are sampled by Asarco and K.C.C. Royalties are based on the actual cash value of the metal contained in each lot:

Ore Value ≦	$20.00	Royalty = 2% of value
	$20.01 - $ 30.00	3%
	$30.01 - $ 40.00	3.5%
	$40.01 - $ 50.00	4%
	$50.01 - $ 60.00	5%
	$60.01 - $ 70.00	6%
	$70.01 - $ 80.00	7%
	$80.01 - $ 90.00	8%
	$90.01 - $100.00	9%
	>$100.00	9%

The managers and chief accountants at both units were extremely pleasant and cooperative during my spur-of-the-moment research and their help is gratefully acknowledged.

Douglas M. Smith, Jr.

DMS:eff

DEC/DFS 1/24/83 This application not Waterloo? AT PRESSTIME

capital cost

WLK file Mining Costs

ASARCO

Rocky Mountain
Exploration Division

April 29, 1982

TO: W. L. Kurtz

FROM: D. M. Smith, Jr.

International Mining Costs
U.S.B.M. Open File

Herewith, photocopies of all available information on Bolivia, Chile, and the Philippines. A copy of the data for Mexico is in our files.

D. M. Smith, Jr.

Douglas M. Smith, Jr.

DMS:lb
Encs.

cc: JHCourtright

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Consulting Mining and Geotechnical Engineers

UNITED STATES BUREAU OF MINES
MINERALS AVAILABILITY SYSTEM

COUNTRY PROFILE
BOLIVIA

335

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BOLIVIA

1.0 BACKGROUND

1.1 ROLE OF MINING IN THE ECONOMY

The economy of Bolivia is more heavily dependent on the mining industry than any other country in Latin America. Bolivia is the second largest tin producer in the world and an important producer of tungsten and silver. However, production of other base metals is on a more modest scale. The annual production of major metals and minerals is given in Table 1.

TABLE 1: BOLIVIAN EXPORTS OF MAJOR METALS AND MINERALS (1975-79)

(Tonnes contained metal, unless otherwise stated.)

	1975	1976	1977	1978	1979*
Tin	26,441	30,353	32,616	30,827	(20,071)
Copper	5,988	4,787	3,670	3,344	(1,963)
Lead	16,796	16,368	18,441	17,963	(9,824)
Zinc	48,701	48,456	60,766	57,710	(31,895)
Tungsten (as WO_3)	2,551	3,278	2,980	3,106	(1,338)
Silver ('000 oz)	5,322	5,091	5,954	6,462	(4,914)
Bismuth	612	303	679	482	N/A
Antimony	11,917	17,407	15,156	12,977	N/A

*Data for 1979 are estimates of actual production by COMIBOL operations only.

Copper production is relatively unimportant in Bolivia and has declined steadily in recent years. At present, there is only one sizeable copper mine in operation, namely the Corocoro mine in the Altiplano region of western Bolivia, which is operated by the state organization COMIBOL (Corporacion Minera de Bolivia). Corocoro currently produces some 3,200 tonnes copper in concentrate per year from an underground operation.

The second largest copper operation was the Chacarilla mine which had a maximum capacity of around 1,000 tonnes per year copper in concentrate. Until its closure in 1976, Chacarilla was operated by Nitto Mining Company, a subsidiary of Dowa Mining Company of Japan. In early 1978, Dowa sold the operation to the private Bolivian smelting group, Funestano, which is understood to be seeking overseas project finance to reopen the mine. However, the underground workings would have to be dewatered and other rehabilitation work carried out before the operation could be brought back into production.

The only other source of copper production in Bolivia at present is the almost negligible output (22 tonnes contained copper in 1978) from the small-mines sector. However, two hydrometallurgical projects are being developed by COMIBOL to extract copper by leaching methods from marginal copper ores and tailings.

The first of these plants, which is being financed by the West German and Austrian governments, will be at Corocoro and will have a 600-tonne per day oxide ore treatment capacity. The second (near Potosi), is designed to extract copper from tailings by bacterially-assisted leaching. COMIBOL projects an investment of 17.5 million U.S. dollars over the next 5 years for the construction of hydrometallurgy plants for extraction of copper and other base metals.

The contribution of the mining industry to the Bolivian economy is illustrated in Table 2, which shows that tin and petroleum exports jointly have contributed over 60% of total exports consistently over the past 5 years. Tin exports alone accounted for over two-thirds of Bolivia's total foreign income in 1978 and, despite some government effort to develop other sectors of the mining industry in recent years, the dependence on tin has increased.

TABLE 2: VALUE OF MAJOR BOLIVIAN MINERAL EXPORTS (1975-1978)
(U.S. $ million)

	1975	1976	1977	1978
Tin	171.4	216.3	326.7	373.7
Natural gas	42.5	54.9	66.8	78.5
Crude petroleum	111.4	112.6	67.4	42.3
Wolframite	22.3	34.8	45.1	39.5
Silver	28.5	24.3	30.8	33.8
Zinc	40.3	39.1	44.7	31.4
Total exports	444.7	566.1	634.3	627.3

Source: IFS

After a steady period of expansion in the mid-1970s, the Bolivian economy has grown at a slower rate in recent years. In 1976 the GDP grew by 6.7%, but the rate of expansion declined to 4.8% in 1977 and to 3.6% in 1978. This decline was brought about primarily by the decrease in output from the petroleum and mineral industries.

In spite of the impetus of high tin prices over the past 3 years, the profitability of the Bolivian tin mining industry has been seriously affected by a steep rise in extraction costs. In addition, there has been a progressive decline in ore grades. In the petroleum sector, production has been declining in line with the depletion of reserves while local consumption rates have increased steadily. As a result, Bolivia was expected to become a net importer of oil in 1979.

The outlook for the Bolivian mining industry will continue to depend strongly on the prospects for tin. However, as a result of technical and financial aid made available through intergovernmental agreements and the World Bank, there are indications that the emphasis may progressively move away from this traditional mainstay of the mining economy. With overseas assistance, the government has set up a National Mineral Exploration Fund (FNEM), while reconnaissance exploration programs have been initiated for a range of base and other metals.

1.2 STATE INVOLVEMENT IN MINING

The structure of the mining industry in Bolivia has been determined largely by the character and distribution of the tin mining operations. Mines are organized into three distinct categories, each of which operates within a different legal framework. The three categories are the large (gran mineria), medium (minas medianas) and small mines (minas pequinas).

The largest mines are those that were expropriated in 1952 and are now controlled by the nationalized mining corporation COMIBOL. The medium mines are privately owned operations which meet certain minimum levels of production. The small mines include all other mines, ranging in size from one-man seasonal operations to mining cooperatives with several hundreds of members.

COMIBOL is the largest single industrial organization in Bolivia. In 1977 it had sales amounting to 333 million U.S. dollars, and accounted for half the total value of Bolivia's exports. COMIBOL produces around 70% of the total tin output and the major share of Bolivia's lead, zinc, silver, copper, and bismuth production.

The medium category comprises 31 private mining companies, most of which generate sales of under 500,000 U.S. dollars per year. This group accounted for about 100 million U.S. dollars (16%) of Bolivia's exports in 1977 and currently produces some 20% of the total tin output. Although tin remains the most important product for this sector, the medium mines produce a wider range of minerals than COMIBOL. They have made more progress along the road to product diversification - a declared aim of government mining policy - than either of the other two mining groups. The medium mines produce over half of Bolivia's tungsten and nearly three-quarters of the antimony. Most of these mines are owned entirely by Bolivians and many of the smaller companies in this group are family concerns.

The small mines are a disparate group of some 3,000 or more operations which also produce a range of minerals but which (except in the case of gold and antimony) contribute a relatively small proportion of Bolivia's total mineral production.

The final key component of the mineral industry of Bolivia is the metallurgical sector, which is dominated by the state-owned Empresa Nacional de Fundicion (ENAF). Following its

creation in the mid-1960s, ENAF was given a near-monopoly of producing and exporting refined metals. With substantial government investment and overseas technical and financial assistance, ENAF has commissioned smelters producing tin (at Vinto, near Oruro), antimony, and bismuth (both at Telamayu) over the past 10 years. Outside Potosi, ENAF and COMIBOL are jointly planning a large lead-zinc smelter and refinery, built by Klockner of West Germany and financed by German and Belgian credit. It is hoped that sales of by-product metals (including copper) will form a substantial part of eventual revenue.

1.3 STATE INDEBTEDNESS

While the trade and balance of payments position in Bolivia have worsened in recent years, there has also been a progressive deterioration in the external debt position.

Bolivia's long term external debt increased from 1.6 billion U.S. dollars in 1976 to 2.5 billion U.S. dollars in 1977 and to 3.16 billion U.S. dollars in 1978. There has been a comparable increase in debt service payments (as a proportion of exports) over this period. The proportion rose from 23% in 1977 to 32% in 1978, and is officially expected to increase to 36% and 40% in 1979 and 1980 respectively. The Instituto Nacional de Financiamiento Externo has stated that public foreign debt at the end of June 1979 totalled 3.38 billion U.S. dollars, with 1.87 billion U.S. dollars drawn down. In the first half of 1979, servicing this debt cost 116.5 million U.S. dollars (amortisation 68.7 million U.S. dollars, interest and commission 57.8 million U.S. dollars) compared with 199 million U.S. dollars (113 million U.S. dollars, 84 million U.S.dollars) in the whole of 1978.

As a result of the increase both in service and total of the debt, the Bolivian government announced in September 1979 that it was to renegotiate the debt with international financial agencies.

2.0 COST FACTORS AND COST INDICES

2.1 COST FACTORS

This section presents (see Table 3) the cost ratios which should be used in conjunction with the Straam cost estimating handbook in preparing estimates of the production costs of Bolivian mining operations. As is stressed in the following section (2.2: Cost Indices), the information collected is incomplete, so that considerable care on the part of the user is advised.

TABLE 3: BOLIVIA - COUNTRY COST FACTORS

		Ratio Bolivia:U.S. Value (1975)
1.	Mine labor: Wage rate	0.08
1A.	Mine labor: Productivity	6.4
2.	Construction labor: Wage rate	0.05
2A.	Construction labor: Productivity (a)	4.6
3.	Equipment and repair parts (b)	2.0
4.	Steel	2.03
5.	Timber	1.32
6.	Fuel	0.70
7.	Explosives	1.8
8.	Tires (c)	2.0
9.	Construction materials	1.0
10.	Industrial materials	1.8
11.	Transportation (c)	2.0
	Electrical power (c)	2.0
	Water (c)	2.0

Notes:

a. Calculated from value for construction labor wage rate ratio.

b. Estimate based on information used in construction of ratios (4) and (6).

c. Approximate estimates only, based on incomplete information used in construction of other ratios.

TABLE 4: BOLIVIA - SELECTED COST INDICES 1975-1979

(Based on Bolivian Pesos)

No	Item	1975	1976	1977	1978	1979*
1	Mine & plant labor (1975=100)	100.0	102.2	106.3	111.7	~~122.7~~ 151.1
2	Construction labor (1975=100)	100.0	103.1	109.0	116.9	~~133.3~~ 130.9
3	Equipment & repairs (1975=100) (U.S. dollars)	100.0	106.0	119.0	135.0	~~138.0~~ 149.0
4	Bits & related steel (1975=100)	100.0	101.9	111.2	125.4	140.6
5	Timber & lumber	100.0	118.0	129.0	142.0	~~174.0~~ 169.0
6	Fuel (U.S. dollars)	100.0	105.0	116.0	117.0	~~178.0~~ 165.0
7	Powder & blasting	See accompanying notes on construction of indices				
8	Tires					
9	Const. materials					
10	Ind. materials	100.0	108.0	123.0	121.0	~~176.0~~ 165.0
11	Transportation (U.S. dollars)	100.0	103.0	112.0	131.0	141.0

*August 1979

Notes:

These cost indices are identical to those expressed in U.S. dollar terms, as the official exchange rate has remained at 20 pesos per dollar throughout the period. The exchange rate changed to 25 pesos to the dollar November 30, 1979.

2.2 COST INDICES

None of the 11 cost indices ~~is~~ are available in official Bolivian publications. Therefore alternative indices, based on several sources which constitute a fair approximation to the actual indices prevailing in the Bolivian economy have been constructed. However, because this broad basis is used, the indices should be used with caution.

The four main sources for the cost indices are:

1. Yearbook of Labor Statistics (International Labor Organisation, Geneva)
2. Monthly Bulletin of Statistics (United Nations, New York)
3. Engineering News Record
4. International Financial Statistics (International Monetary Fund, Washington)

The construction of each index and sources of information used are detailed below:

1. INDEX OF MINE AND PLANT LABOR (1975=100)

Definition: Constructed index of wages in mining and quarrying.

Explanation: ILO data on wages in mining and quarrying in Bolivia are available only up to 1975. To update the figures to 1979, they have been correlated with the retail price index as follows:

Bolivia: Wages in mining and quarrying and Retail Price Index (1970-1975)

calc. coeff. variable!

Year	Wages (Pesos/month)	RPI (1975=100)
1970	1033	36.2
1971	1090	37.5
1972	1225	43.3
1973	1345	56.9
1974	1745	92.6
1975	1745	100.0
Average annual growth rate 1970-75 (%)	11.05	22.53

Source: Wages: ILO; RPI: IMF

The ratio between growth in wages and RPI (11.05/22.53 x 100 = 49.04) is assumed to be the proportion of the increase in the RPI which is attributed to wages in mining.

Example: For 1976 the RPI = 104.5, which is 4.5% higher than the 1975 figure (equal to 100). But, 4.5 x 0.4904 = 2.2068 which is the increase in wages in mining in 1976 over the 1975 figure. Thus, for the period 1976-1979, the procedure gives the following series:

	RPI (1975=100)	RPI (Annual growth)	RPIx0.4904 (Annual growth)	Wages in Mining (1975=100)	Wages in Mining (Nominal)
1976	104.5	4.50	2.2068	102.2	1783.39
1977	113.0	8.13	3.9869	106.3	1854.93
1978	124.7	10.35	5.0756	111.7	1949.16
1979 (Aug)	~~149.9~~ 146.07	20.20	9.9061 8.4	~~122.7~~ 121	2141.11

If further updating is required, the rate of growth in the RPI over the previous year should be calculated, then multiplied by 0.4904, and finally the most recent index of mining should be adjusted by this amount.

2. INDEX OF CONSTRUCTION LABOR (1975=100)

Definition: Constructed index of monthly earnings in construction.

Explanation: Following the same procedure as described in 1., an index of wages in construction related to the Retail Price Index is obtained.

Bolivia Wages in Construction and Retail Price Index, 1970-1975.

Year	Wages (Pesos/month)	RPI (1975=100)
1970	775	36.2
1971	954	37.5
1972	1089	43.3
1973	1209	56.9
1974	1609	92.6
1975	1609	100.0
Average annual growth rate 1970-1975	15.73	22.53

The ratio (growth in wages: growth in RPI) = 0.6982, which gives the following results:

	RPI (1975=100)	RPI (Annual growth)	RPIx0.6982 (Annual growth)	Wages in Const. (1975=100)	Wages in Const. (Nominal)
1976	104.5	4.50	3.14	103.1	1658.9
1977	113.0	8.13	5.68	109.0	1753.8
1978	124.7	10.35	7.23	116.9 +13.98	1880.9
1979 (Aug	~~149.9~~ 146.07	~~20.20~~	14.10 11.96	~~133.3~~ 130.88	2144.8

3. EQUIPMENT AND REPAIRS (1975=100)

Definition: Export Price Index of machines for special industries.

Explanation: The figure quoted is the average export price index for three countries: Japan, West Germany, and the United States.

Source: Index under heading: Machines for special industries, Special Table C: Export Price Index of Machinery and Transport Equipment for selected countries.

Publication: Monthly Bulletin of Statistics - U.N. (Special Table C is published in February, May, August, and November.)

4. BITS AND RELATED STEEL (1975=100)

Definition: Constructed Price Index of U.S. steel traded internationally. (Based on Dollars per hundredweight)

Source: Steel - U.S. (Item 182). Table 60: Prices of important commodities traded internationally. Section: Wages and Prices.

Publication: Monthly Bulletin of Statistics - U.N.

5. TIMBER AND LUMBER (1975=100)

Definition: World export price index of lumber.

Source: Index under heading: Lumber (Table 59: World export price indices of primary commodities and non-ferrous base metals)
Section: Wages and Prices.

6. FUEL (1975=100)

Definition: World export price index of fuels. (Includes coal, crude petroleum, natural gas, and crude fertilizers.)

Source: Index under heading: Fuels (Table 59: World export price indices of primary commodities and non-ferrous base metals.)

7. POWDER AND BLASTING AGENTS* (see 9)
8. TIRES* (see 9)
9. CONSTRUCTION MATERIALS*

*Information which might be used to construct satisfactory indices for these three categories is not available. It is suggested that the Retail Price Index (tabulated in the notes under Index (1) Mine and Plant Labor) may be used instead. It is recognized, however, that this alternative is not entirely satisfactory though actual experience in Bolivia shows it to be a reasonable assumption. Considerable care is therefore necessary in performing the Straam cost calculations on Bolivian examples, and the user's judgement in individual cases is warranted.

10. INDUSTRIAL MATERIALS (1975=100)

Definition: World export price index of primary commodities for developing market economies.

Source: Index number under: Primary commodities - Developing market economies. (Table 59: World export price indices of primary commodities and non-ferrous base metals.)

Publication: Monthly Bulletin of Statistics - U.N.

11. TRANSPORTATION (1975=100)

Definition: Export price index of transport equipment (includes: Japan, Germany, U.S.A. and Sweden).

Source: Index under: Transport equipment. (Special Table C: Export Price Index of machinery and transport equipment for selected countries.)

Publication: Monthly Bulletin of Statistics - U.N., (see [3]).

3.0 GOVERNMENT REGULATIONS AND TAXATION

3.1 REGULATIONS GOVERNING THE MINING INDUSTRY

The three major tin mining companies in Bolivia were nationalized in 1952, but smaller companies producing tin and other metals remain in private ownership. Major investments in new mining projects are affected by the provisions of the Investment Law issued in December 1971.

The smelting of metals, however, is classified as a strategic industry. Any investment must be carried out either by state-owned companies or by national or foreign private capital in conjunction with a state company. In the latter case, the state company must either have a majority holding or must progressively increase its holding until it becomes a majority holding.

Bolivia is a member of the Andean Pact. Although Bolivia is not presently enforcing the legislation relating to foreign companies under the terms of the Pact, this must be expected to occur in time.

Within 3 years of the legislation coming into force, foreign companies in Bolivia must contract to transform themselves into mixed or national companies. (Mixed companies have from 51 to 80% Bolivian ownership and national companies have more than 80% Bolivian ownership). However, foreign companies whose production is destined 80% or more for export outside the Andean zone are not subject to these limitations. It can be assumed, therefore, that mining projects may be 100% owned by foreign or domestic capital up to and including the production of concentrates. As mentioned previously, state participation is required in smelting and refining.

3.2 TAXATION OF MINING COMPANIES

In place of the conventional tax on company profits, Bolivia raises revenue from its mining industry by levying royalties and taxes on the value of minerals exported. New mining legislation was proposed in 1977 by the Harvard Institute of International Development which would have substituted a tax on profits for taxes on exports. The effect would have been, in the short term, to reduce the state's revenue from the mining industry. Perhaps for this reason the new legislation has not been enacted.

The royalties and taxes that apply to minerals are as follows:

1. A royalty based on the price of the mineral at the time of exportation and the mineral content of the shipment by analysis. The royalty is paid irrespective of whether the company has any profit from which to pay it. A refund is theoretically payable when the producer is not covering costs, however such refunds rarely happen as is the case with COMIBOL. If a sale is made to a smelter, the royalty is based on the quantity of mineral paid for by the smelter and the price at the time of sale. The royalty rate for tin ranges from 2.1% at a tin price of $1.20/lb to 21.3% at $2.50/lb and over. For copper, assume an average royalty rate of 15%.

2. A 6% tax on the value of the product at the time of export. (This tax is collected on behalf of the universities in Bolivia).

3. A commission payable to the Banco Minero de Bolivia. This varies from 0.25% to 1.50% and is payable when the company markets its own products. For copper, assume a commission rate of 1%.

4. A tax on the gross value of minerals at the time of export. This ranges from 1 to 7.5% For copper, assume 5%.

Total royalty plus commission and export tax on copper, therefore, amounts to 27% of the value of copper minerals exported or sold to a Bolivian smelter.

Since these taxes are levied effectively on sales, rather than on profits, the question of depreciation and other allowances does not arise.

3.3 INCENTIVES FOR MINING COMPANIES

Private investment projects must be registered with the National Investment Institute (INI), which administers the benefits available under the Investment Law. Projects are categorized according to the priority given to them; mining and metallurgical projects are placed in the first category.

Mining projects, once approved by the INI, qualify for the following benefits:

1. Exemption from import duties and any related taxes on imported machinery, equipment, and spare parts.

2. Exemption from taxes on transfers of capital and credits, domestic or foreign, to be invested in the approved project.

3. Ten-year exemption from all taxes on new construction and also on transfer of real estate which constitutes part of the capital of the company.

3.4 EXCHANGE CONTROLS AND REMITTANCE OF PROFITS

The Bolivian peso is freely convertible. The Andean Pact legislation places a 14% ceiling on annual net profits that may be remitted abroad by foreign companies, but this restriction does not apply to companies exporting 80% of their production outside the Andean zone.

Dividends paid to foreign shareholders are subject to 30% withholding tax, and other income paid to non-residents is also subject to withholding tax at the same rate.

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COUNTRY PROFILE
CHILE

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March 1980

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CHILE

1.0 CHILEAN COPPER SECTOR

Chile accounts for 16% of the western world's copper mine output, and is the second largest producer (after the United States) with 1.05 million tonnes per year of contained copper. But mine output represents only two-thirds of the total supply of refined copper; the other one-third consists of recycled copper. Therefore, Chile produces only about 11% of the non-socialist world's production of refined copper but it accounts for a much higher share of copper exports.

1.1 INDUSTRIAL STRUCTURE

Copper mining in Chile is divided into two sectors. On the one hand, there is what in Chile is called the large-scale copper mining (LCM) sector, which consists of four mines - Chuquicamata and El Salvador (previously operated by Anaconda), El Teniente (previously operated by Kennecott), and Andina. Today, these mines are divisions of the state-owned corporation. The LCM sector has produced an average of about 80% of Chilean copper output during the last decade but, since it is much less labor intensive than the rest of the copper mining sector, it employs only about 60% of the workers engaged in copper mining.

On the other hand, there is the small- and medium-scale copper mining (SMCM) sector, which is internally very heterogeneous. About half of the sector's output is produced by five medium-sized firms, most of which were owned by foreign investors until President Allende's Government. All except one were nationalized between 1971 and 1973. The rest of the SMCM sector's output is produced by a large number of small independent miners, almost all of whom sell their minerals to a

state enterprise that owns several smelters and two refineries. This enterprise is the Empresa Nacional de Mineria (ENAMI) which also markets most of the copper produced by small-scale mining. The SMCM sector, as a whole, has significantly increased its share of total Chilean copper production from about 10% in the late fifties to over 20% in the late sixties and about 16% in the mid-seventies. Output in the SMCM sector appears to be more responsive to price variations than that of the LCM sector.

There are significant variations in copper production costs within the country. The LCM has the lower costs per pound (about 42 cents), while those of the SMCM are, on average, about 50% higher (62 to 65 cents) but with high variations within the sector. These are very approximate estimates, since it should be borne in mind that in periods of low prices the small mines and producers stop production completely.

The main reasons for the higher costs of the SMCM sector in general are a lower capital intensity and smaller orebodies which do not make large-scale operations profitable. To a large extent cost differentials result from technical rather than economic considerations.

1.2 EMPLOYMENT IN COPPER

The total number of workers employed in the copper industry is estimated to be about 47,000 (28,500 in the LCM sector and 18,500 in the SMCM sector). That is less than 2% of the labor force in the country. Therefore, the government does not attach great importance to creating extra jobs through the development of the copper sector. If anything, the government is more interested in reducing the work force in the state-owned firms in the LCM sector in order to reduce costs and increase profits. In fact, the number of workers in the LCM sector fell from 30,000 in 1973 to 28,500 in 1977.

Within the context of the present economic model, the government expects total employment to increase automatically through the expansion of more labor intensive export sectors and from a higher growth rate of the economy as a whole, resulting partially from higher investment financed from copper revenues.

Chile's traditional policy had been to encourage greater vertical integration in the copper industry. However, the present government has no such commitment and its explicit policy is to allow the free market and private investors to determine the extent to which copper should be exported as a manufactured product. Presently there are two main copper semimanufacturing firms in Chile which are increasingly becoming oriented toward external markets.

1.3 EXTERNAL RELATIONS

Chile is a founding member of the International Council of Copper Producers (CIPEC) and has been participating in the negotiations for formation of UNCTAD's Commodity Fund and the Copper Program within it. But, given the free market orientation of the present government, the country does not give high priority to increasing the influence of those international organizations.

In fact, the role played by Chile in CIPEC and UNCTAD is rather passive and, in general, the government does not favor the formation of a producers' cartel, but the development of closer cooperation between producers and consumers.

2.0 COPPER PRODUCTION COSTS IN CHILE

Chile is a relatively low-cost copper producer. Total production costs, including administrative and financial costs plus depreciation, and after deducting credits for by-products, have been estimated at about 45 to 47 U.S. cents per pound in 1977 in the country as a whole. These costs had been falling in real terms during recent years, notwithstanding the rise in energy costs. In the Codelco mines, average costs during the decades of 1950 to 1960 have been estimated at around 45 cents per pound and had risen to over 90 cents per pound in 1974; they then fell to about 55 cents in 1975 and 49 cents in 1976 (all figures expressed in 1977 U.S. dollars). The main reasons for the recent fall in production costs have been the reduction in wages and, to a lesser extent, the increase in capacity utilization (and thus the fall in unit costs) and the rise in income from by-products. Probably the first factor has been the most important, particularly in 1973-74 which were the years in which the sharpest fall in costs occurred.

2.1 LABOR COSTS

In the decade of the 1960's, labor costs represented about 40% of all copper production costs, and in 1972-73 that figure was probably higher. There are no separate statistics available about labor costs at present in the copper industry. In fact, there are estimates of operating costs, which include labor, energy and other costs, for Codelco only. Codelco, however, accounts for more than 80% of Chile's copper production. Recent cost estimates for Codelco are presented in Table 1.

TABLE 1: CODELCO'S PRODUCTION COSTS, 1973-1977
(U.S. cents per pound in 1977 dollars)

	1973	1974	1975	1976	1977
Gross operating costs	74.8	73.9	42.1	37.9	37.3
Administrative & sales costs	12.9	12.6	13.0	4.0	3.5
Gross Costs	87.7	86.5	55.1	41.9	40.8
Income from by-products	2.8	4.3	6.5	5.1	6.4
Net Operating Costs	84.9	82.2	48.6	36.8	34.4
Depreciation & financial costs	11.8	9.5	1.8	7.7	7.3
Total costs (before tax)	96.7	91.7	50.4	44.5	41.7

Source: Copper Studies

From the table, it can be seen that the main factor behind the 1974-75 total cost reduction of about 41 cents was the fall in operating costs (by 32 cents). This reduction, in turn, was achieved through a reduction of real wages and of the labor force. The former resulted from the military government's assumption of control over the mines after the September 1973 coup, and the concession of wage increases of about 190% compared to an inflation rate of 352%. This implied a fall in real wages of about 36%.

In addition, the labor force in Codelco (excluding the Andina division) fell from 30,818 in 1973, to 27,863 in 1974 (almost 10%), and to 25,941 in 1976 (an additional 7%).

Since 1975, nominal wages have been increasing faster than the consumer price index, but all these figures have to be interpreted with care as a result of the distortions that took place in 1973 and 1974 when inflation reached incredibly high levels (350% to 500%). Inflation in those years reached 15% to 20% in some months and, thus, the failure of the government to grant nominal wage increases in some of them resulted in distortions that have been carried on during the following years. Also, comparisons give very different results when different months or annual averages are taken as a basis. There is a long-standing debate in the country about the relevant wage statistics that should be used.

Table 2 shows that wages in real terms in 1975 had fallen substantially as compared to 1970, both in the economy and in the mining industry itself. Wages in mining started increasing faster from 1975 to 1977, but recently they have been rising more slowly than the average in the country. It should be noted, however, that the index presented in the table includes not only copper production, but also other minerals and coal. Wages in the latter are particularly low and have been allowed to increase less rapidly.

TABLE 2: CHILE: CONSUMER PRICE INDEX AND NOMINAL AND REAL WAGE AND SALARY INDICES

	Consumer Price Index (1970 = 100)	Nominal Wage and Salary Indices		Real Wage and Salary Indices	
		General (1959=100)	Mining (1959=100)	General (1970=100)	Mining (1970=100)
1970	100	2,126	2,677	100	100
1971	119	3,253	4,440	n.a.	n.a.
1972	211	4,563	5,406	n.a.	n.a.
1973	959	12,602	15,449	n.a.	n.a.
1974	0.58	8.1	8.7	n.a.	n.a.
1975	2.75	41.6	53.6	62.6	64.0
1976	8.54	158.6	200.0	69.9	70.0
1977	16.39	453.2	609.9	87.7	95.7
1978	22.96	1124.8	1396.7	107.9*	106.4

Source: Central Bank, Boletin Mensual, August 1979.
International Financial Statistics - International Monetary Fund
*Estimate: (University of Chile)

Note: Nominal wages refer to the month of April only, while real wages and the price indices are averages for the year. Nominal wage and salary indices and the consumer price index have been divided by 10,000 from 1974 onwards.

The real wage and salary indices are not the simple division of the nominal indices and the consumer price index presented in this table. They have been independently estimated by the University of Chile to correct some errors in the price index. In addition, they refer to the whole year's average and not to April of each year. The differences between those two figures were large in 1974-1976 when inflation exceeded 300% PA but are not so important now that inflation is down to 30%-35%. Thus after 1979, the April figures published by the Central Bank can be used to update the real wage and salary series.

Salaries in the large-scale copper sector are higher than in the rest of the economy, but have not necessarily risen faster. In other words, there has been a trend towards the equalization of wages in different sectors.

Since 1973 all wages have been controlled by the government. After 1975, they have been systematically increased in line with the level of the consumer price index, but with a lag that has allowed for some increases in real terms (plus some extra allowances granted a couple of times in the last 6 years). Therefore, it was during the period between the end of 1973 and 1975 when wage earners lost most of their purchasing power.

The evolution of wages and salaries in the future will depend essentially on the results of the new labor legislation that will allow collective bargaining in some sectors. This topic is analyzed in Section 5 which refers to government regulations in the copper sector.

2.2 ENERGY COSTS

Costs of fuel have been estimated at about 12% of the net cost of production in Chile in 1975. This fraction is four times larger than before the oil crisis. About 1.3 tonnes of petroleum are needed to produce each tonne of copper in Chile. Thus, the 1974 petroleum price increase led to additional costs of about 100 million U.S. dollars.

Practically all oil used by the Chilean copper sector is imported. In fact, Chile as a whole covers only about a third to one-fifth of its oil needs from domestic production. The country has relatively large resources of hydroelectric power; two-thirds

of Chile's electricity supply comes from that source and the remainder from thermal plants. But, unfortunately for the country, most of the copper is found in the northern desert region where there is no hydroelectric power. In general terms, however, the availability of energy is not likely to be an important bottleneck for the expansion of copper production in the medium term.

Chile has a considerable hydroelectric potential that has barely been tapped. A number of investment projects are under consideration, the most immediately important being the Colbun project which is expected to produce some 890 megawatts for transmission to Santiago. This would imply an increase of about 50% of the present capacity. In addition, there are advanced plans for extending the electricity network based on hydroelectric power to the north where the main copper mines are located.

The main sources of energy in Chile and their evolution since 1960 are shown in Table 3.

TABLE 3: SOURCES OF PRIMARY ENERGY IN CHILE
(Percentages of Total Energy Supply)

	1960	1970	1978
Imported oil	18.3	31.6	45.7
Domestic oil	12.1	18.6	9.3
Natural gas	3.2	10.0	12.0
Coal	27.4	17.0	11.5
Hydroelectricity	5.1	4.8	6.5
Others	33.9	18.0	15.0

Source: Comision Nacional de Energia

Table 3 shows an increasing dependence on imported oil, but this trend is likely to be reversed in the coming decade because of new oil discoveries in the last 2 years. Chile should be providing 35% to 45% of its oil requirements by 1983, as compared to 20% in 1978, according to the estimates of the National Planning Office and the head of the State Petroleum Company (ENAP). Oil production is expected to increase by over 25% in 1979.

Chile also produces about 800,000 tonnes of coal a year. More could be produced, but Chilean coal is of low quality and production costs are high because installations are antiquated and the state-owned firm that produces most of the coal has a very large labor force (some 12,000 workers) which is presently being reduced to about 10,000 workers.

There is considerable interest in converting several oil-fired power stations to coal. One such possibility is at Tocopilla in the north (500 megawatts), relatively close to where the new Andacollo mine is likely to be opened. But there are no definite plans to make these changes at Tocopilla or other similar stations in the short run.

3.1 COST FACTORS

The methodology by which cost factors for Chile are constructed and applied is described in the supplementary report, "Country Cost Factors." The cost factors are shown in Table 4.

TABLE 4: CHILE: COUNTRY COST FACTORS

		Ratio Chile:U.S. Value (1975)
1.	Mine labor: wage rate	0.07
1A.	Mine labor: productivity	3.97
2.	Construction labor: wage rate	0.03
2A.	Construction labor: productivity	6.9
3.	Equipment & repair parts (a)	(1.0)
4.	Steel	1.22
5.	Timber	0.58
6.	Fuel	1.24
7.	Explosives	0.85
8.	Tires	4.03
9.	Construction materials	1.05
10.	Industrial materials (a)	(1.0)
11.	Transportation (a)	(1.0)
	Electrical power	1.24
	Water (b)	(1.5-1.20)

(a) No information available. Estimate made based on other unit costs.

(b) No information available. Estimate made depending upon remoteness of location and nature of terrain.

3.2 COST INDICES

The information used in the construction of the cost indices shown in Table 5 is drawn from the following sources:

1. Informativo Estadistico, January-March 1979 Republica de Chile, Ministerio de Economica Fomento y Reconstruccion, Instituto Nacional de Estadisticas

2. Boletin Mensual de Banco Central de Chile, August 1979

3. International Financial Statistics, June 1980

The indices of Table 5 are converted to a U.S. dollar base in Table 6 by a simple transformation using the market exchange rate factor based on the series (rf) compiled in International Financial Statistics. The exchange rates are given in Table 7. For the purpose of updating estimates the data of Table 6 should be used. Updating the indices involves using the following formula:

$$I\$N = \frac{I_{PN}/RN}{I_{P75}/R_{75}} \times 100$$

Where

$I_{\$N}$ = index in U.S. dollar terms for year or period N
I_{PN} = index in pesos for year or period N
I_{P75} = index in pesos terms for 1975
R_{75} = exchange rate (pesos per U.S. dollar) for 1975
R_N = exchange rate pesos per U.S. dollar in period N

For the purposes of backdating to 1965, the Wholesale Price Index presented in Table 7 may be used.

TABLE 5--Chile: Selected Cost Indices

(Based on Pesos)

	Item	Base Yr=100	1975	1976	1977	1978	1979
1.	Mine and plant labor	1975	100.0	476.6	1192.4	1775.5	2605.8[4]
2.	Construction labor	1974	472.5	1458.5	2603.2	3937.3	4642.7[2]
3.	Equipment and repair parts	1975	100.0	301.6	602.6	812.7	1026.3[3]
4.	Drill bits and related steel	1974	494.9	1324.5	2339.0	3269.7	3454.8[1]
5.	Timber and lumber	1974	354.9	1621.1	3511.3	5373.2	6246.5[1]
6.	Fuel	1974	789.0	2494.8	4218.7	6116.7	9540.2[1]
7.	Powder and blasting agents	1974	409.6	1252.3	2235.7	3048.3	4343.3[1]
8.	Tires	1974	660.2	2092.9	5397.3	8294.3	9896.7[1]
9.	Construction materials	1974	399.5	1176.9	2074.9	3001.5	3833.0[2]
10.	Industrial materials	1975	100.0	315.5	591.0	902.6	1232.3[3]
11.	Transportation	1974	662.6	1995.4	3930.6	5867.6	7771.3[1]

1. Index for March 1979
2. Index for July 1979
3. Average of first 8 months only
4. Index for April 1979

TABLE 6--Chile: Selected Cost Indices
(Based on U.S. dollars)

	Item	Base Yr=100	1975	1976	1977	1978	1979
1.	Mine and plant labor	1975	100	179.3	272.0	275.4	343.7
2.	Construction labor	1975	100	116.1	125.7	129.2	129.6
3.	Equipment and repair parts	1975	100	113.5	137.5	126.0	135.4
4.	Drill bits and related steel	1975	100	100.7	107.8	102.5	92.1
5.	Timber and lumber	1975	100	171.8	225.7	234.8	232.2
6.	Fuel	1975	100	119.0	122.0	120.2	159.5
7.	Powder and blasting agents	1975	100	115.0	124.5	115.4	140.2
8.	Tires	1975	100	119.3	186.5	194.9	197.7
9.	Construction materials	1975	100	110.8	118.5	116.5	126.6
10.	Industrial materials	1975	100	118.7	134.8	140.0	162.5
11.	Transportation	1975	100	113.3	135.3	137.3	154.7

TABLE 7--Chile: Wholesale Price Index
(Base year 1975 = 100)

Year	Wholesale Price Index Pesos	Wholesale Price Index U.S. dollars	Exchange Rate (Dinar:U.S. dollar)	R_{75}/R_N
1965	0.05	81.9	0.003	1637.0
1966	0.06	73.7	0.004	1227.75
1967	0.07	57.3	0.006	818.50
1968	0.09	63.1	0.007	701.57
1969	0.12	65.5	0.009	545.67
1970	0.17	75.9	0.011	446.45
1971	0.2	81.9	0.012	409.25
1972	0.3	73.7	0.020	245.55
1973	1.5	66.4	0.111	44.243
1974	17.2	101.5	0.832	5.9026
1975	100.0	100.0	4.911	1.0000
1976	321.1	120.8	13.054	0.3762
1977	597.4	136.3	21.529	0.2281
1978	854.0	132.5	31.656	0.1551
1979	1,275.9	168.2	37.246	0.1319

Source: International Financial Statistics, June 1980, September 1978, October 1975, and January 1973

In December 1974 the peso worth 1,000 escudo was introduced to replace the escudo. The exchange rate given for years prior to 1975 is given in terms of new pesos per dollar.

Cost Indices: Construction and Sources

1. Mine and plant labor

Definition: Index of salaries and wages in the mining sector

Source: Index of salaries and wages (Indice de salaries y Sueldos), base year April 1959 = 100, pg. 1,453

Publication: Boletin Mensual de Banco de Chile, August 1979

Calculation: The average index for each year was calculated and the indices with base year 1959 were then transformed to indices with base year 1975 using the following formula:

$$\frac{\text{Index for year N, base year 1959=100}}{\text{Index for year 1975, base year 1959=100}} \times 100 = \text{index for year N, base year 1975 = 100}$$

2. Index of construction labor

Definition: Index of labor costs in the construction industry for December of each year

Source: Cost index of average costs in the building industry, base year December 1974 = 100 (Indice costs de edificacion de tipo medio segun insumos). p. 1,444.

Publication: As in 1

3. Index of equipment and repair parts

Explanation: The government does not publish an index for these items. However, intermediate and capital goods account for about 80% of the total value of imported products and, therefore, we believe that the index of wholesale prices of all imported products is representative of the index of wholesale prices of equipment and repair parts.

Definition: Index of wholesale prices of all imported products, average for each year

Source: Index of wholesale prices (Indice de precios al por mayor), base year December 1974 = 100, pg. 1,450

Publication: As in 1

Calculation: The indices with base year December 1974 = 100 were converted to indices with base year 1975 = 100 using the following formula:

$$\frac{\text{Index for year N, December 1974 = 100}}{\text{Index for 1975, December 1974 = 100}} \times 100 = \text{index for year N, 1975 = 100}$$

4. Index of drill bits and related steel

Explanation: No wholesale price index for these items is available from government sources and, therefore, an index was constructed from actual wholesale prices

4.0 GOVERNMENT REGULATION AND TAXATION

4.1 MINERAL LEGISLATION

4.1.1 Mineral Rights

Mineral rights are vested in the state, but since 1974 concessions and ownership policy has become very flexible. The previous policy according to which foreign companies were to be at least 51% owned by the Chilean state has been reversed, and 100% foreign ownership may be retained.

4.1.2 Taxes

For Codelco and other Chilean mining companies, taxation is calculated as follows:

Sales Revenue:

Minus Cost of Sales
Equals Gross Income
Minus Depreciation (Rates set out below: Codelco's actual depreciation charge in 1978 was 11% on book value of depreciable assets)
Equals Taxable Income
Tax paid is made up as follows:

1. Tax law 13196 sets tax at 30% of taxable income.
2. Income tax (first category): 10% but can be reduced by advance payments.
3. Housing tax: 5% minus amount actually spent on housing by company. The total tax theoretically payable equals 45% but reductions in items 2 and 3 reduced the actual tax paid in 1978 to 39.9% of taxable income.

Foreign companies have two choices. They may opt for:

a) A fixed total tax charge of 49.5% of taxable income (defined as for Codelco) for 10 years from startup. This includes income tax, withholding tax, and housing tax, which are all applied as one charge without subdivision. We expect that foreign companies investing in Chile will opt for this system. This option is not available to Chilean investors.

b) The current rate of tax applied to foreign corporations, which can change from year to year. In January 1977, this rate was computed as follows:

Taxable Income	100.00
Minus Housing Tax	4.76
	95.24
Minus First-Category Tax	9.52
Minus Additional-Tax	38.09
	47.63

Total tax rate under this system is 52.37% but the government's policy is to reduce this.

Dividends paid to foreign shareholders are subject to 40% income tax; one tax is set off against the other.

4.1.3 Depreciation and Other Allowances

Fixed assets are depreciated on a straight-line basis according to set rates. The depreciation rates prevailing in 1977 were as follows:

Buildings	4%
Machinery	10%
Tools	20%
Heavy tools	10%
Mining installations	20%
Heavy trucks	14%
Organizational expenses	20%

Costs of acquiring mineral concessions as well as exploration and development costs are recoverable over the life of the mine in proportion to the units of ore produced.

The government is empowered to grant major copper producers special provisions for depreciation of new investment. Imports are not subject to tax, provided prices are in accordance with those normally charged. The Central Bank reviews the value of imports and in practice does not authorize import licenses when prices are unreasonable.

4.1.4 Exchange Controls

The repatriation of capital and profits is guaranteed within fairly wide limits. The Chilean peso is in principle convertible and there are only formal controls on currency transfers.

4.2 INSTITUTIONAL ISSUES

In principle, all large investments have to be registered with a Committee of Foreign Investment under the Ministry of the Economy.

In practice, actual negotiation of access to new copper deposits has to be done with their owners, which are mainly government agencies or firms. For instance, Exxon's negotiations

for the purchase of Disputada were done with ENAMI which was the former owner of the company. Noranda's negotiations for Andacollo also involved ENAMI. The major deposits in which new foreign investment may be made belong to Codelco.

4.3 NEW LABOR LEGISLATION

An important determinant of the profitability of new investment in copper in Chile will be the cost of labor and the possibility of labor disruptions. In this field, the government has recently promulgated new labor legislation which reintroduces collective bargaining, following its suspension since 1973. It also sets the rules for labor union organization and recognizes the right to strike, but under very restricted conditions.

Collective bargaining may be carried out only at the individual plant level, and labor union federations cannot participate in it. The latter are to have a very limited role. In addition, more than one union can be formed in each work place, provided each represents 10% of the work force. Membership of the union is completely voluntary.

There are several limitations on strike action. Among the most important are:

(1) Strikes are forbidden in public utility industries, in the public sector, and in any area which could affect supplies, the health of the population, the economy at large, and national security. Strikes in the large-scale copper mining sector are forbidden.

(2) The law gives the employers the right to lock out workers and to dismiss them and hire new ones if they think their company is "very badly affected" by the strike.

(3) If employers offer a wage increase at least equivalent to the cost of living increase, the workers on strike are obliged to accept it and end the strike or lose their jobs.

(4) No strike may last more than 60 days, and if it reaches that deadline the workers must accept the employer's latest proposal except where it falls below the increase in the cost of living.

It comes as no surprise that the private business community has hailed the new labor legislation, while almost all labor leaders (including those who still support the government) have been very critical. But the latter have little power to obtain changes in the new legislation since they have no political representation; the traditionally strong labor unions have been considerably weakened and there is widespread unemployment in the country.

Since July 1979, there have been several collective labor agreements reached in those enterprises selected by the government to implement the new system. There have also been a few strikes. On the whole, agreements have implied wage increases somewhat higher than the rise in the cost of living in the past, but future real wage increases will depend on future inflation. However, it is not possible to generalize from this experience because the companies that have reached new pay agreements are mainly the largest, most modern, and profitable private companies in the country.

In the case of copper, although workers are not allowed to operate under the general collective bargaining rules nor to go on strike, there were several forms of labor protest in 1978 and early 1979 aimed at applying pressure to achieve wage increases. A copper workers' congress in May required its union leaders to ask for wage talks immediately, without waiting for collective bargaining to be authorized by the government. The 12,000 mineworkers at the largest state-owned copper mine - Chuquicamata - obtained a 15% increase in their wages in July. Workers at El Salvador and El Teniente obtained 12% and 10% respectively. But those of Andina rejected the 10% offer made by the government in July. Restlessness over wage increases is reported to have continued, however, in all Codelco's mines, even after acceptance of the government's offers.

It should be recalled that the last collective pay talks in the large-scale copper mining sector had taken place 7 years ago, and that wage increases since then had only partially offset higher costs of living among miners.

5.0 INVESTMENT CLIMATE

The recent history of government attitudes to foreign investment in Chile is a familiar one. Following the coup in 1973, the previous policy of hostility to overseas involvement in the mining industry was reversed and most of the restrictions were removed. Indeed the government found that the constraints placed on policy by the Andean Pact, which laid down terms on which the Andean group of South American countries agreed to accept foreign investment, were too restrictive. Thus Chile left the Pact in 1976 in order to have a free hand in offering concessions to prospective overseas investors.

During recent years there has been a considerable revival of interest in prospecting and exploration by foreign international mining companies in Chile. Exxon bought a medium-scale copper mine (La Disputada) from ENAMI in late 1977 and is considering investing heavily to expand its production. Agreements have also been signed for the investigation of three unexploited deposits. These are the Andacollo copper prospect (Noranda), the Quebrada Blanco copper prospect (a consortium involving Falconbridge Copper and others), and the small, complex El Indio deposit (St. Joe) - now under an 85 million U.S. dollar development plan. A Japanese group has meanwhile continued work on the vast El Abra copper prospect. Outside the mining sector, a number of new industrial ventures involving foreign capital have also been announced.

It is clear that some of the big international natural resource companies increasingly regard Chile as an acceptable area of operations once again, and on the whole they are no longer deterred by the feeling that, however favorable the political complexion of today's government, the country is inherently too unstable to justify a major long-term investment commitment there. Even Anaconda, despite the expropriation of its copper assets in Chile, has bought the concession to exploit a middle-sized copper deposit. Nevertheless, the real test of attitudes of the mining companies will not come until a decision has to be made on developing a major new mine. The agreements signed so far are concerned with prospecting and exploration programs, and include only declarations of provisional intent regarding actual development of the deposits.

In fact, once it is felt that market conditions justify it, the external financing of a significant project in Chile should not be too difficult, since multinational banks are now quite content to give favorable consideration to loans for projects in Chile. Certainly there is currently little problem in raising short-term loans for balance of payments purposes, for example, or refinancing the very large external debt burden of the country.

In summary, foreign investors presently face a very favorable investment climate, but no special concessions in terms of cheap finance or tariff exemptions for inputs and machinery. But there is still some uncertainty about the long-term stability of the present Chilean military government.

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PHILIPPINES

1.0 BACKGROUND

1.1 ECONOMY

Between 1970 and 1977 the economy of the Philippines achieved an average real rate of growth of 6.4% a year in gross national product (GNP). More recently, however, the rate of growth has slackened because of a number of problems: import costs have risen rapidly (particularly for fuel, since the country imports over 80% of its energy requirements); inflation and unemployment have been rising; and the burden of overseas debt servicing is now substantial. Recent figures for some main economic indicators are shown in Table 1.

TABLE 1--Gross National Product, Consumer Price Index, and Exchange Rate Movements for the Philippines, 1975-1978

Economic Indicator	1975	1976	1977	1978
GNP (millions of pesos, 1975 prices)	114.26	122.28	129.98	137.51
Annual growth in GNP (%)		7.0	6.3	5.7
Consumer Price Index (1975 = 100)	100	106.1	114.1	123.2
Exchange rate (pesos per US$)	8.79	8.64	8.96	9.62

Source: International Financial Statistics, 1978 Yearbook

The breakdown of gross domestic product (GDP) by sector is presented in Table 2.

TABLE 2--Philippines: Main Components of Gross Domestic Product, 1976-1978
(Millions of pesos)

Sector	1976	1977	1978
Agriculture	37,341	42,688	47,126
Mining	2,128	2,472	3,202
Manufacturing	32,545	37,834	42,607
Construction	9,784	11,356	12,605
Others	52,130	59,694	67,314
TOTAL	133,928	154,044	172,854

Source: Table 65, Monthly Bulletin of Statistics, United Nations, January 1980.

Although the mining sector did not expand as fast as manufacturing in 1978, the sharp increase in prices in 1979 of the country's major major mineral products (copper, gold, nickel, and cobalt) will have resulted in a substantial rise in the value of mining output in that year.

The worsening of the balance of trade in 1978, when imports rose by 20% and exports by 10%, caused a deficit of almost US$1.4 billion, and a deficit of US$1.6 billion is expected for 1979. The trend is likely to continue in 1980 when the deficit could reach US$2 billion. This would represent 6% of GNP and almost 30% of total exports.

Between 1970 and mid-1979 the country's external debt grew from US$2 billion to US$8.7 billion. The debt service ratio (defined as total payments due during the year in interest and capital repayments as a percentage of the value of exports of goods and services) stood at 19% in 1979.

1.2 THE MINING INDUSTRY

The Philippines has substantial porphyry copper deposits, with important by-product values in gold, molybdenum, and silver. The area is also a significant producer of nickel and chrome ores. The country's principal mineral products in 1977 and 1978 are shown in Table 3 on the following page.

1.3 THE COPPER MINING INDUSTRY

The Philippines ranks ~~as the~~ seventh largest copper producing country in the non-Socialist world. The output of the country's major copper producers in 1978 is shown in Table 4.

TABLE 4--Output of Major Philippine Copper Producers, 1978

Company	Copper (million kilograms)	Gold (grams)	Silver (grams)	Molybdenite (kilograms)
Atlas Consolidated	127.73	3,262,039	14,104,869	44,583*
Lepanto	15.98	2,268,945	7,328,738	---
Marcopper	53.60	2,283,474	9,686,036	---
Marinduque	21.89	---	---	46,662**
Philex	26.86	5,086,142	5,410,184	---

*54.5% molybdenum

**60% molybdenum content of MoS_2

Source: Copper Studies, December 28, 1977

TABLE 3--Mineral Production of the Philippines
(in tonnes unless otherwise indicated)

Product	Production 1977	Production 1978	Percent Change	1978 value (million pesos)
Metallics:				
Gold (kg)	17,373	18,957	+9.12	807.1
Silver (kg)	50,429	51,864	+2.84	59.4
Cobalt	1,084	1,183	+9.13	176.2
Copper	272,792	263,425	-3.43	2,161.2
Lead	3,695	1,696	-54.10	5.9
Nickel	36,781	31,046	-15.59	672.6
Zinc	12,442	9,330	-25.01	18.4
Chromite (dry tonnes):				
Metal concentrate	95,434	106,487	+11.58	50.0
Metal ore	40,739	26,002	-36.18	13.5
Refractory ore	402,126	400,243	-0.47	184.4
Iron (lump ore)	---	4,747	---	0.8
Manganese				
Washed ore	6,581	NP	---	---
Unwashed ore	14,018	3,556	-74.63	1.1
TOTAL METALLICS				4,150.6
Nonmetallics:				
Bentonite	2,279	3,307	+45.11	1.6
Cement (bags)	104,914	106,668	+1.69	1,190.9
Coal	284,554	313,009	+10.00	50.1
Salt	200,000	214,000	+7.00	102.2
Silica sand	310,925	401,046	+28.98	14.4
Sand and gravel (cubic meters)	7,347,081	8,601,377	+17.07	266.3
Other Nonmetalics				80.2
TOTAL NONMETALLICS				1,705.7
GRAND TOTAL				5,856.3

Source: Philippine Bureau of Mines

Although ore grades are not high (averaging between 0.4% and 0.57% copper for the largest producers), the rich by-products present in most orebodies have lowered the cost of producing copper and made copper mining a very profitable sector that has attracted considerable investment in recent years.

As a result, copper production capacity has expanded rapidly in recent years and further expansion is underway. Three new mines (Sabena, Basay, and Ino) came on stream during 1979; the Dizon mine came into operation at the end of 1979; and Bullybueno and Amacan will start production within the next 2 years (Table 5).

The copper minng companies are locally owned with the exception of Marcopper Mining ~~in~~ which Placer Development holds a ~~8%~~ stake. In addition, several ~~companies are~~ quoted on the Philippine stock exchange ~~and have~~ a proportion of foreign shareholders. Foreign investors and banks regard the country in favorable terms, and the raising of finance for suitable projects is not a problem. The outlawing of strikes in "vital industries" (including high export industries such as copper) ensures a stable labor force: generally good infrastructure and communications within the country also contribute to the success of the copper industry.

A major problem faced by many Philippine producers is the lack of a regular power supply and rising power costs, due to the sharp increase in the price of imported fuel. The country is heavily dependent on imports as domestic sources can supply only 12% to 15% of the total energy requirements.

TABLE 5--Philippine Copper Mine Production Capacity, 1978-1982
(Thousands of tonnes of copper contained in concentrates)

Company	Mine	Capacity 1978	1979	1980	1981	1982
Acoje Mining	Barlo (a)	3	3	3	3	3
Apex Exploration	Masara	2	2	2	2	2
Atlas Consolidated	Various (b)	152	152	152	152	165
Baguio Gold	Santo Nino	6	6	6	6	11
Benguet Consolidated	Dizon	---	2	27	27	27
CDCP Mining	Southern Star (c)	---	19	19	28	28
Consolidated Mines	Ino et al	5	20	20	20	20
Frontino	Kennon	4	4	4	4	6
Hercules	Bullybueno	---	---	---	7	8
Lepanto Consolidated	Lepanto	25	25	25	25	25
Marcopper	Tapian/San Antonio	54	54	54	54	54
Marinduque	Sipalay	32	32	32	32	42
	Bagacay (d)	7	7	7	7	7
~~North~~ Davao	Amacan	---	---	---	10	25
Philex	~~Santo Tomas~~	31	31	31	31	31
Sabena Mining	Campostela	1	20	20	20	20
Western Minolco	Boneng/Lobo	18	18	18	18	18
Zambales	Ayala	1	1	1	1	1
TOTAL		341	396	421	447	493

(a) Currently offstream but can be reactiviated

(b) This assumes Lantoy ores replaced by Carmen or Frank in early 1980's

(c) Current production capacity is a little over 19,000 tonnes per year. It may be expanded to 28,000 tonnes per year, but the development schedule is unclear

(d) Bagacay ores depleted in early 1980's and assumed to be replaced by Rosy-Purita ore to maintain production

Hitherto the entire copper production of the Philippines has been exported in the form of concentrates. Plans to build a local smelter have been under discussion for several years. A site has now been selected, and a contract has been awarded to Marubeni Corporation of Japan to construct a smelter with the capacity to produce 138,000 tonnes of blister copper per year, to be followed by a refinery of 100,000 tonnes per year. The smelter may be on stream by 1983. The government will hold 35% of the equity in the project, local investors will hold 35%, and the remaining 30% will be open to foreign investors.

1.4 GOVERNMENT ATTITUDE TOWARD FOREIGN INVESTMENTS

The Philippine government encourages foreign investment on a selective basis, according to the priority which it attaches to the development of various industries and the political importance of maintaining national control of industries. The permitted level of foreign ownership is graduated as follows:

- No foreign participation is permitted in rural banks, mass media, retail trade, or most professional practice

- In the exploitation of natural resources (which includes copper mining and all other forms of mining) and in the operation of public utilities, up to 40% foreign ownership is permitted in the company or corporation which owns the project. Citizens of the Philippines must own at least 60%. If a mine is owned by individuals, they must be citizens of the Philippines

- In some areas of shipping, foreign ownership is limited to 25% or 30%.

- Foreign ownership of 40% is permitted in areas designated nonpioneer in the Investment Priorities Plan

- Foreign ownership of 100% is permitted in areas designated pioneer in the Investment Priorities Plan. Such areas include the manufacture of goods not already produced in the Philippines on a commercial scale or industries which introduce a new design, process, or product into the country. Full foreign ownership is also allowed in some geographical areas but this does not override the 40% limit on foreign ownership in mining

Copper mining and beneficiation is listed in the Investment Priorities Plan as a nonpioneer preferred industry. Mining companies are entitled to various tax concessions listed in Section 3.

All investors and enterprises are entitled to the following basic rights and guarantees, provided in the constitution:

- Right to repatriate investments and remit profits abroad

- Right to remit foreign exchange to service foreign loans

- Freedom from expropriation of investment

- Freedom from requisition of investment, except during a war or national emergency

There are some restrictions on the repatriation of foreign investments made before March 15, 1973. In export oriented businesses certified by the Central Bank, investments may be repatriated in full or in annual installments to the extent of the foreign investor's share in the net foreign exchange earnings in the preceeding year.

In the case of investments made after March 15, 1973, in export oriented businesses, the investment must be registered with the Central Bank. Repatriation is then permitted at any time.

Profits and dividends accruing to nonresidents may be remitted in full (subject to withholding tax); remittance of interim dividends or profits before the end of any fiscal or calendar year is not permitted.

Foreign investors can remit interest and repayments in foreign loans at the exchange rate prevailing at the time of remittance. Service, commitment, and other reasonable fees can be paid abroad. Prepayment of foreign borrowings is not normally allowed.

2.0 COST FACTORS AND COST INDICES

2.1 COST FACTORS

Cost factors for the Philippines are presented in Table 6. These should be used to adjust values derived from the Straam handbook in converting U.S. mining costs into corresponding Philippines costs.

TABLE 6--Philippines: Country Cost Factors

	Item	Ratio Philippines:U.S. Value (1975)
1.	Mine labor: wage rate	0.04
1A.	Mine labor: productivity	.2264 5.66 .2264
2.	Construction labor: wage rate	0.04
2A.	Construction labor: productivity	5.66
3.	Equipment and repair parts (a)	1.3
4.	Steel	0.98
5.	Timber	0.10
6.	Fuel	1.32
7.	Explosives (b)	1.5
8.	Tires	1.42
9.	Construction materials (b)	1.0
10.	Industrial materials (b)	1.5
11.	Transportation	1.06
	Electrical power	1.59 use 1.6
	Water (b)	1.5

(a) No information. Value based on steel, fuel, and industrial materials

(b) No information available

2.2 COST INDICES

The information used in the construction of the cost indices, shown in Table 7, is drawn principally from three sources:

- Statistical Appendix to Annual Report of Central Bank of the Philippines

- Central Bank of the Philippines Statistical Bulletin. (Published by the Department of Economic Research, Manila, Philippines)

- International Financial Statistics, May 1980. Published by the International Monetary Fund, Washington, D.C.

The indices given in Table 7 are converted to a U.S. dollar base in Table 8. For the purpose of updating cost estimates obtained with the Straam system, the data of Table 8 should be used. The construction of the indices in Table 8 involves simple transformation of the data of Table 7 using the market exchange rate factor, based on the series compiled in International Financial Statistics (IFS).

TABLE 7--Philippines: Selected Cost Indices
(Based on Philippine pesos)

	Item	Base Yr=100	1975	1976	1977	1978	1979*
1.	Mine and plant labor	1972	160.6	157.9	204.6	223.8	265.9**
2.	Construction labor	1972	140.6	158.8	183.4	205.2	243.8**
3.	Equipment and repair parts	1972	162.6	176.1	183.7	204.6	242.0*
4.	Drill bits and related steel	1972	228.2	246.8	254.1	274.2	324.3*
5.	Timber and lumber	1972	178.0	205.6	242.9	257.4	304.5*
6.	Fuel	1972	186.5	210.1	217.7	221.1	261.6*
7.	Powder and blasting agents	1972	226.3	248.2	255.0	257.6	304.7*
8.	Tires	1972	226.1	225.4	234.1	238.7	282.4*
9.	Construction materials	1972	213.3	224.2	251.2	277.9	328.8*
10.	Industrial materials	1972	177.2	199.6	214.8	234.2	277.1*
11.	Transportation	1972	155.9	166.7	170.4	189.1	223.7*

*Updated using Wholesale Price Index

**Updated using Consumer Price Index

Source: International Financial Statistics, May 1980

TABLE 8--Philippines: Selected Cost Indices
(Based on U.S. dollar)

	Item	Base Yr=100	1975	1976	1977	1978	1979
1.	Mine and plant labor	1975	100	96.0	125.1	137.5	163.0
2.	Construction labor	1975	100	110.0	128.1	144.0	170.7
3.	Equipment and repair parts	1975	100	105.8	110.9	124.1	146.5
4.	Drill bits and related steel	1975	100	105.6	109.4	111.3	139.9
5.	Timber and lumber	1975	100	112.8	134.0	142.6	168.4
6.	Fuel	1975	100	110.0	114.6	116.9	138.1
7.	Powder and blasting agents	1975	100	107.1	110.7	112.3	132.6
8.	Tires	1975	100	97.4	101.7	104.1	123.0
9.	Construction materials	1975	100	102.7	115.7	128.5	151.8
10.	Industrial materials	1975	100	110.0	119.0	130.4	153.9
11.	Transportation	1975	100	104.4	107.3	119.6	141.3

Exchange rate (par rate/market rate, rf):

	1975	1976	1977	1978	1979
Pesos per U.S. dollar	7.2746	7.4472	7.4074	7.3750	7.3889
Ratio of 1975 rate	1.0	0.9768	0.9821	0.9864	0.9845

In order to update the indices, the following expression should be used:

$$I_{\$N} = \frac{I_{PN}/R_N}{I_{P75}/R_{75}} \times 100$$

Where:

$I_{\$N}$ = index in U.S. dollar terms for year or period N

I_{PN} = index in pesos for year or period N

R_N = exchange rate (pesos per U.S. dollar) in period N

I_{P75} = index in pesos terms for 1975

R_{75} = exchange rate (pesos ~~per U.S. dollar~~) for 1975

Wholesale price indices for some of the items in Table ~~8~~ 7? were not found in published sources. Therefore, price indices were constructed using the wholesale price index for imported products and the wholesale price index for domestic products.

TABLE 9--Philippines: Wholesale Price Index

(Base year 1975 = 100)

Year	Wholesale Price Index (local currency)	Wholesale Price Index (U.S. dollars)	Exchange Rate	R_{75}/R_N
1965	32.1	59.7	3.91	1.8605
1966	33.5	62.5	3.90	1.8653
1967	34.3	63.5	3.93	1.8510
1968	35.3	65.3	3.93	1.8510
1969	35.8	66.1	3.94	1.8463
1970	44.2	50.0	6.43	1.1313
1971	51.1	57.8	6.43	1.1313
1972	51.9	56.3	6.7005	1.0857
1973	64.2	69.1	~~6.7629~~ 6.7563	1.0757
1974	94.9	101.6	~~6.7948~~ 6.7881	1.0706
1975	100.0	100.0	~~7.2746~~ 7.2479	1.0000
1976	109.2	106.7	~~7.4472~~ 7.4403	0.~~9768~~ .9741
1977	120.2	118.0	~~7.4074~~ 7.4085	0.~~9821~~ .9790
1978	128.2	126.5	~~7.3750~~ 7.3658	0.~~9864~~ .9839
1979	~~149.2~~ 151.7	146.9	~~7.3889~~ 7.3776	0.~~9845~~ .9824

Cost Indices: Sources and Construction

1. Index of mine and labor

(a) 1975-1978

Definition: Index of average monthly earnings of wage earners by industry

Source: Table 133, Subgroup: mining labor

Publication: Central Bank of Philippines, Statistical Bulletin 1978. Published by the Department of Economic Research, Manila, Philippines

(b) 1979

Source: International Financial Statistics, May 1980, Published by International Monetary Fund

Calculation: 1979 figure has been estimated, using the Consumer Price Index for 1978 + 1979, calculated as below:

$$\frac{\text{CPI 1979}}{\text{CPI 1978}} \times \text{1978 Index of Mine Labor}$$

$$= \text{1979 Index Mine of Labor}$$

2. Index of construction labor

(a) 1975-1978

Definition: As in 1(a).

Source: Table 133, Subgroup: construction labor

Publication: As in 1(a)

(b) 1979

As in 1(b)

3. Index of equipment and repair parts

(a) 1975-1979

Definition: Average of electrical machinery and nonelectrical machinery (wholesale price index for domestic ~~products plus~~ imported products)

Source: Wholesale Price Index for Domestic Products--Table 125 and Wholesale Price Index for Imported Products--Table 128

Publication: As in 1(a)

Calculation: Arithmetic mean of domestic and imported price for

(i) electrical machinery

(ii) nonelectrical machinery

(b) 1979

Calculation: 1979 estimate calculated using Wholesale Price Index to update the 1978 index figure:

$$\frac{\text{1979 WPI}}{\text{1978 WPI}} \times (\text{1978 Index}) = \text{1979 Index}$$

4. Index of drill bits and related steel

(a) 1975-1978

Definition: Metal products index (Wholesale Price Indices for domestic and imported products)

Source: As in 3

Publication: As in 1(a)

Calculation: Arithmetic mean of domestic and imported price indices for metal products

(b) 1979

As in 3(b)

5. Index of timber and lumber

(a) 1975-1979

Definition: Wholesale Price Index, Subgroup: forestry and logging products

Source: Table 124

Publication: As in 1(a)

(b) 1979

As in 3(b)

6. Index of fuel

(a) 1975-1978

Definition: Retail Price Index, Subgroup: fuel

Source: Table 121

Publication: As in 1(a)

(b) 1979

As in 3(b)

7. Index of power and blasting agents

(a) 1975-1978

Definition: Wholesale Price Index for domestic products and imports, Subgroup: chemicals

Source: Tables 125 and 128

Publication: As in 1(a)

Calculation: Arithmetic mean of indices of prices for domestic and imported chemicals

(b) 1979

As in 3(b)

8. Index of tires

(a) 1975-1978

Definition: Who~~lesale Price~~ Index for domestic and imported products, Subgroup: rubber products

Source: As in 7(a)

Publication: As in 1(a)

Calculation: Arithmetic mean of indices of prices for domestic and imported rubber products

(b) 1979

As in 3(b)

9. Index of construction materials

(a) 1975-1978

Definition: Retail Price Index, Subgroup: construction materials

Source: Table 121

Publication: As in 1(a)

(b) 1979

As in 3(b)

10. Index of industrial materials

(a) 1975-1978

Definition: Wholesale Price Index for domestic and imported products, subgroup: miscellaneous manufacturers

Source: Tables 125 and 128

Publication: As in 1(a)

Calculation: Arithmetic mean of indices of prices for domestic and imported products

(b) 1979

As in 3(b)

11. Index of transport

(a) 1975-1978

Definition: Wholesale Price Index, Subgroup: transport equipment

Source: Tables 125 and 128

Publication: As in 1(a)

Calculation: Arithmetic mean of indices of prices for domestic and imported equipment

(b) 1979

As in 3(b)

3.0 GOVERNMENT REGULATIONS AND TAXATION

3.1 MINING LEGISLATION

Mineral rights are vested in the state. Once initial prospecting work has outlined a mineral deposit, the prospector can apply for a mining claim for further exploration work. Each mining claim will cover a block approximately 81 hectares in area, and will be registered with the Bureau of Mines. The claim owner is obliged to spend a minimum of ₱20 per hectare each year on the property before a lease contract is issued, and ₱100 per hectare after a lease contract is issued.

Within 2 years of a mining claims registration, the holder has to apply for a lease on claims held. The mining lease is issued for 25 years and is renewable for a further 25 years. The maximum area that can be held by a company is 5,000 hectares in any one province and 10,000 hectares in the whole of the Philippines. The acquisition of a lease entitles the holder to exploit all minerals within the boundaries of his claims.

In an effort to prevent the "locking up" of orebodies, the government has recently promulgated a decree that owners of mining claims are obliged to put their areas into actual commercial production within 5 years. Failure to do so will be considered as abandonment of the mining claims.

Occupation fees for mining claims and lease rentals range from ₱1 to ₱5 per hectare per year.

Royalty is assessed on the actual market value of minerals extracted. Current rates are 1.5% for gold and 2% for copper and other minerals.

3.2 TAXATION OF MINING COMPANIES

3.2.1 Taxation of Corporate Income

Companies pay tax on their taxable income at the rate of 25% on the first ₱100,000 and 35% on income above that figure. In addition, companies are subject to a further tax of 5% on any taxable income that exceeds 10% of net assets.

Taxable income is gross income minus allowable deductions. Gross income includes all revenue from sales, rent, royalties, dividends, interest received, and capital gains. There is no separate tax on capital gains.

Allowable expenses include the following:

- Operating Costs--This includes costs of necessary materials, services, wages, and salaries.

- Depreciation--Any recognized and reasonable depreciation method may be used. The annual depreciation charge is based on the cost of each item, its estimated useful life, and its salvage value. Common rates are 20% for equipment and 10% for buildings, on a straight-line basis.

  Mining companies registered with the Board of Investments under the Investment Incentives Act can claim accelerated depreciation for buildings and plants. If the expected life is 10 years or less, the depreciation rate may be double the normal rate. If the expected life is more than 10 years, the asset may be depreciated over any number of years between 5 and the expected life.

- Depletion--Mining companies have the option of using expensing or cost depletion.

  Under the expensing method, a mining company may deduct accumulated exploration and development expenditure plus exploration and development expenditure incurred during the tax year in question from taxable income but this deduction may not exceed 25% of net income from mining operations.

Under the cost depletion method, the calculation is as follows: the adjusted cost of exploration and development is divided by the number of units of minerals remaining at the start of the tax year; the depletion unit thus calculated is multiplied by the number of units of minerals sold within the tax year.

- Interest on Debt--Provided that interest on foreign borrowings is not more than 2 percentage points above the prime rate in the country from which the loan is made, it is an allowable expense.

- Royalties (2% of sales value for copper) and other taxes.

- Losses--Enterprises registered under the Investment Incentives Act may carry forward as a deduction against taxable income a net operating loss incurred in any of the first 10 years of operation. It may be deducted from taxable income in any of the 6 years following the year of the loss.

- Special deductions granted as incentives (Section 3.2.8).

3.2.2 Import Duties

These range from 10% to 90% but imports of mining machinery and equipment are exempt.

3.2.3 Sales Tax

Minerals and mineral products are exempt from this tax.

3.2.4 Export Taxes

A 4% export tax was imposed in March 1977, and in March 1980 a 20% premium duty was introduced. Both taxes were repealed in April 1980.

3.2.5 Residence Tax

The basic annual tax is ₱50 for a company plus a graduated additional annual tax rising to a base of ₱6,000, on the basis of income.

3.2.6 Real Estate Tax

An annual tax is imposed ~~by~~ local government on all real estate within the Philippines. ~~The tax base is~~ a certain percentage of the market ~~value of~~ the real estate (50% in the case of mining property). The rate of tax is then set by the local government at between 0.25% and 2% of the tax base. An additional 1% is levied for the Special Education Fund.

3.2.7 Withholding Tax

On payments made to a domestic corporation or a resident foreign corporation the following rates apply:

Dividends:	10%
Interest:	15% creditable against final tax payable
Professional fees:	5% creditable
Payments to engineering and construction contractors:	3% creditable

On payments made to nonresident foreign corporations the following rates apply:

Dividends:	15%
Interest:	15%
Royalties and technical assistance fees:	35%

3.2.8 Tax Incentives for Mining Companies

- New mines and old mines which resume production are exempt from all taxes except income tax for 5 years from the start of commercial production of saleable mineral products.

- When a company registered ~~with the Board~~ of Investments reinvests undistributed profits in machinery, equipment, or construction, a percentage of the amount invested is allowed as a deduction from taxable income. The percentage for nonpioneer industries (which includes mining) is either 25%, 37.5%, or 50% to be determined by the Board of Investments.

- Half the cost of the training of labor is allowed as a deduction from taxable income, provided it does not exceed 10% of the direct labor bill.

- Tax credit is given for tax withheld on interest payments on foreign loans, provided no such credit is enjoyed by the lender in his own country.

- Registered enterprises under the Investment Incentives Act can obtain a tax credit equivalent to all sales tax and duties on materials and products used in the production of export products.

- Registered export producers under the Investment Incentives Act can get tax exemption on imported capital equipment that is not manufactured in the Philippines in reasonable quantity and quality.

3.2.9 Tax Computation

A typical tax computation for a Philippine mining company would therefore be as follows:

Sales Revenue	
plus	royalties
	dividends
	interest receipts
	capital gains
equals	gross revenue
minus	operating costs
	depreciation
	depletion
	interest payments
	royalties
	past losses
	investment or other tax credits
	real estate taxes or any other applicable taxes

equals	taxable income
minus	tax less than 25% on first ₱100,000
	35% on all excess
	5% on taxable income in excess of 10% of net assets
equals	net income
minus	dividends (subject to withholding tax)
equals	retained profits

4.0 BIBLIOGRAPHY

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Mining Costs

RECEIVED
JAN 31 1980
EXPLORATION DEPARTMENT

FROM: DOUGLAS M. SMITH, JR. 1/29/80

TO: Harold

You inquired once about the cost of the Tayoltita operation, but I had lost my final pre-departure financial report. So, nearly four years later, here it is.

I see that we were mining for $50.72/m.t., but that cost carried the entire company including outside exploration and a commercial (money losing) airline. We also stood to net $0.44 for every $1.00 rise in the price of gold as well as $0.45 for an equivalent increase in silver.

As Bill Kurtz may have told

FROM: DOUGLAS M. SMITH, JR. 1/29/80

TO: J. H. C.

you, a 49% interest in Minas de San Luis, S.A. was sold during mid-1979 for $44 million. A good buy when viewed in the light of January 1980 metal prices.

Saludos,
Doug

cc: WLK w/ att. ✓

BOARD OF DIRECTORS MEETING

MINAS DE SAN LUIS, S. A.

FINANCIAL REPORTS

JULY - 1976

I N D E X

1.- Balance Sheet - May 31, 1976.

2.- Statement of Income as of May 31, 1976-1975.

3.- Profit and Loss Estimated Year 1976

4.- A comparison of Production and Operational Cost Per Milled Ton May 1975-1976.

5.- Cash Flow 1976.

6.- Determination of Net Profit on account of gold and silver price variation.

peso @ 12.5/dollar = $0.08 U.S. Cy.

MINAS DE SAN LUIS, S. A.

BALANCE SHEET

MAY - 1976

A S S E T S

CURRENT ASSETS:		
Cash on Hand		$ 2,165,368
Accounts Receivable		
Met-Mex Penoles, S.A.	$ 20,312,796	
Other Accounts Receivable	2,356,047	
	$ 22,668,843	
Less: Reserve for bad debts	(178,043)	22,490,800
Account receivable by subsidy		3,043,456
Inventory		
Ore		6,590,531
Total Current Assets		34,290,155
PENSION PLAN FUND		5,163,114
INTERCOMPANY ACCOUNTS RECEIVABLE		3,756,124
OTHER ASSETS:		
Inventory Spare Parts.	$ 44,043,293	
Deferred	1,688,124	45,731,417
FIXED ASSETS:		
Property Plant & Equipment	$ 100,217,551	
Less: Reserve For Amortization & Depreciation	(69,047,646)	31,169,905
T O T A L		$ 120,110,715

L I A B I L I T I E S

CURRENT LIABILITIES:		
Bank Loans		$ 10,625,000
Accounts Payable		7,808,984
Dividends Payable		12,598,246
Accrued Liabilities		8,496,424
Reserve for Income Tax		2,897,000
Rve. for Employees Profit Participation		1,038,789
Total Current Liabilities		$ 43,464,443
INTERCOMPANY ACCOUNTS PAYABLE		4,987,371
LONG TERM LIABILITIES		
Notes Payable to San Luis Mining Company		2,270,521
CONTINGENT LIABILITIES		
Reserve for Contingency		3,725,000
PENSION FUND RESERVE		5,163,114
EQUITY:		
Capital Stock	$ 33,000,000	
Legal Reserve	4,247,593	
Retained Earnings	18,076,788	
Net Income for the year	5,175,885	60,500,266
		$ 120,110,715

MINAS DE SAN LUIS, S. A.

STATEMENT OF INCOME AS OF MAY 31, 1976 & 1975

P E S O S

		1 9 7 6		1 9 7 5		
		FIVE MONTHS	PER TON MILLED	FIVE MONTHS	PER TON MILLED	1975-1976 OVER (UNDER)
TONS MINED		58,333		56,435		1,898
TONS MILLED		69,530		68,828		702
PRODUCTION:	BARS	823		766		57
	KILOS GOLD	440.810		411.737		29.073
	KILOS SILVER	25,110.842		23,485.022		1,625.820
PRICE PER OUNCE-GOLD	DLS.	127.99		172.79		(44.80)
PRICE PER OUNCE-SILVER	DLLS.	4.22		4.26		(.04)
PRICE PER KILO-GOLD	MEX. CY.	51,437		69,442		(18,005)
PRICE PER KILO-SILVER	MEX. CY.	1,696		1,712		(.16)
SALE	GOLD	$ 22,673,185	$ 326	$ 28,591,929	$ 415	$ (5,918,744)
	SILVER	42,542,301	612	40,165,406	584	2,376,895
	TOTAL	$ 65,215,486	$ 938	$ 68,757,335	$ 999	$ (3,541,849)
LESS:						
FIRST HAND SALES TAX-GOLD & SILVER		$ 4,483,600	$ 64	$ 7,190,439	$ 104	$ (2,706,839)
PRODUCTION & EXPORT TAX (NET)		3,098,550	46	2,171,062	32	927,488
FREIGHT AND REFINING EXPENSES		676,189	10	590,274	9	85,915
	NET SALES	$ 56,957,147	$ 818	$ 58,805,560	$ 854	$ (1,848,413)
TOTAL OPERATING EXPENSE		44,156,715	634	35,001,621	508	9,155,094
OPERATING PROFIT OR (LOSS)		$ 12,800,432	$ 184	$ 23,803,939	$ 346	$ (11,003,507)
OTHER INCOME OR (EXPENSE)		(1,746,547)	(25)	197,595	3	(1,944,142)
PROFIT BEFORE INCOME TAX AND -EMPLOYEES PROFIT SHARING PARTICIPATION		$ 11,053,885	$ 159	$ 24,001,534	$ 349	$ (12,947,649)
INCOME TAX		4,937,000	71	10,715,000	156	(5,778,000)
EMPLOYEES PROFIT SHARING		941,000	14	2,040,000	30	(1,099,000)
NET PROFIT		$ 5,175,885	$ 74	$ 11,246,534	$ 163	$ (6,070,649)

MINAS DE SAN LUIS, S. A.

PROFIT AND LOSS ESTIMATED YEAR 1976

P E S O S

		REAL JANUARY/ MAY	ESTIMATED JUNE/ DECEMBER	TOTAL ESTIMATED ANNUAL
Bars production		823	1,120	1,943
Price per ounce:	Gold (Dlls)	127.99	125.00	
	Silver (Dlls)	4.22	4.50	
Gross bullion sales:				
Gold		$ 22,673,185	$ 29,820,000	$ 52,493,185
Silver		42,542,301	62,122,900	104,665,201
Total		$ 65,215,486	$ 91,942,900	$ 157,158,386
Taxes and Marketing:				
First hand sales tax-Gold &		$ 4,483,600	$ 6,165,600	$ 10,649,200
Production Tax gold		4,466,617	5,874,400	10,341,017
Production Tax Silver		5,034,062	7,582,400	12,616,462
Total		$ 13,984,279	$ 19,622,400	$ 33,606,679
Less: Automatic Subsidy		(3,233,399)	(4,877,600)	(8,110,999)
Additional Subsidy		(3,168,730)	(4,877,600)	(8,046,330)
Net taxes		$ 7,582,150	$ 9,867,200	$ 17,449,350
Marketing expenses		676,189	819,700	1,495,889
Total		$ 8,258,339	$ 10,686,900	$ 18,945,239
Net bullion revenue		$ 56,957,147	$ 81,256,000	$ 138,213,147
Other income		(1,746,547)	(2,171,400)	(3,917,947)
Total		$ 55,210,600	$ 79,084,600	$ 134,295,200
Expenses		$ 34,742,661	$ 50,640,839	$ 85,383,500
Depreciation and Amortization		812,157	2,387,843	3,200,000
Prospecting and Exploration Expense -Subsidied Mazatlán		540,006	2,009,994	2,550,000
Prospecting and Exploration Expense -Subsidied Mina		3,037,416	2,962,584	6,000,000
Tunel		2,704,183	6,545,817	9,250,000
Amortization as per agreement		1,207,912	92,088	1,300,000
Depletion as per agreement		1,112,380	1,541,620	2,654,000
Total		$ 44,156,715	$ 66,180,785	$ 110,337,500
Income before Income Tax and - Profit Participation.		$ 11,053,885	$ 12,903,815	$ 23,957,700
Income Tax		(4,937,000)	(5,629,200)	(10,566,200)
Profit sharing partipation		(941,000)	(1,071,500)	(2,012,500)
NET PROFIT		$ 5,175,885	$ 6,203,115	$ 11,379,000

-MINAS DE SAN LUIS, S. A.

A COMPARISON OF PRODUCTION AND OPERATIONAL COST PER MILLED TON

MAY 1975 - 1976

		P E S O S		
		1 9 7 5	1 9 7 6	VARIATION + (-)
Gold Price Ounce	DLS.	172.79	127.99	(44.80)
Silver Price Ounce	DLS.	4.26	4.22	.04
Gold Price per Kilogram	MEX. CY.	69,442	51,437	(18,005)
Silver Price per Kilograms	MEX. CY.	1,712	1,696	(16)
Production in kilograms:	GOLD	412	441	29
	SILVER	23,485	25,111	1,626
Meters developed		2,752	2,519	(233)
Metric Tons. Broken		56,435	58,333	1,898
Metric Tons. Shipped		72,892	73,060	168
Metric Tons. Dry Milled		68,828	69,530	702
Total direct. expense	MEX. CY.	473	590	117
Depreciation	MEX. CY.	35	44	9
Total operating expense	MEX. CY.	508	634	126
		$40.64 US/m.t.	$50.72/m.t.	$10.08/m.t. (+24.8%

MINAS DE SAN LUIS, S. A.

CASH FLOW 1976

MEXICAN CURRENCY

	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
	REAL	REAL	REAL	REAL	REAL	ESTIMATED	ESTIMATI	ESTIMATED	ESTIMATED	ESTIMATED	ESTIMATED	ESTIMATED	
BARS PRODUCED	146	155	151	170	201	160	16	160	160	160	160	160	
Sale price per ounce: Silver	3.97	3.95	4.21	4.33	4.51	4.50	4.5	4.50	4.50	4.50	4.50	4.50	
Gold	129.66	127.38	129.97	128.48	125.41	125.00	125.0	125.00	125.00	125.00	125.00	125.00	
BEGINNING CASH BALANCE	$ 1,674,000	$3,914,500	$3,775,000	$ 3,569,000	$ 2,696,000	$ 2,165,000	$ 5,174,00	$ 5,310,700	$ 7,790,800	$ 6,972,400	$ 9,827,500	$ 13,656,700	$ 1,674,000
Estimated net income for the year	$ 654,000	$ 250,000	$ 547,000	$ 1,227,000	$ 2,497,000	$ 871,000	$ 931,00	$ 880,000	$ 881,000	$ 880,000	$ 881,000	$ 880,000	11,379,000
Add: Charges to results which no cash is required:													
Increases to liabilities reserves	294,000	294,000	294,000	294,000	294,000	294,000	294,00	294,000	294,000	294,000	294,000	298,000	3,532,000
Depletion and Depreciation	140,000	146,000	164,000	174,000	188,000	342,000	341,00	341,000	341,000	341,000	341,000	341,000	3,200,000
Amortization as per subsidy agreement	281,000	211,000	7,200	371,000	337,000	92,800							1,300,000
Depletion as per subsidy agreement	190,000	197,000	200,900	275,000	249,000	221,600	220,50	220,000	220,000	220,000	220,000	220,000	2,654,000
Reserve for Income Tax	639,000	303,000	587,000	1,158,000	2,250,000	734,200	780,00	823,000	823,000	823,000	823,000	823,000	10,566,200
Reserve for profit participation to employees.	122,000	57,000	112,000	220,000	430,000	142,500	149,00	156,000	156,000	156,000	156,000	156,000	2,012,500
Reserve for San Luis Mining Company Interests.	32,900	30,600	32,900	31,700	32,900	31,700	32,90	32,900	31,700	32,900	31,700	21,200	376,000
Reserve for San Luis Mining Company - Interests	19,600	18,200	19,600	16,700	18,200	17,500	18,20	18,200	17,500	18,200	17,500	18,200	217,600
- on Fluoresqueda Machinery Account.	72,300	72,300	72,300	72,300	72,300	111,800	160,00	160,000	160,000	160,000	160,000	160,000	1,433,300
Interest on Wells Fargo Bank - Loan	100,000	486,000	85,000	370,000	139,000	220,000	300,00	80,000	80,000	80,000	80,000	30,000	2,050,000
Collections from Cooperative loans.													
Diferences between sales & Income Tax deposits	1,810,400)	330,600	(270,000)	(2,138,500)	(3,628,400)	3,574,000							(321,900)
Metal net sales	2,054,000)		(39,600)	14,600	(650,000)								1,379,000
Subsidy					1,250,000	10,000,000							11,250,000
Wells Fargo Bank - Loan.							1,000,00	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	6,000,000
Consumption of materials previously purchased.					750,000								750,000
Collections from TATSA loan													
SUM :	$ 6,409,200	2,395,700	$1,812,300	$ 2,085,800	$ 4,229,000	$16,653,100	$ 4,226,60	$ 4,005,100	$ 4,004,200	$ 4,005,100	$ 4,004,200	$ 3,947,400	57,777,700
TOTAL :	$ 8,083,200	6,310,200	$5,587,300	$ 5,654,800	$ 6,925,000	$18,818,100	$ 9,400,60	$ 9,315,800	$11,795,000	10,977,500	13,831,700	17,604,100	59,451,700
DISBURSEMENTS:													
Note Payable to San Luis Mining Company												1,250,000	1,250,000
Interest payments to San Luis Mining Company	105,000											217,600	322,600
- Fluoresqueda Machinery Account.	36,300					502,600						930,700	1,469.600
Interest on Wells Fargo Bank - Loan			274,400			176,800						199,200	650,400
Interest payments to San Luis Mining Company	118,700	370,400	15,000	743,000	500,000	400,000	452,90						2,600,000
Machinery and Equipment Purchases	379,000	406,400	376,900	343,600	297,000	147,100	150,00	150,000	150,000	150,000	150,000	150,000	2,850,000
Building (Housing, hospital and shool)													
Payments against reserves previously acrued in	31,000	31,000	32,000								25,000	2,645,000	2,764,000
- liabilities.	750,000	400,000	300,000		300,000	300,000							2,050,000
Loan to Cooperative	400,000	454,000		370,000	200,000	235,000						250,000	1,909,000
Islander Payment by TATSA		56,000			50,000	10,000,000	2,000,00	375,000					12,481,000
Projected Dividend Payment									3,672,600			4,263,000	7,935,600
Income Tax Payment					2,800,000	60,000	140,00						3,000,000
Profit participation to employees payment	1,978,700	327,400	175,000	617,200	150,000	222,600							3,470,900
Excess Purchase of Materials													
LA LIBERTAD - PROJECT :													
Housing Machinery and Equipment Additions	370,000	490,000	845,000	285,000	163,000	500,000	347,00						3,000,000
Note Payable to San Luis Mining Company.-												3,186,000	3,186,000
- Fluoresqueda Machinery Account.				600,000	300,000	1,100,000	1,000,00	1,000,000	1,000,000	1,000,000			6,000,000
Payment to Plant Installation Contractor													
Total La Libertad Project	$ 370,000	$ 490,000	$ 845,000	$ 885,000	$ 463,000	$ 1,600,000	1,347,00	1,000,000	1,000,000	1,000,000		3,186,000	12,186,000
Total	$ 4,168,700	$2,535,200	$2,018,300	$ 2,958,800	$ 4,760,000	$13,644,100	4,089,90	$ 1,525,000	$ 4,822,600	$ 1,150,000	175,000	$ 13,091,500	54,939,100
ENDING CASH BALANCE :	$ 3,914,500	$3,775,000	$3,569,000	$ 2,696,000	$ 2,165,000	$ 5,174,000	$ 5,310,70	$ 7,790,800	$ 6,972,400	$ 9,827,500	$13,656,700	$ 4,512,600	$ 4,512,600

MINAS DE SAN LUIS, S. A.

Variatem on net profit considering changes in prices for each dollar in Gold and 0.10 U.S. cents in Silver.

	GOLD	SILVER
	DOLARE	
Variation in prices per ounce	1.00	.10
Less:		
First hand sale Tax	.1005	.0051
Production Tax	.197	.0123
Automatic Subsidy	(.0885)	(.0036)
Additional Subsidy	(.0885)	(.0037)
Net Total Taxes	.1205	.0101
Net Sales	.8795	.0899
Income Tax	.3694	.0377
Profit Sharing participation to Employes	.0704	.0072
NET PROFIT	.4397	.0450

DEVELOPMENT

Work file
Mining Costs

DIRECT COST ESTIMATE

3000' ADIT 8'x8' — NEVADA

	HIGH COST/FT	LOW COST/FT.	AVE. COST/FT.
Drilling	46.38	136.33	
Blasting	23.60		
Mucking	33.00		
Scaling	10.49		
Ditching	6.49	2.24	
Support	47.93	—	
Ventilation	12.80	5.57	
Supervision	3.59	—	
Other	3.20	.78	
	$187.48	$144.92	$158.34

American Mine Service will give a rough contract price on this work.

1-17-80

make copy for: Gold file
Mining Costs file

For more information, Circle No. 116

and this 49

2/1/79

Mining Costs

Sacaton .45 + 50% = .68 (Percival say $1)
Silverbell .53 + 50% = .80

San Manuel ±80% recovery MoS_2 heads .00226 MoS_2 (.0186)

2/6/79 Percival

Sacaton Mining Cost All Material 1978

Direct	.45
Indirect	.14
^Gen Deduct	.32
TOTAL	91

× General Deduct include NMO, SWO, Depr, Depl, etc

Mill Costs 1.79 per ton ore

TOTAL/TONNAGE 5.13

SACATON 1978	11,067,800	waste
	4,152,400	ore
	15,220,200	

Direct Mining	6,986,172
Ind "	2,067,205
Gen Deduct	4,813,842
	13,867,219 = 91¢

ASARCO

Exploration Department
Western USA

January 28, 1977

Mr. T. C. Osborne
New York Office

Indirect Expense
Mining-Milling

The below list of indirect expenses is from SW Mining Department Accounting Office. The largest single item is, of course, State Property Taxes.

1	GENERAL EXPENSE
2	[illegible]nting (machine)
3	Administration
4	Advertising
5	Assessment work
6	Auditing
7	Automobile expense
8	Bond premium
9	Donations (detail on sheet 2)
10	Engineering supplies
11	Examinations & Research
12	Express & Freight
13	Extra warehouse labor
14	Fire protection
15	General hauling
16	Geological expense
17	Janitors
18	Legal expense
19	Lighting
20	Memberships (detail on sheet 2)
21	Messhouse & Bunkhouse deficit
22	Newspapers & Periodicals
23	Office heating
24	Office supplies
25	Overhead on labor from others
26	Postage and box rent
27	Purchasing
28	Rent of buildings and grounds
29	Statutory representation
30	Telegrams
31	Telephone rents & tolls
32	Telephone repairs
33	Transportation of Employees
34	Traveling expense
35	[illegible]etchmen
36	[illegible]ter-drinking
37	Other (detail on sheet 2)
38	TOTAL GENERAL EXPENSE
39	VACATION ALLOWANCES PAYABLE
40	HOLIDAY ALLOWANCES PAYABLE
41	PENSION ACCRUALS
42	TAXES—Federal—Old age benefit
43	Telephone & Telegraph
44	Unemployment Insurance
45	Other
46	State—Franchise
47	Property
48	Sales on Products
49	Sales on Purchases
50	Severance
51	Telephone & Telegraph
52	Unemployment Insurance
53	Use
54	
55	
56	TOTAL TAXES
57	INSURANCE—Employer's liability
58	Fire
59	Health & Accident
60	Life
61	Use & Occupancy
62	Other (detail on sheet 2)
63	TOTAL INSURANCE
64	SALARIES—Engineering
65	General Office
66	Timekeeping
67	Warehouse
68	Additional compensation
[illegible]	TOTAL SALARIES
[illegible]	MISCELLANEOUS MAINTENANCE
71	Office
72	Warehouse
73	Machine Shop
74	Lube Center
75	Tire Shop
76	Laboratory
77	Change house
78	Roads & Grounds
79	Lighting Lines
80	Water lines
81	Sewers & Drains
82	Metallurgical Laboratory
83	Salvage Building
84	Filter Building
85	Other
86	TOTAL MISC. MAINTENANCE
87	RECEIVING AND BUYING
95	TOTAL RECEIVING AND BUYING
96	SHIPPING AND SELLING
97	Hauling and loading
98	Sampling and assaying
99	Umpires
100	Smelter representation
101	Storage and Demurrage
102	Weighing
103	TOTAL SHIPPING AND SELLING
104	SAFETY & WELFARE (Form J)
105	EMPLOYMENT (Form J)
106	MEDICAL & SURGICAL (Form J)
107	Security and Severance Plan
108	Permanent & Total Disability

W. L. Kurtz

WLK:lb

cc: Division Supervisors

Mining Cost

From GRC KK 1977 STAR ~~Bonita Hill Mine~~ POND CREEK

		MN-MU	XTRA	MN-MU	XTRA		
* depr, deple, admin prg tax, net profits	1973	28.06	.35	9.30	1.45	20.22	.51
		32.17	.48	14.40	.81	23.23	.52
		37.52	1.39	13.46	.77	24.23	.87
		38.28	1.00	12.70	.51	26.32	.52
	1977	41.01	1.04	18.27	1.03	27.22	.37

E. BAYLEY
N. LAVE
R. SMITH
MR. CLOOS

Metal Prices
Gold, $212.00 per oz.
Silver, $5.548 per oz.
Lead, 33c per pound
Zinc, 31.50c per pound
Copper 67c per pound

THE WALLACE M

VOLUME LXXII No. 33 THE WALLACE MINER, WALLACE, IDAHO 83873 SEPT. 7, 1978

District's Mine Net Profits At $30,716,296 For 1977

Compiled from Sworn Statements on File with the County Assessor

MINE PRODUCTION AND EARNINGS IN 1977

	Tons Extracted	Gross Value	Cost of Extraction	Freight and Treatment	Betterments, Repairs or other Improvements	Net Profit	Net Loss
Asarco (Callahan Galena)	177,704	$16,447,221	$ 7,912,746	$ 531,414	$ 26,329	$ 8,003,051	
Asarco (CDA Mines-Coeur)	146,924	11,624,058	3,839,151	388,501	24,742	7,371,664	
Big Creek Apex	—	456,012	140,071			315,941	
Bunker Hill (Bunker Mine)	452,137	16,908,259	14,462,019	4,109,149	721,936		$1,884,845
Bunker Hill (Crescent)	15,095	1,254,745	1,616,477	105,925	8,011		475,268
Bunker Hill (Star 70%)	205,426	12,413,339	6,834,117	4,815,631	74,025	589,566	
Hecla (Lucky Friday)	182,412	25,684,252	6,835,756	7,101,725	4,957	9,941,813	
Hecla (Star 30%)	88,040	7,609,508	3,427,811	3,860,540		321,156	
Hecla (Sunshine Unit)	44,024	5,186,959	3,723,499	324,304		1,139,156	
Silver Dollar	—	1,376,923	1,189,599			187,324	
Silver Syndicate	—	149,330	89,217			60,112	
Sunshine	155,116	10,325,893	7,252,308	396,117	393,527	2,677,468	
LEASER:							
Mt. Goat (Zanetti-DMI)	—	66,495	57,450			9,045	
	1,466,878	$109,503,184	$57,380,221	$21,533,306	$1,253,527	$30,716,296	$2,360,113

Favored by high silver prices and mining operations not seriously affected by mines of the Coeur d'Alenes posted a net profit valuation total of labor problems. $30,716,296 in 1977. $12

pletion, federal, state and local taxes and other normal items of expense. Twelve mines and one lesser filed net profit valuation reports for 1977 and all reporting were in the "net profit"

Friday operations, the Asarco Galena-Callahan Mine's property, the Sunshine, Hecla's Sunshine Unit, and a newcomer, the Asarco's Coeur Mine of Coeur d'Alene Mines Corporation. High on the

1963	1,446,947	49,581,707
1964	1,683,024	55,075,339
1965	1,749,112	59,170,613
1966	1,432,101	61,365,629

Well file < 1) Gold
2) Mining Costs

1st 1/4 Rpt Benguet Cons Inc. June '78

Net Prod Costs ₱62.40 per ounce
or
₱146.53 per ton = US. ≈ ₱21

CONFIDENTIAL

T. C. Osborne

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EXPLORATION DEPT.

MISSION UNIT
COMPARATIVE REPORT - LIFE OF PROPERTY
1961 - 1976

PROFIT AND LOSS

Year	Copper Concentrate	Molybdenum Concentrate	Zinc Conc't.	Total Income	Less Royalties	Operating Income
1961-66	$ 66,447,598	$ 1,418,306	$ 155,268	$ 68,021,172	$ 577,402	$ 67,443,770
1967	12,835,303	380,193	-	13,215,496	465,744	12,749,752
1968	14,429,806	325,264	-	14,755,070	703,245	14,051,825
1969	22,347,596	567,842	-	22,915,438	1,197,307	21,718,131
1970	27,120,304	526,766	-	27,647,070	1,281,616	26,365,454
1971	17,845,553	646,543	-	18,492,096	1,011,645	17,480,451
1972	15,775,822	679,425	-	16,455,247	1,267,464	15,187,783
1973	22,541,834	874,734	-	23,416,568	1,189,690	22,226,878
1974	25,487,907	95,886	-	25,583,793	1,283,378	24,300,415
1975	7,258,571	(42,965)	-	7,215,606	489,071	6,726,535
1976	9,761,534	(300,661)	-	9,460,873	785,649	8,675,224
	$ 241,851,828	$ 5,171,333	$ 155,268	$ 247,178,429	$ 10,252,211	$ 236,926,218

Year	Other Income and Expense	Strike Expense	Sub Total	Less NYO Expense	Less SWMD Expense	Less State Income Tax
1961-66	$ 70,318	$ -	$ 67,514,088	$ 2,517,860	$ 112,254	$ 456,000
1967	141,524	-	12,891,276	709,140	86,838	48,000
1968	170,252	-	14,222,077	790,440	103,630	55,000
1969	211,482	-	21,929,613	945,780	137,864	88,000
1970	111,121	-	26,476,575	1,114,020	198,842	20,000
1971	106,002	(1,041,172)	16,545,281	1,163,810	229,505	-
1972	(8,722)	-	15,179,061	1,061,880	228,022	10,000
1973	249,120	-	22,475,998	1,049,640	296,335	30,300
1974	167,744	(465,327)	24,002,832	1,124,580	215,802	56,000
1975	37,772	-	6,764,307	1,137,840	219,730	-0-
1976	(62,269)	-	8,612,955	879,120	214,068	-0-
	$ 1,194,344	$ (1,506,499)	$ 236,614,063	$ 12,494,110	$ 2,042,890	$ 763,300

Year	Outcome Before Depr, Depl, & Amort.	Less Depreciation	Less Depl. M. L. No. 1	Less Depl. M. L. No. 2	Less Amortization	Net Outcome
1961-66	$ 64,427,974	$ 13,753,837	$ 300,338	$ 3,201,857	$ 75,000	$ 47,096,942
1967	12,047,298	1,820,960	22,343	222,722	-	9,981,273
1968	13,273,007	2,062,309	29,058	289,666	-	10,891,974
1969	20,757,969	2,360,764	38,272	381,516	-	17,977,417
1970	25,143,713	2,328,177	38,557	384,359	-	22,392,620
1971	15,151,966	2,114,115	32,343	322,411	2,499	12,680,598
1972	13,879,159	2,150,233	31,803	317,027	4,992	11,375,104
1973	21,099,723	2,183,377	33,818	337,108	1,719	18,543,701
1974	22,606,450	1,666,565	27,620	275,328	-	20,636,937
1975	5,406,737	1,107,447	18,887	188,269	-	4,092,134
1976	7,519,767	* 568,542	6,104	60,850	-	6,884,271
	$ 221,313,763	$ 32,116,326	$ 579,143	$ 5,981,113	$ 84,210	$ 182,552,971

* Includes Auto Depreciation (Previously charged to Operations)

MISSION UNIT
COMPARATIVE REPORT - LIFE OF PROPERTY
1961 - 1976

MINING ACTIVITY

Year	Tons Ore Mined	Operating Days	Tons Ore Mined/ Oper. Day	Tons Waste Moved	Total Tons Waste Plus Ore	Tons Waste & Ore/Oper Day	Ratio of Tons Waste to Tons Or
1961-66	36,005,200	2,046	17,598	160,042,500	196,047,700	95,820	4.44
1967	4,603,600	207	22,240	14,330,900	18,934,500	91,471	3.11
1968	6,009,700	283	21,236	16,119,800	22,129,500	78,196	2.68
1969	7,939,500	357	22,239	20,478,100	28,417,600	79,601	2.58
1970	8,038,900	357	22,518	18,549,000	26,587,900	74,476	2.31
1971	6,724,900	302	22,268	20,028,600	26,753,500	88,588	2.98
1972	8,363,800	357	23,428	25,506,400	33,870,200	94,875	3.05
1973	8,782,500	356	24,670	21,532,400	30,314,900	85,154	2.45
1974	7,539,100	321	23,486	17,122,300	24,661,400	76,827	2.27
1975	5,089,800	226	22,521	7,578,200	12,668,000	56,053	1.49
1976	6,407,300	272	23,556	9,762,800	16,170,100	59,449	1.52
	105,504,300	5,084	20,752	331,051,000	436,555,300	85,868	3.14

MINING COST PER TON ORE MINED

Year	Tons Ore Mined	Open Pit Mining Direct	Diamond Drilling Direct	Pima Common Boundary	Total Direct	Total Indirect	Eisenhower Mining Co. Payment	Total Mining *
1961-66	36,005,200	$ 1.05	$ .02	$ -	$ 1.07	$ .25	$ -	$ 1.32
1967	4,603,600	.77	.01	-	.78	.41	-	1.19
1968	6,009,700	.69	-	-	.69	.31	-	1.00
1969	7,939,500	.75	-	-	.75	.32	-	1.07
1970	8,038,900	.78	-	.13	.91	.38	-	1.29
1971	6,724,900	.82	-	.01	.83	.46	-	1.29
1972	8,363,800	.81	-	-	.81	.48	-	1.29
1973	8,782,500	.77	-	(.03)	.74	.36	-	1.10
1974	7,539,100	1.00	-	(.04)	.96	.55	-	1.51
1975	5,089,800	1.01	-	(.01)	1.00	.37	-	1.37
1976	6,407,300	.99	.00	.00	.99	.39	(.08)	1.30
	105,504,200	$ .91	$ .01	$ .00	$ .92	$ .35	$ .00	$ 1.27

* Sum [illegible]

NOTE: 1971 & 1974 figures do not include any Strike Expenses which are reported on Page One as a separate item.

MISSION UNIT
COMPARATIVE REPORT - LIFE OF PROPERTY
1961 - 1976

MILLING ACTIVITY

Year	Tons Ore Milled	Operating Days	Tons Ore Milled/ Oper. Day	ASSAY Silver	ASSAY Copper	CONTENT Silver Ounces	CONTENT Copper Tons
1961-66	35,937,600	1,936	18,563	.19	.80	6,765,579	288,072
1967	4,603,600	207	22,240	.19	.88	879,695	40,409
1968	6,009,700	283	21,236	.12	.76	735,625	45,892
1969	7,939,500	357	22,239	.12	.70	955,677	55,611
1970	8,038,900	357	22,518	.13	.67	1,019,577	53,586
1971	6,724,900	302	22,268	.13	.67	869,495	45,385
1972	8,363,800	357	23,428	.12	.61	958,086	51,403
1973	8,782,500	356	24,670	.16	.60	1,411,849	52,692
1974	7,539,100	321	23,486	.14	.61	1,068,601	45,800
1975	5,089,800	226	22,521	.10	.60	522,041	30,701
1976	6,407,300	272	23,556	.12	.62	797,320	39,768
	105,436,700	4,974	21,198	.15	.71	15,983,545	749,319

MILLING COST PER TON MILLED

Year	Tons Ore Milled	Operations	Maintenance	Total Direct	Total Indirect	Total Milling
1961-66	35,937,600	$ .48	$ .12	$ .60	$ .19	$ .79
1967	4,603,600	.57	.17	.74	.30	1.04
1968	6,009,700	.56	.21	.77	.35	1.12
1969	7,939,500	.57	.24	.81	.34	1.15
1970	8,038,900	.60	.23	.83	.36	1.19
1971	6,724,900	.61	.25	.86	.37	1.23
1972	8,363,800	.59	.25	.84	.34	1.18
1973	8,782,500	.65	.26	.91	.33	1.24
1974	7,539,100	.89	.36	1.25	.45	1.70
1975	5,089,800	1.28	.46	1.74	.66	2.40
1976	6,407,300	1.27	.40	1.67	.55	2.22
	105,436,700	$ .65	$ .23	$ .88	$ .32	$ 1.20

NOTE: 1971 & 1974 figures do not include any Strike Expense which are reported on Page One as a separate item.

MISSION UNIT
COMPARATIVE REPORT - LIFE OF PROPERTY
1961 - 1976

COPPER CONCENTRATES PRODUCTION

Year	Tons	ASSAY Silver	ASSAY Copper	CONTENT Silver Ounces	CONTENT Copper Tons	PERCENT RECOVERY IN CONCENTRATES Silver	PERCENT RECOVERY IN CONCENTRATES Copper
1961-66	932,098	5.25	28.41	4,896,088	264,832	72.4	91.9
1967	137,609	4.38	26.70	602,218	36,747	68.5	90.9
1968	144,547	3.43	27.08	495,684	39,144	67.4	85.3
1969	183,015	3.61	27.34	660,378	50,034	69.1	90.0
1970	174,176	3.58	27.37	624,248	47,678	61.2	89.0
1971	145,865	3.35	27.85	489,146	40,618	56.3	89.5
1972	166,066	2.80	27.32	464,761	45,371	48.5	88.3
1973	169,644	3.36	27.44	571,252	46,558	40.5	88.4
1974	148,911	3.43	27.08	510,837	40,332	47.8	88.1
1975	98,119	2.97	27.46	291,515	26,946	55.8	87.8
1976	133,046	3.06	26.45	407,183	35,190	51.1	88.5
	2,433,096	4.12	27.68	10,013,310	673,450	62.6	89.9

COPPER CONCENTRATES SALES

Year	Tons	Total Copper Content	Settlement Quotation	PER POUND COPPER CONTENT Net Revenue	Cost of Sales	Net Outcome	OUTCOME
1961-66	931,355	264,636	32.9¢	26.2¢	13.6¢	12.6¢	$ 66,447,598
1967	138,094	36,871	38.1	30.8	13.4	17.4	12,835,303
1968	144,085	39,005	41.8	34.2	15.7	18.5	14,429,806
1969	182,033	49,829	47.5	39.3	16.9	22.4	22,347,596
1970	174,060	47,577	57.6	48.6	20.1	28.5	27,120,304
1971	146,751	40,878	51.3	41.7	19.9	21.8	17,845,553
1972	161,376	44,246	50.6	39.4	21.6	17.8	15,775,822
1973	159,744	43,877	59.3	46.4	20.7	25.7	22,541,834
1974	140,271	37,937	75.2	60.3	26.7	33.6	25,487,907
1975	115,109	31,677	63.7	44.5	33.1	11.4	7,258,571
1976	124,769	32,915	69.2	45.9	31.1	14.8	9,761,534
	2,418,147	669,448	46.4¢	36.4¢	18.3¢	18.1¢	$ 241,851,828

MISSION UNIT
COMPARATIVE REPORT - LIFE OF PROPERTY
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MOLYBDENUM CONCENTRATE PRODUCTION

Year	Tons	ASSAY Mo	ASSAY Cu	CONTENT Mo Pounds	CONTENT Cu Pounds	PERCENTAGE OF MOLYBDENUM Recovered in Mo Conc't.	Lost in Copper Conc't.	Lost in Tailings
1961-66	1,312	51.63	.94	1,354,899	24,661	37.3	25.8	36.9
1967	360	53.59	1.06	385,902	7,607	20.9	30.6	48.5
1968	535	51.34	1.02	549,016	10,933	24.4	27.3	48.3
1969	755	51.78	.81	782,105	12,235	23.9	23.5	52.6
1970	758	52.02	.72	788,862	10,976	29.4	17.5	53.1
1971	1,088	52.24	.66	1,136,561	14,301	36.5	26.7	36.8
1972	1,809	52.57	.38	1,902,029	13,635	35.2	29.7	35.1
1973	771	52.77	.55	813,742	8,525	26.7	25.0	48.3
1974	627	51.84	.65	649,919	8,204	23.2	27.6	49.2
1975	418	51.71	1.07	432,304	8,945	21.2	23.6	55.2
1976	261	51.55	1.11	268,679	5,764	10.8	27.9	61.3
	8,694	52.13	.72	9,064,018	125,786	27.8	26.1	46.1

MOLYBDENUM CONCENTRATE SALES

Year	Tons	Pounds Moly Content	Per Pound of Molybdenum Content: Net Revenue	Cost of Sales	Net Outcome	OUTCOME
1961-66	1,270	1,311,210	$ 2.03	$ .95	$ 1.08	$ 1,418,306
1967	402	429,591	1.88	.99	.89	380,193
1968	502	516,893	1.48	.85	.63	325,264
1969	761	787,483	1.62	.90	.72	567,842
1970	763	792,911	1.67	1.00	.67	526,766
1971	612	646,313	1.68	.68	1.00	646,543
1972	1,074	1,116,242	1.23	.62	.61	679,425
1973	1,962	2,069,028	1.26	.84	.42	874,734
1974	638	660,569	1.72	1.57	.15	95,886
1975	411	425,761	2.42	2.52	(.10)	(42,965)
1976	257	265,526	3.01	4.14	(1.13)	(300,661)
	8,652	9,021,527	$ 1.65	$ 1.08	$ .57	$ 5,171,333

MISSION UNIT
COMPARATIVE REPORT - LIFE OF PROPERTY
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ZINC CONCENTRATES PRODUCTION

Year	Tons	ASSAY Ag	ASSAY Cu	ASSAY Zn	CONTENT Silver Ounces	CONTENT Copper Tons	CONTENT Zinc Tons
1961-66	5,135	2.30	2.33	51.18	11,815	120	2,628
1967	-	-	-	-	-	-	-
1968	-	-	-	-	-	-	-
1969	-	-	-	-	-	-	-
1970	-	-	-	-	-	-	-
1971	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-
	5,135	2.30	2.33	51.18	11,815	120	2,628

ZINC CONCENTRATE SALES

Year	Tons	Pounds Zinc Content	Net Revenue	Cost of Sales	Net Outcome	OUTCOME
1961-66	5,135	5,256,249	6.4¢	3.4¢	3.0¢	$ 155,268
1967	-	-	-	-	-	-
1968	-	-	-	-	-	-
1969	-	-	-	-	-	-
1970	-	-	-	-	-	-
1971	-	-	-	-	-	-
1972	-	-	-	-	-	-
1973	-	-	-	-	-	-
1974	-	-	-	-	-	-
1975	-	-	-	-	-	-
1976	-	-	-	-	-	-
	5,135	5,256,249	6.4¢	3.4¢	3.0¢	$ 155,268

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Mining Costs

New Development Highlights . . .Continued from page 2

Mining Costs

ore milled in 252 U. S. A. plants in 1975

concentration almost 22 percent increased in proportion to tons milled to [illegible] dorum Company and the Questa mill of

cont
file Mining Co

EMJ5 Nov. '76 p. ~~188 189~~ p. 185 & 189

Equity Mining Corp (open pit Ag-Au-Cu)
(Sam Goodloe)

president said $40-50 million to dev. mine
at 3300 to 5000 tpy

NATIONAL
45-481
Made in U.S.A.

cue file

8-26-76 UNDERGROUND MINING COSTS

TES:

Climax 4.25

Lakeshore 5.00

" 4.60 best areas (oxide?)

Sacaton - using 5.00

cpy: WLK - 2 copies
JHC
RBC done yesterday

SAN MANUEL 10/15/75

-2-

from Jack Still

Arizona current UG Miners rate is $5.7825/hr or $46.26/shift
Assume 35% of crew is on bonus and earning $30/day over wages:

65% @ $46.26
35% @ $76.26
then average $56.76, further assuming that payroll load costs are 32%, the $56.76 x 1.32 = $74.92
plus Cost of Living allowance = 3.64
then Mine Dept. cost/MS = $78.56

Tons/MS

$78.56/36 = $2.182 labor cost/ton
$2.182/.65 = $3.35 mining cost/ton

WLK calculation:

$56.76
+ 3.64 Cost of living
$60.40 direct labor

$60.40 ÷ 36 tons per MS = $1.6778 labor

assume labor equals 65% of direct mining cost then,

total direct mining cost = 2.5812
indirect @ 50% = $3.87 total direct + indirect mining cost

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RBC

SAN MANUEL

10/15/75

-2-

from Jack Still

Arizona current UG Miners rate is $5.7825/hr or $46.26/shift
Assume 35% of crew is on bonus and earning $30/day over wages:

65% @ $46.26
35% @ $76.26
then average $56.76, further assuming that payroll load costs are 32%, the $56.76 x 1.32 = $74.92
plus Cost of Living allowance = 3.64
then Mine Dept. cost/MS = $78.56

Thousands

$78.56/36 = $2.182 labor cost/ton
$2.182/.65 = $3.35 mining cost/ton

WLK calculation:

$56.76
+ 3.64 Cost of living
$60.40 direct labor

$60.40 ÷ 36 tons per MS = $1.6778 labor

assume labor equals 65% of direct mining cost then,

total direct mining cost = 2.5812
indirect @ 50% = $3.87 total direct + indirect mining cost

cpy: WLK - 2 copies
JHC
RBC

San Manuel

10/15/75

-2-

from Jack Still

Arizona current UG Miners rate is $5.7825/hr or $46.26/shift
Assume 35% of crew is on bonus and earning $30/day over wages:

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then average $56.76, further assuming that payroll load costs are 32%, the $56.76 x 1.32 = $74.92
plus Cost of Living allowance = 3.64
then Mine Dept. cost/MS = $78.56

Tons

$78.56/36 = $2.182 labor cost/ton
$2.182/.65 = $3.35 mining cost/ton

WLK calculation:

$56.76
+ 3.64 Cost of living
$60.40 direct labor

$60.40 ÷ 36 tons per MS = $1.6778 labor

assume labor equals 65% of direct mining cost then,

total direct mining cost = 2.5812
indirect @ 50% = $3.87 total direct + indirect mining cost

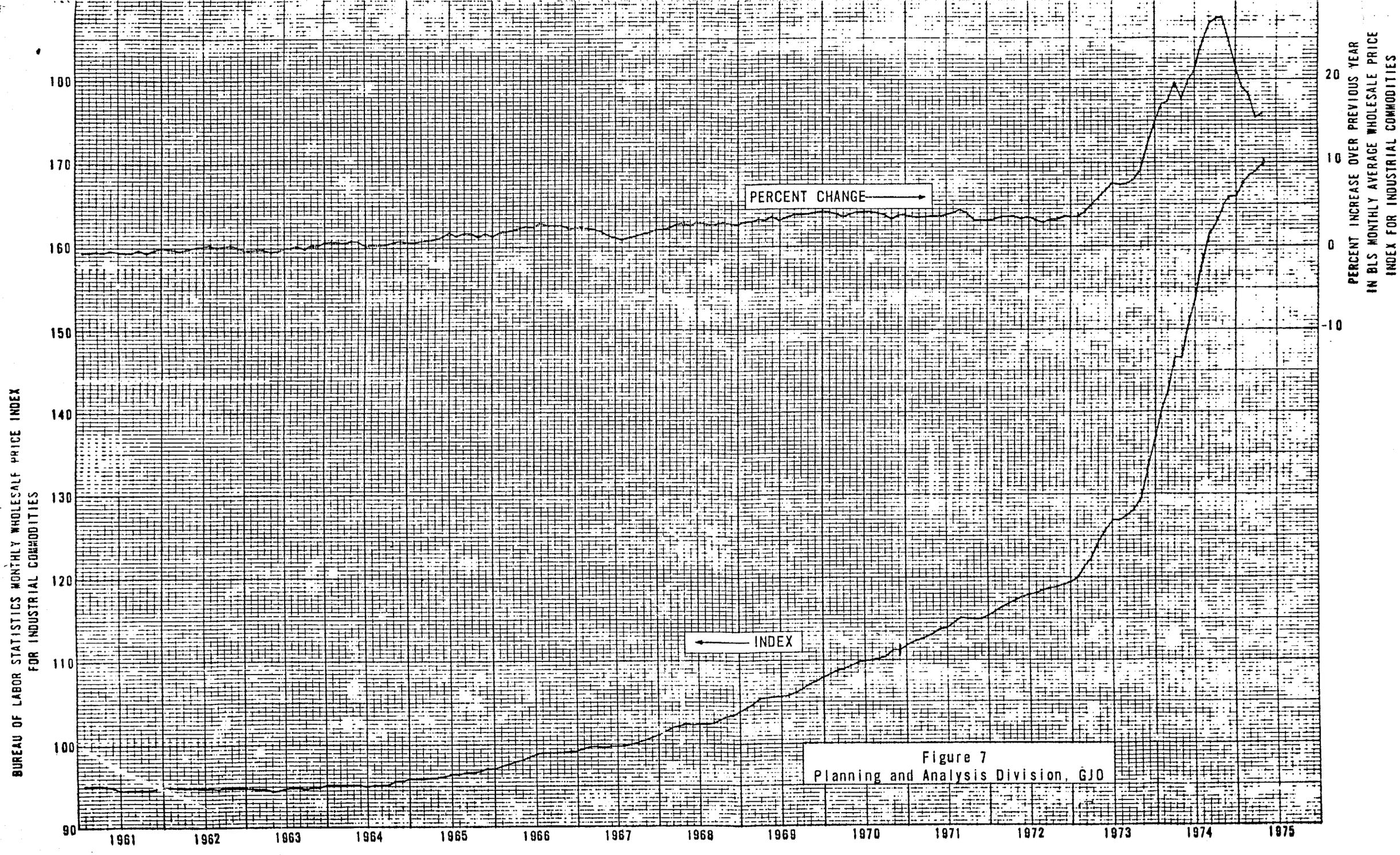


Figure 7
Planning and Analysis Division, GJO

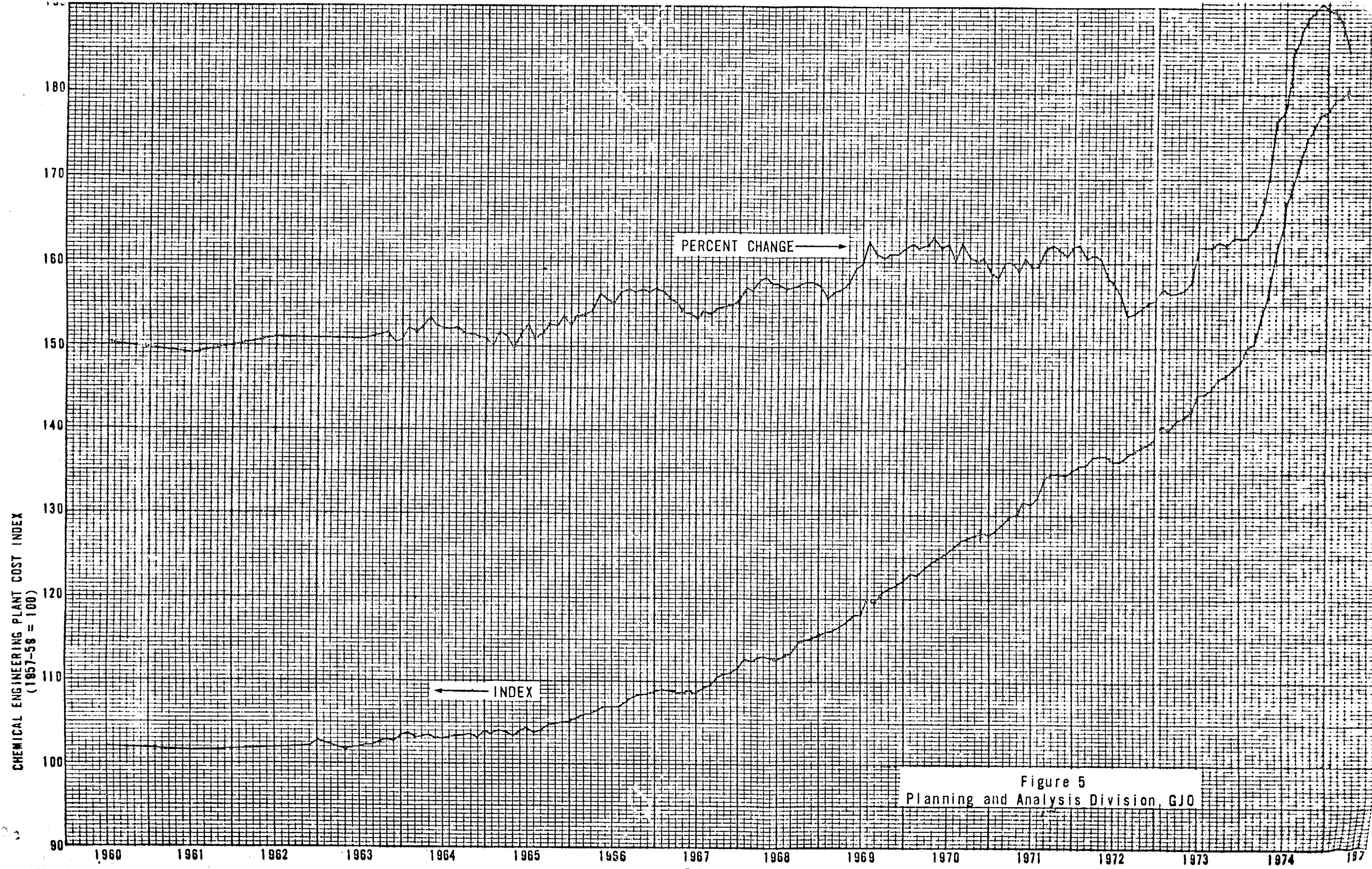


Figure 5
Planning and Analysis Division, GJO

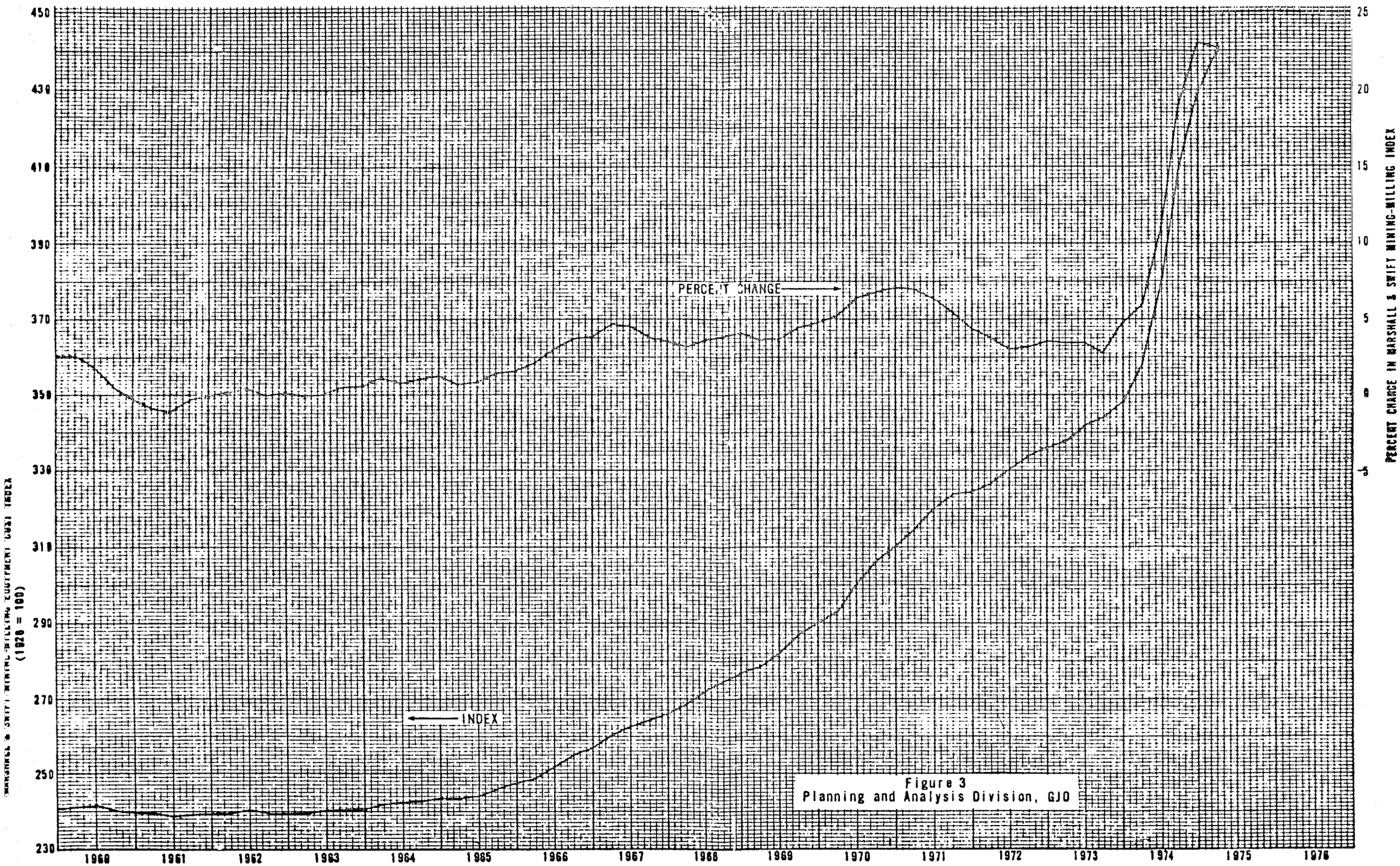


Figure 3
Planning and Analysis Division, GJO

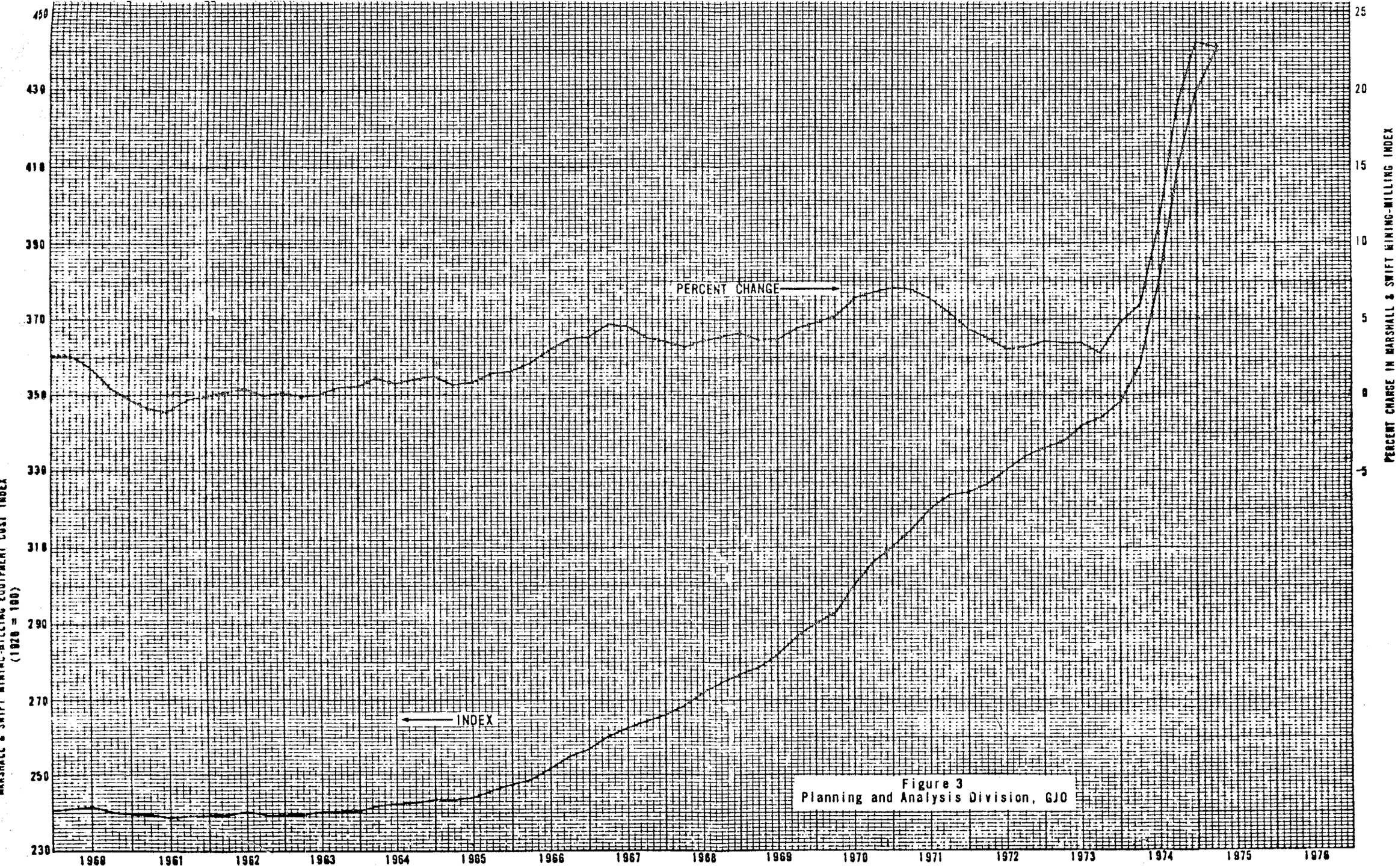


Figure 3
Planning and Analysis Division, GJO

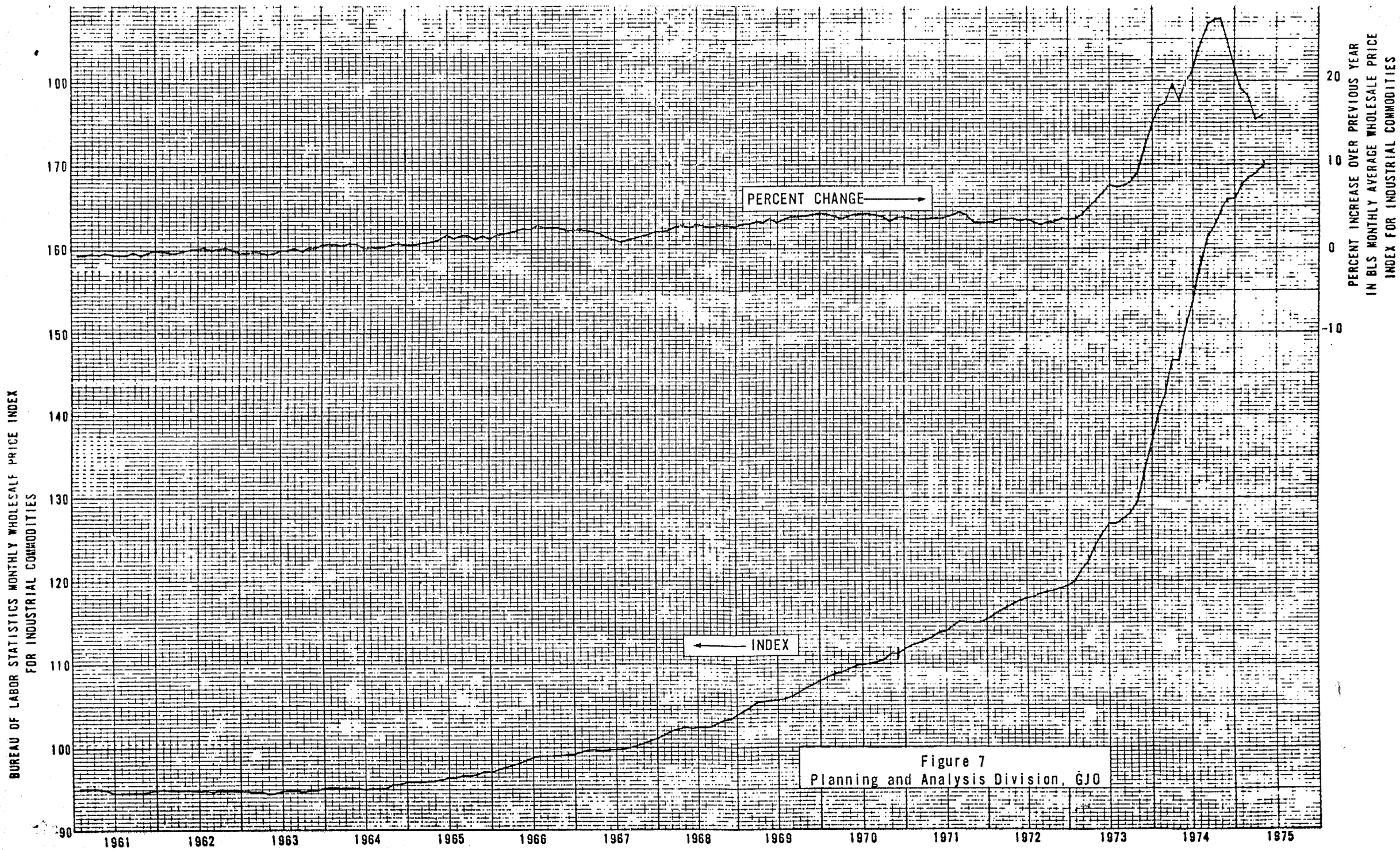


Figure 7
Planning and Analysis Division, GJO

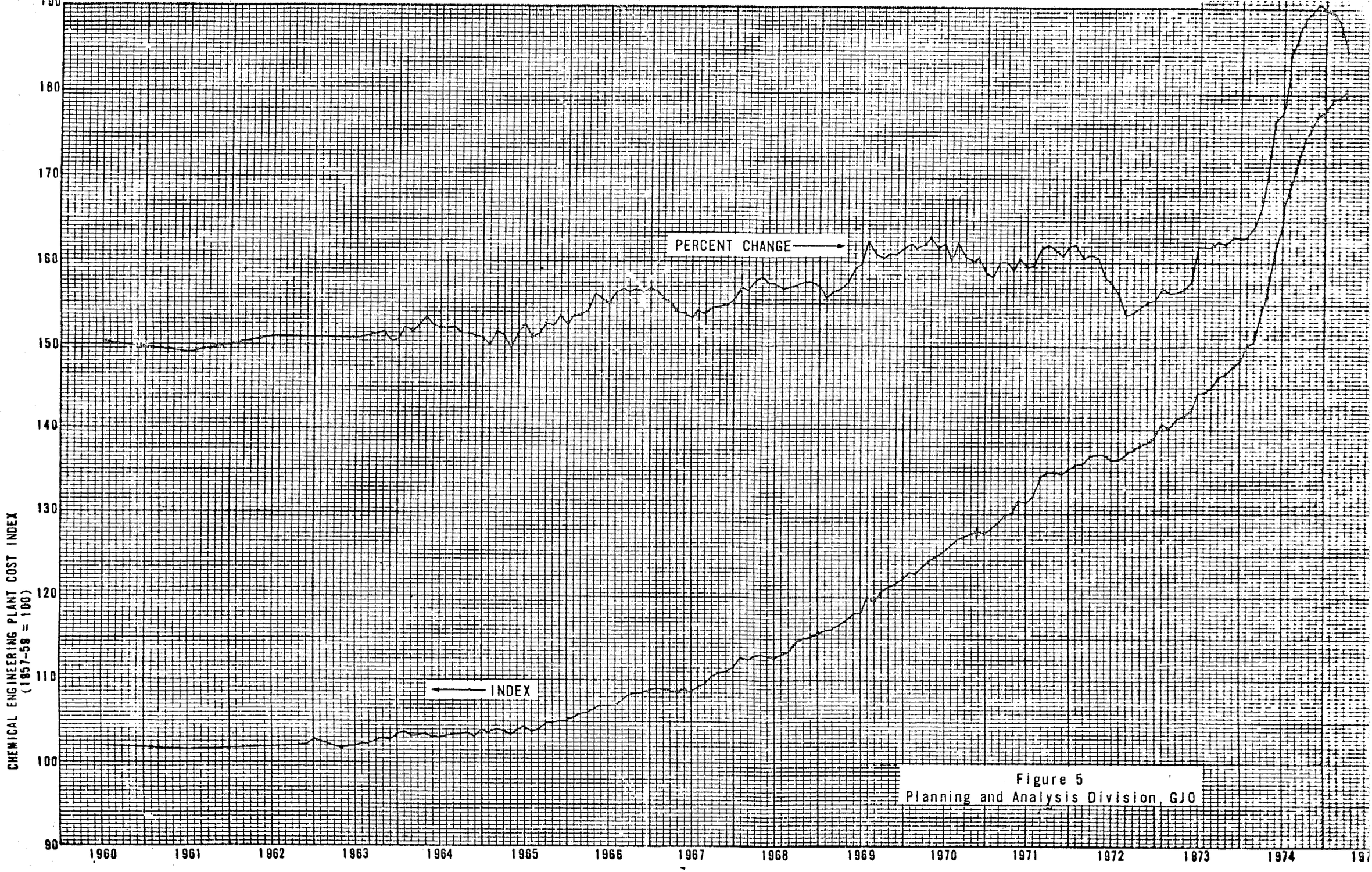


Figure 5
Planning and Analysis Division, GJO

10/15/75

Arizona current UG Miners rate is $5.7825/hr or $46.26/shift
Assume 35% of crew is on bonus and earning $30/day over wages:

65% @ $46.26
35% @ $76.26
$56.76, further assuming that payroll load costs are 32%, the $56.76 x 1.32 = $74.92
plus Cost of Living allowance = 3.64
then Mine Dept. cost/MS = $78.56

Thousands

$78.56/36 = $2.182 labor cost/ton
$2.182/.65 = $3.35 mining cost/ton

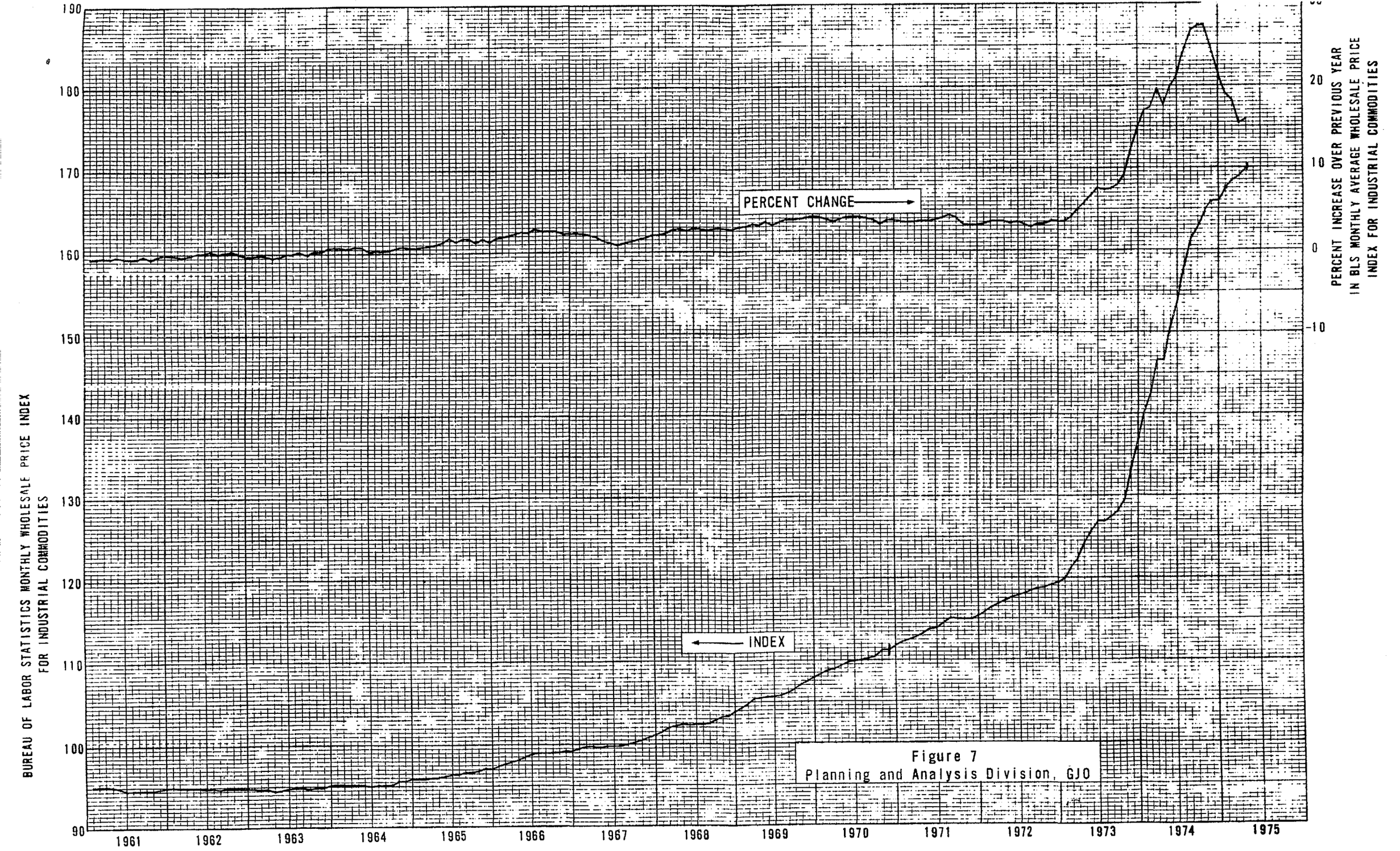


Figure 7
Planning and Analysis Division, GJO

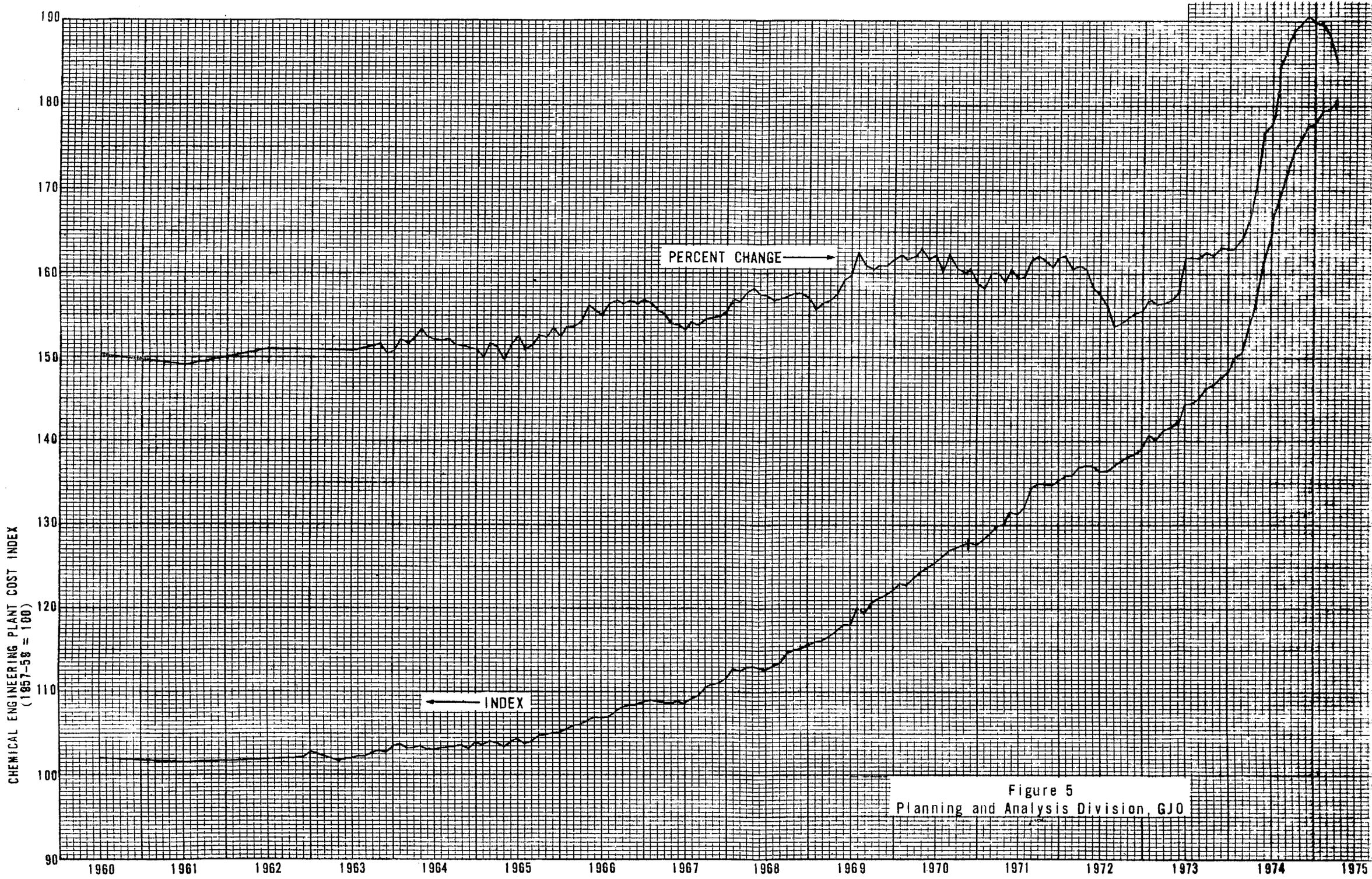


Figure 5
Planning and Analysis Division, GJO

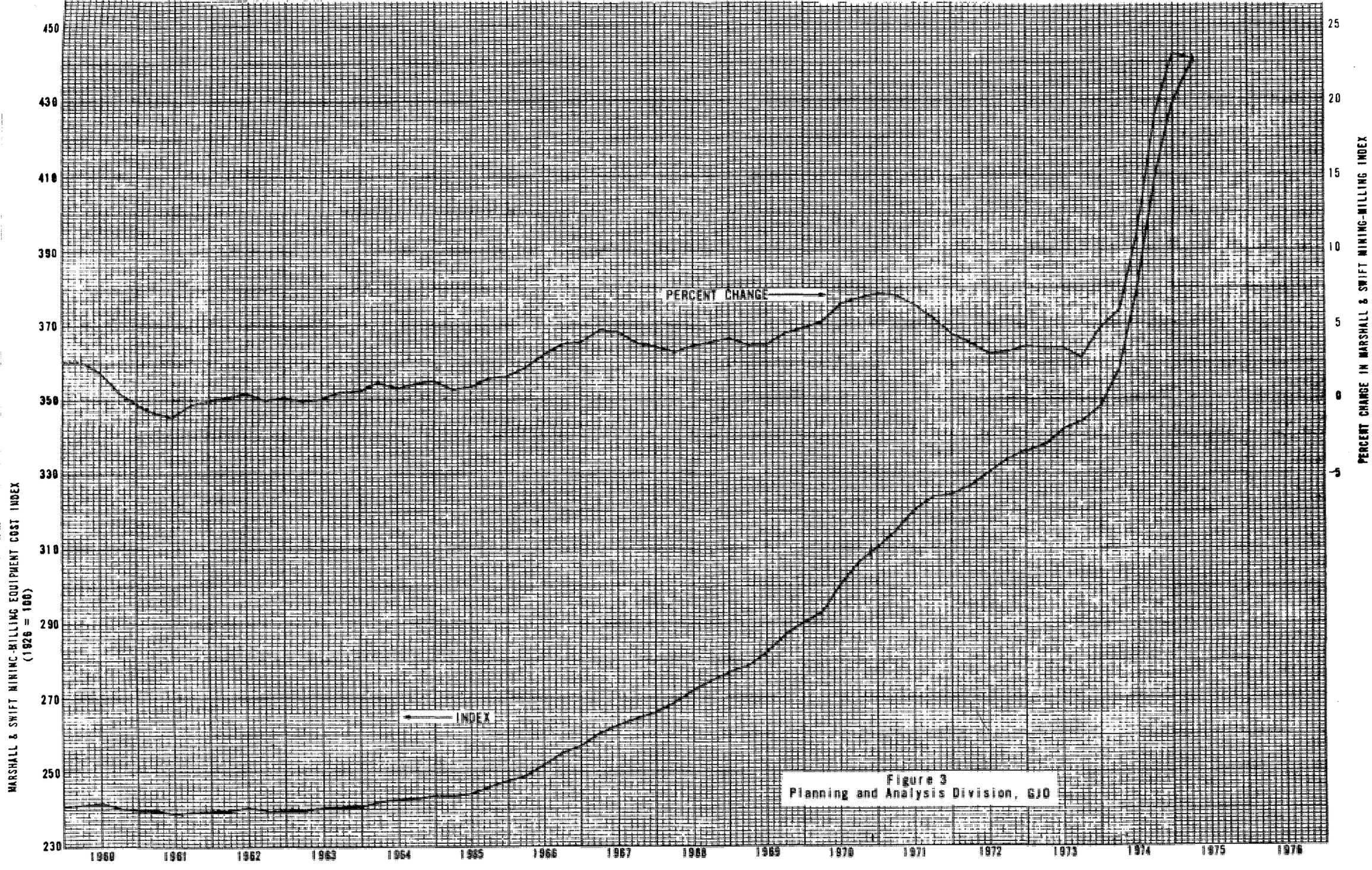


Figure 3
Planning and Analysis Division, GJO

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

June 9, 1972

Mr. J. J. Collins
Director of Exploration
New York Office

Dear Sir:

Enclosed are Mr. Crist's calculations showing the rate of return on a hypothetical deep, underground copper ore body amenable to block caving.

The total operating costs ($3.45 per ton) used were arrived at after consultation with Messrs. MacDonald and Williams. The $1.24 mining cost is the same as the Sacaton cost and, therefore, includes the latest round of wage increases. A comparison of Sacaton cost and those used in Mr. Crist's calculations are:

	Sacaton (10,500 tpd)	Crist's (40,000 tpd)
Mining	$1.24	$1.24
Milling	.74	.74
Indirect	.84	.99
Development	.70	.48
	$3.52	$3.45

The Freight-Smelter-Refinery charge of 14¢/lb. is approximately two cents higher than current charges.

I believe the calculations justify our continued exploration for both deep secondarily enriched ore bodies and deep primary ore bodies.

Very truly yours,

W. L. Kurtz

W. L. Kurtz

WLK:lad
Encs.

cc: JHCourtright - w/enc.
RBCrist - w/o enc.

(000's OMITTED)

HYPOTHETICAL DEEP BLOCK CAVE
CASH FLOW AFTER TAX

40,000 TPD

COPPER GRADE	0.6%	0.8%	1.0%	0.6%	0.8%	1.0%	0.6%	0.8%	1.0%
COPPER PRICE	.50	.50	.50	.60	.60	.60	.70	.70	.70
CASE	7A	7B	7C	8A	8B	8C	9A	9B	9C
Capital Investment	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000
Gross Revenue	63,072	84,096	105,120	80,592	107,456	134,320	98,112	130,816	163,520
Less Operating Costs	50,370	50,370	50,370	50,370	50,370	50,370	50,370	50,370	50,370
Less Depreciation *	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Less Depletion	1,351	11,863	15,768	10,111	16,118	20,148	14,717	19,622	24,528
Taxable Income	1,351	11,863	28,982	10,111	30,968	53,802	23,025	30,824	78,622
Less Income Tax (48%)	648	5,694	13,911	4,853	14,865	25,825	11,052	14,796	37,739
CASH EARNING AFTER TAX	12,054	28,032	40,839	25,369	42,221	58,125	36,690	65,650	75,411
15% of Gross Income	9,461	12,614	15,768	12,089	16,118	20,148	14,717	19,622	24,528
Taxable Income Before Depletion	2,702	23,726	44,750	20,222	47,086	73,950	37,742	70,446	103,150
50%	1,351	11,863	22,375	10,111	23,543	36,975	18,871	35,223	51,575

*Straight Line Depreciation

(000's OMITTED)

HYPOTHETICAL ESTIMATION OF DEEP BLOCK CAVING INCOME

40,000 TPD - 20 Year Life - Minimum Reserve 320,000,000 Tons - $200 Million Capital Expenditure

Recoverable Copper (1) Grade % Cu	Lbs./Ton	NSR(2) Value/Lb.	Market Value	Gross Inc./Year	Operating Cost/Year (3)	Fed. Inc. Tax	AFTER TAX Cash Earnings	AFTER TAX Payback Years	AFTER TAX DCF-ROR	AFTER TAX Earnings Per Lb. Cu	BEFORE TAX Cash Earnings	BEFORE TAX DCF-ROR	BEFORE TAX Earnings Per Lb. Cu	CASE
0.6	12	.36	.50	63,072	50,370	648	12,054	16.9	1.6%	$0.069	12,702	2.1	$0.072	7A
0.8	16	.36	.50	84,096	50,370	5,694	28,032	7.1	11.0%	0.120	33,726	13.6	0.144	7B
1.0	20	.36	.50	105,120	50,370	13,911	40,839	4.9	16.6%	0.140	54,750	21.7	0.234	7C
0.6	12	.46	.60	80,592	50,370	4,853	25,369	7.9	9.7%	$0.145	30,322	12.1	$0.173	8A
0.8	16	.46	.60	107,456	50,370	14,865	42,221	4.7	17.1%	0.181	57,086	22.5	0.244	8B
1.0	20	.46	.60	134,320	50,370	25,825	58,125	3.4	22.9%	0.199	83,950	31.0	0.287	8C
0.6	12	.56	.70	98,112	50,370	11,052	36,690	5.5	14.9%	$0.209	47,742	19.2	$0.272	9A
0.8	16	.56	.70	130,816	50,370	14,796	65,650	3.0	25.4%	0.281	80,446	29.9	0.344	9B
1.0	20	.56	.70	163,520	50,370	37,739	75,411	2.7	28.4%	0.258	113,150	38.8	0.387	9C

(1) Recoverable Copper or Equivalent Values
(2) Freight-Smelter-Refinery 0.14/lb.
(3) Block Cave Mining, Milling, Indirects and Development Costs

Mining	$1.24
Milling	.74
Indirects	.99 *
Development	.48 **
	$3.45

* 50% of Total Direct Cost. The Indirect Costs include all State and Local Taxes plus general administrative and overhead.

** Yearly Capital Development Costs based on .04/lb. of lowest est. grade.

BEFORE TAXES

CASE 7-A HYPOTHETICAL DEEP BLOCK CAVE 40,000 TPD .6 PCT. GRADE $.50 CU

CALCULATION OF RETURN ON INVESTMENT

TABLE A

INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 2.1 PCT	VALUE AT COMPLETION DATE
1ST	4,000,000	1.09809	4,392,374
2ND	18,000,000	1.07550	19,359,139
3RD	22,000,000	1.05338	23,174,506
4TH	76,000,000	1.03172	78,410,758
5TH	80,000,000	1.01050	80,840,000
TOTAL	$200,000,000		$206,176,777

PRODUCTION CAPITAL

0 PRESENT VALUE = 0

TABLE B

EARNINGS FROM PROJECT

YEAR	CASH EARNINGS BEFORE TAXES	PRESENT VALUE DISCOUNTED AT 2.1 PCT FACTOR	DISCOUNTED VALUE
1	12,702,000	0.989715	12,571,372
2	12,702,000	0.969359	12,312,803
3	12,702,000	0.949421	12,059,553
4	12,702,000	0.929893	11,811,511
5	12,702,000	0.910767	11,568,571
6	12,702,000	0.892034	11,330,628
7	12,702,000	0.873687	11,097,579
8	12,702,000	0.855717	10,869,323
9	12,702,000	0.838116	10,645,762
10	12,702,000	0.820878	10,426,799
11	12,702,000	0.803994	10,212,340
12	12,702,000	0.787458	10,002,292
13	12,702,000	0.771261	9,796,564
14	12,702,000	0.755398	9,595,068
15	12,702,000	0.739861	9,397,716
16	12,702,000	0.724643	9,204,423
17	12,702,000	0.709739	9,015,105
18	12,702,000	0.695141	8,829,682
19	12,702,000	0.680843	8,648,073
20	12,702,000	0.666839	8,470,198
TOTAL	$254,040,000		$207,865,360

DIFFERENCE = 1,688,584

AFTER TAXES

CASE 7-A HYPOTHETICAL DEEP BLOCK CAVE 40,000 TPD .6 PCT. GRADE $.50 CU

CALCULATION OF RETURN ON INVESTMENT

TABLE A

INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 1.6 PCT	VALUE AT COMPLETION DATE
1ST	4,000,000	1.07407	4,296,307
2ND	18,000,000	1.05716	19,028,921
3RD	22,000,000	1.04051	22,891,309
4TH	76,000,000	1.02412	77,833,728
5TH	80,000,000	1.00800	80,640,000
TOTAL	$200,000,000		$204,690,265

PRODUCTION CAPITAL

0 PRESENT VALUE = 0

TABLE B

EARNINGS FROM PROJECT

YEAR	CASH EARNINGS AFTER TAXES	PRESENT VALUE DISCOUNTED AT 1.6 PCT FACTOR	DISCOUNTED VALUE
1	12,044,000	0.992125	11,949,165
2	12,044,000	0.976501	11,760,990
3	12,044,000	0.961123	11,575,777
4	12,044,000	0.945988	11,393,481
5	12,044,000	0.931090	11,214,057
6	12,044,000	0.916427	11,037,457
7	12,044,000	0.901995	10,863,639
8	12,044,000	0.887791	10,692,558
9	12,044,000	0.873810	10,524,171
10	12,044,000	0.860049	10,358,436
11	12,044,000	0.846505	10,195,311
12	12,044,000	0.833174	10,034,755
13	12,044,000	0.820053	9,876,728
14	12,044,000	0.807139	9,721,189
15	12,044,000	0.794428	9,568,099
16	12,044,000	0.781917	9,417,420
17	12,044,000	0.769604	9,269,114
18	12,044,000	0.757484	9,123,144
19	12,044,000	0.745555	8,979,473
20	12,044,000	0.733814	8,838,064
TOTAL	$240,880,000		$206,393,028

DIFFERENCE = 1,702,762

BEFORE TAXES

CASE 7-B HYPOTHETICAL DEEP BLOCK CAVE 40,000 TPD .8 PCT. GRADE $.50 CU

CALCULATION OF RETURN ON INVESTMENT

TABLE A

INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 13.6 PCT	VALUE AT COMPLETION DATE
1ST	4,000,000	1.77862	7,114,503
2ND	18,000,000	1.56569	28,182,450
3RD	22,000,000	1.37824	30,321,494
4TH	76,000,000	1.21324	92,206,848
5TH	80,000,000	1.06800	85,440,000
TOTAL	$200,000,000		$243,265,295

PRODUCTION CAPITAL

0 PRESENT VALUE = 0

TABLE B

EARNINGS FROM PROJECT

YEAR	CASH EARNINGS BEFORE TAXES	PRESENT VALUE DISCOUNTED AT 13.6 PCT FACTOR	DISCOUNTED VALUE
1	33,726,000	0.940140	31,707,190
2	33,726,000	0.827588	27,911,259
3	33,726,000	0.728511	24,569,770
4	33,726,000	0.641295	21,628,319
5	33,726,000	0.564520	19,039,013
6	33,726,000	0.496936	16,759,695
7	33,726,000	0.437444	14,753,252
8	33,726,000	0.385074	12,987,018
9	33,726,000	0.338973	11,432,234
10	33,726,000	0.298392	10,063,586
11	33,726,000	0.262669	8,858,791
12	33,726,000	0.231223	7,798,231
13	33,726,000	0.203541	6,864,640
14	33,726,000	0.179173	6,042,817
15	33,726,000	0.157723	5,319,381
16	33,726,000	0.138841	4,682,554
17	33,726,000	0.122219	4,121,966
18	33,726,000	0.107587	3,628,492
19	33,726,000	0.094707	3,194,095
20	33,726,000	0.083369	2,811,703
TOTAL	$674,520,000		$244,174,006

DIFFERENCE = 908,711

AFTER TAXES

CASE 7-B HYPOTHETICAL DEEP BLOCK CAVE 40,000 TPD .8 PCT. GRADE $.50 CU

CALCULATION OF RETURN ON INVESTMENT

TABLE A

INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 11.0 PCT	VALUE AT COMPLETION DATE
1ST	4,000,000	1.60156	6,406,257
2ND	18,000,000	1.44285	25,971,313
3RD	22,000,000	1.29986	28,597,041
4TH	76,000,000	1.17105	88,999,800
5TH	80,000,000	1.05500	84,400,000
TOTAL	$200,000,000		$234,374,411

PRODUCTION CAPITAL

0 PRESENT VALUE = 0

TABLE B

EARNINGS FROM PROJECT

YEAR	CASH EARNINGS AFTER TAXES	PRESENT VALUE DISCOUNTED AT 11.0 PCT FACTOR	DISCOUNTED VALUE
1	28,032,000	0.950450	26,643,027
2	28,032,000	0.856261	24,002,727
3	28,032,000	0.771406	21,624,078
4	28,032,000	0.694961	19,481,152
5	28,032,000	0.626091	17,550,587
6	28,032,000	0.564046	15,811,340
7	28,032,000	0.508149	14,244,450
8	28,032,000	0.457792	12,832,838
9	28,032,000	0.412425	11,561,115
10	28,032,000	0.371554	10,415,419
11	28,032,000	0.334733	9,383,261
12	28,032,000	0.301562	8,453,388
13	28,032,000	0.271677	7,615,665
14	28,032,000	0.244754	6,860,959
15	28,032,000	0.220499	6,181,044
16	28,032,000	0.198648	5,568,508
17	28,032,000	0.178962	5,016,674
18	28,032,000	0.161227	4,519,526
19	28,032,000	0.145249	4,071,645
20	28,032,000	0.130855	3,668,149
TOTAL	$560,640,000		$235,505,554

DIFFERENCE = 1,131,144

BEFORE TAXES

CASE 7-C HYPOTHETICAL DEEP BLOCK CAVE 40,000 TPD 1.0 PCT. GRADE $.50 CU

CALCULATION OF RETURN ON INVESTMENT

TABLE A

INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 21.7 PCT	VALUE AT COMPLETION DATE
1ST	4,000,000	2.43163	9,726,532
2ND	18,000,000	1.99805	35,964,989
3RD	22,000,000	1.64178	36,119,317
4TH	76,000,000	1.34904	102,527,382
5TH	80,000,000	1.10850	88,680,000
TOTAL	$200,000,000		$273,018,220

PRODUCTION CAPITAL

0 PRESENT VALUE = 0

TABLE B

EARNINGS FROM PROJECT

YEAR	CASH EARNINGS BEFORE TAXES	PRESENT VALUE DISCOUNTED AT 21.7 PCT FACTOR	DISCOUNTED VALUE
1	54,750,000	0.910846	49,868,837
2	54,750,000	0.748435	40,976,859
3	54,750,000	0.614984	33,670,385
4	54,750,000	0.505328	27,666,709
5	54,750,000	0.415224	22,733,533
6	54,750,000	0.341186	18,679,978
7	54,750,000	0.280350	15,349,201
8	54,750,000	0.230362	12,612,326
9	54,750,000	0.189286	10,363,456
10	54,750,000	0.155535	8,515,576
11	54,750,000	0.127802	6,997,187
12	54,750,000	0.105014	5,749,537
13	54,750,000	0.086289	4,724,353
14	54,750,000	0.070903	3,881,966
15	54,750,000	0.058260	3,189,783
16	54,750,000	0.047872	2,621,021
17	54,750,000	0.039336	2,153,674
18	54,750,000	0.032322	1,769,658
19	54,750,000	0.026559	1,454,115
20	54,750,000	0.021823	1,194,836
TOTAL	$1,095,000,000		$274,172,991

DIFFERENCE = 1,154,771

AFTER TAXES

CASE 7-C HYPOTHETICAL DEEP BLOCK CAVE 40,000 TPD 1.0 PCT. GRADE $.50 CU

CALCULATION OF RETURN ON INVESTMENT

TABLE A

INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 16.6 PCT ******	VALUE AT COMPLETION DATE
1ST	4,000,000	2.00180	8,007,236
2ND	18,000,000	1.71681	30,902,713
3RD	22,000,000	1.47239	32,392,781
4TH	76,000,000	1.26277	95,971,128
5TH	80,000,000	1.08300	86,640,000
TOTAL	$200,000,000		$253,913,859

PRODUCTION CAPITAL

0 PRESENT VALUE = 0

TABLE B

EARNINGS FROM PROJECT

YEAR	CASH EARNINGS AFTER TAXES	PRESENT VALUE DISCOUNTED AT 16.6 PCT FACTOR	DISCOUNTED VALUE
1	40,839,000	0.928816	37,931,936
2	40,839,000	0.796583	32,531,677
3	40,839,000	0.683176	27,900,238
4	40,839,000	0.585914	23,928,163
5	40,839,000	0.502499	20,521,580
6	40,839,000	0.430960	17,599,983
7	40,839,000	0.369605	15,094,325
8	40,839,000	0.316985	12,945,390
9	40,839,000	0.271857	11,102,393
10	40,839,000	0.233154	9,521,778
11	40,839,000	0.199960	8,166,190
12	40,839,000	0.171492	7,003,594
13	40,839,000	0.147077	6,006,513
14	40,839,000	0.126138	5,151,383
15	40,839,000	0.108180	4,417,996
16	40,839,000	0.092779	3,789,019
17	40,839,000	0.079570	3,249,587
18	40,839,000	0.068242	2,786,953
19	40,839,000	0.058526	2,390,183
20	40,839,000	0.050194	2,049,899
TOTAL	$816,780,000		$254,088,780

BEFORE TAXES

CASE 8-A HYPOTHETICAL DEEP BLOCK CAVE 40,000 TPD .6 PCT. GRADE $.60 CU

CALCULATION OF RETURN ON INVESTMENT

TABLE A

INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 12.1 PCT ******	VALUE AT COMPLETION DATE
1ST	4,000,000	1.67468	6,698,740
2ND	18,000,000	1.49392	26,890,570
3RD	22,000,000	1.33266	29,318,691
4TH	76,000,000	1.18882	90,350,358
5TH	80,000,000	1.06050	84,840,000
TOTAL	$200,000,000		$238,098,359

PRODUCTION CAPITAL

0 PRESENT VALUE = 0

TABLE B

EARNINGS FROM PROJECT

YEAR	CASH EARNINGS BEFORE TAXES	PRESENT VALUE DISCOUNTED AT 12.1 PCT FACTOR	DISCOUNTED VALUE
1	30,322,000	0.946030	28,685,532
2	30,322,000	0.843916	25,589,234
3	30,322,000	0.752824	22,827,149
4	30,322,000	0.671565	20,363,202
5	30,322,000	0.599076	18,165,211
6	30,322,000	0.534412	16,204,470
7	30,322,000	0.476728	14,455,371
8	30,322,000	0.425271	12,895,067
9	30,322,000	0.379367	11,503,182
10	30,322,000	0.338418	10,261,536
11	30,322,000	0.301890	9,153,913
12	30,322,000	0.269304	8,165,846
13	30,322,000	0.240235	7,284,430
14	30,322,000	0.214304	6,498,153
15	30,322,000	0.191172	5,796,747
16	30,322,000	0.170537	5,171,050
17	30,322,000	0.152130	4,612,890
18	30,322,000	0.135709	4,114,978
19	30,322,000	0.121060	3,670,810
20	30,322,000	0.107993	3,274,585
TOTAL	$606,440,000		$238,693,356

AFTER TAXES

CASE 8-A HYPOTHETICAL DEEP BLOCK CAVE 40,000 TPD .6 PCT. GRADE $.60 CU

CALCULATION OF RETURN ON INVESTMENT

TABLE A
INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 9.7 PCT	VALUE AT COMPLETION DATE
1ST	4,000,000	1.51843	6,073,722
2ND	18,000,000	1.38416	24,914,996
3RD	22,000,000	1.26177	27,759,035
4TH	76,000,000	1.15020	87,415,542
5TH	80,000,000	1.04850	83,880,000
TOTAL	$200,000,000		$230,043,296

PRODUCTION CAPITAL
0 PRESENT VALUE = 0

TABLE B
EARNINGS FROM PROJECT

YEAR	CASH EARNINGS AFTER TAXES	PRESENT VALUE DISCOUNTED AT 9.7 PCT FACTOR	DISCOUNTED VALUE
1	25,369,000	0.955788	24,247,399
2	25,369,000	0.871274	22,103,372
3	25,369,000	0.794234	20,148,926
4	25,369,000	0.724005	18,367,298
5	25,369,000	0.659986	16,743,207
6	25,369,000	0.601628	15,262,723
7	25,369,000	0.548431	13,913,148
8	25,369,000	0.499937	12,682,906
9	25,369,000	0.455731	11,561,446
10	25,369,000	0.415434	10,539,148
11	25,369,000	0.378700	9,607,245
12	25,369,000	0.345214	8,757,744
13	25,369,000	0.314689	7,983,358
14	25,369,000	0.286863	7,277,446
15	25,369,000	0.261498	6,633,953
16	25,369,000	0.238375	6,047,359
17	25,369,000	0.217298	5,512,634
18	25,369,000	0.198083	5,025,190
19	25,369,000	0.180568	4,580,848
20	25,369,000	0.164602	4,175,796
TOTAL	$507,380,000		$231,171,144

DIFFERENCE = 1,127,849

BEFORE TAXES

CASE 8-B HYPOTHETICAL DEEP BLOCK CAVE 40,000 TPD .8 PCT. GRADE $.60 CU

CALCULATION OF RETURN ON INVESTMENT

TABLE A

INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 22.5 PCT	VALUE AT COMPLETION DATE
1ST	4,000,000	2.50521	10,020,845
2ND	18,000,000	2.04507	36,811,269
3RD	22,000,000	1.66944	36,727,797
4TH	76,000,000	1.36281	103,573,750
5TH	80,000,000	1.11250	89,000,000
TOTAL	$200,000,000		$276,133,661

PRODUCTION CAPITAL

0 PRESENT VALUE = 0

TABLE B

EARNINGS FROM PROJECT

YEAR	CASH EARNINGS BEFORE TAXES	PRESENT VALUE DISCOUNTED AT 22.5 PCT FACTOR	DISCOUNTED VALUE
1	57,086,000	0.908163	51,843,408
2	57,086,000	0.741357	42,321,150
3	57,086,000	0.605190	34,547,877
4	57,086,000	0.494032	28,202,349
5	57,086,000	0.403291	23,022,326
6	57,086,000	0.329217	18,793,735
7	57,086,000	0.268749	15,341,825
8	57,086,000	0.219387	12,523,938
9	57,086,000	0.179091	10,223,623
10	57,086,000	0.146197	8,345,815
11	57,086,000	0.119344	6,812,910
12	57,086,000	0.097424	5,561,559
13	57,086,000	0.079529	4,540,048
14	57,086,000	0.064922	3,706,162
15	57,086,000	0.052997	3,025,438
16	57,086,000	0.043263	2,469,746
17	57,086,000	0.035317	2,016,119
18	57,086,000	0.028830	1,645,811
19	57,086,000	0.023535	1,343,519
20	57,086,000	0.019212	1,096,751
TOTAL	$1,141,720,000		$277,384,108

DIFFERENCE = 1,250,447

AFTER TAXES

CASE 8-B HYPOTHETICAL DEEP BLOCK CAVE 40,000 TPD .8 PCT. GRADE $.60 CU

CALCULATION OF RETURN ON INVESTMENT

TABLE A

INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 17.1 PCT ******	VALUE AT COMPLETION DATE
1ST	4,000,000	2.04106	8,164,271
2ND	18,000,000	1.74301	31,374,226
3RD	22,000,000	1.48848	32,746,606
4TH	76,000,000	1.27112	96,605,158
5TH	80,000,000	1.08550	86,840,000
TOTAL	$200,000,000		$255,730,261

PRODUCTION CAPITAL

0 PRESENT VALUE = 0

TABLE B

EARNINGS FROM PROJECT

YEAR	CASH EARNINGS AFTER TAXES	PRESENT VALUE DISCOUNTED AT 17.1 PCT FACTOR	DISCOUNTED VALUE
1	42,135,000	0.926985	39,058,533
2	42,135,000	0.791618	33,354,853
3	42,135,000	0.676019	28,484,076
4	42,135,000	0.577300	24,324,574
5	42,135,000	0.492998	20,772,480
6	42,135,000	0.421006	17,739,095
7	42,135,000	0.359527	15,148,672
8	42,135,000	0.307025	12,936,526
9	42,135,000	0.262190	11,047,418
10	42,135,000	0.223903	9,434,174
11	42,135,000	0.191207	8,056,511
12	42,135,000	0.163285	6,880,026
13	42,135,000	0.139440	5,875,343
14	42,135,000	0.119078	5,017,372
15	42,135,000	0.101689	4,284,690
16	42,135,000	0.086839	3,659,001
17	42,135,000	0.074158	3,124,680
18	42,135,000	0.063329	2,668,386
19	42,135,000	0.054081	2,278,725
20	42,135,000	0.046184	1,945,965
TOTAL	$842,700,000		$256,091,099

BEFORE TAXES

CASE 8-C HYPOTHETICAL DEEP BLOCK CAVE 40,000 TPD 1.0 PCT. GRADE $.60 CU

CALCULATION OF RETURN ON INVESTMENT

TABLE A

INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 31.0 PCT ******	VALUE AT COMPLETION DATE
1ST	4,000,000	3.40147	13,605,896
2ND	18,000,000	2.59654	46,737,812
3RD	22,000,000	1.98209	43,606,101
4TH	76,000,000	1.51305	114,991,800
5TH	80,000,000	1.15500	92,400,000
TOTAL	$200,000,000		$311,341,609

PRODUCTION CAPITAL

0 PRESENT VALUE = 0

TABLE B

EARNINGS FROM PROJECT

YEAR	CASH EARNINGS BEFORE TAXES	PRESENT VALUE DISCOUNTED AT 31.0 PCT FACTOR	DISCOUNTED VALUE
1	83,950,000	0.881679	74,016,985
2	83,950,000	0.673037	56,501,515
3	83,950,000	0.513769	43,130,928
4	83,950,000	0.392190	32,924,372
5	83,950,000	0.299381	25,133,109
6	83,950,000	0.228535	19,185,579
7	83,950,000	0.174454	14,645,480
8	83,950,000	0.133171	11,179,756
9	83,950,000	0.101657	8,534,165
10	83,950,000	0.077601	6,514,630
11	83,950,000	0.059237	4,973,000
12	83,950,000	0.045219	3,796,183
13	83,950,000	0.034518	2,897,850
14	83,950,000	0.026350	2,212,099
15	83,950,000	0.020114	1,688,625
16	83,950,000	0.015354	1,289,027
17	83,950,000	0.011721	983,990
18	83,950,000	0.008947	751,137
19	83,950,000	0.006830	573,387
20	83,950,000	0.005213	437,700
TOTAL	$1,679,000,000		$311,369,514

AFTER TAXES

CASE 8-C HYPOTHETICAL DEEP BLOCK CAVE 40,000 TPD 1.0 PCT. GRADE $.60 CU

CALCULATION OF RETURN ON INVESTMENT

TABLE A

INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 22.9 PCT ******	VALUE AT COMPLETION DATE
1ST	4,000,000	2.54265	10,170,624
2ND	18,000,000	2.06888	37,239,876
3RD	22,000,000	1.68338	37,034,503
4TH	76,000,000	1.36972	104,098,758
5TH	80,000,000	1.11450	89,160,000
TOTAL	$200,000,000		$277,703,761

PRODUCTION CAPITAL

0 PRESENT VALUE = 0

TABLE B

EARNINGS FROM PROJECT

YEAR	CASH EARNINGS AFTER TAXES	PRESENT VALUE DISCOUNTED AT 22.9 PCT FACTOR	DISCOUNTED VALUE
1	58,125,000	0.906834	52,709,774
2	58,125,000	0.737863	42,888,344
3	58,125,000	0.600377	34,896,944
4	58,125,000	0.488508	28,394,584
5	58,125,000	0.397484	23,103,811
6	58,125,000	0.323421	18,798,870
7	58,125,000	0.263158	15,296,070
8	58,125,000	0.214123	12,445,948
9	58,125,000	0.174226	10,126,890
10	58,125,000	0.141762	8,239,943
11	58,125,000	0.115347	6,704,592
12	58,125,000	0.093855	5,455,323
13	58,125,000	0.076366	4,438,831
14	58,125,000	0.062137	3,611,742
15	58,125,000	0.050559	2,938,765
16	58,125,000	0.041138	2,391,184
17	58,125,000	0.033473	1,945,633
18	58,125,000	0.027236	1,583,103
19	58,125,000	0.022161	1,288,123
20	58,125,000	0.018031	1,048,106
TOTAL	$1,162,500,000		$278,306,576

BEFORE TAXES

CASE 9-A HYPOTHETICAL DEEP BLOCK CAVE 40,000 TPD .6 PCT. GRADE $.70 CU

CALCULATION OF RETURN ON INVESTMENT

TABLE A

INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 19.2 PCT	VALUE AT COMPLETION DATE
1ST	4,000,000	2.21266	8,850,658
2ND	18,000,000	1.85626	33,412,720
3RD	22,000,000	1.55726	34,259,873
4TH	76,000,000	1.30643	99,288,832
5TH	80,000,000	1.09600	87,680,000
TOTAL	$200,000,000		$263,492,082

PRODUCTION CAPITAL

0 PRESENT VALUE = 0

TABLE B

EARNINGS FROM PROJECT

YEAR	CASH EARNINGS BEFORE TAXES	PRESENT VALUE DISCOUNTED AT 19.2 PCT FACTOR	DISCOUNTED VALUE
1	47,742,000	0.919463	43,897,007
2	47,742,000	0.771361	36,826,348
3	47,742,000	0.647115	30,894,587
4	47,742,000	0.542882	25,918,278
5	47,742,000	0.455438	21,743,522
6	47,742,000	0.382078	18,241,210
7	47,742,000	0.320535	15,303,028
8	47,742,000	0.268906	12,838,111
9	47,742,000	0.225592	10,770,227
10	47,742,000	0.189255	9,035,426
11	47,742,000	0.158771	7,580,055
12	47,742,000	0.133197	6,359,107
13	47,742,000	0.111742	5,334,821
14	47,742,000	0.093743	4,475,521
15	47,742,000	0.078644	3,754,632
16	47,742,000	0.065976	3,149,859
17	47,742,000	0.055349	2,642,499
18	47,742,000	0.046434	2,216,862
19	47,742,000	0.038954	1,859,783
20	47,742,000	0.032680	1,560,221
TOTAL	$954,840,000		$264,401,100

DIFFERENCE = 909,017

AFTER TAXES

CASE 9-A HYPOTHETICAL DEEP BLOCK CAVE 40,000 TPD .6 PCT. GRADE $.70 CU

CALCULATION OF RETURN ON INVESTMENT

TABLE A

INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 14.9 PCT ******	VALUE AT COMPLETION DATE
1ST	4,000,000	1.87277	7,491,116
2ND	18,000,000	1.62992	29,338,575
3RD	22,000,000	1.41855	31,208,231
4TH	76,000,000	1.23460	93,829,638
5TH	80,000,000	1.07450	85,960,000
TOTAL	$200,000,000		$247,827,560

PRODUCTION CAPITAL

0 PRESENT VALUE = 0

TABLE B

EARNINGS FROM PROJECT

YEAR	CASH EARNINGS AFTER TAXES	PRESENT VALUE DISCOUNTED AT 14.9 PCT FACTOR	DISCOUNTED VALUE
1	36,690,000	0.935161	34,311,057
2	36,690,000	0.813891	29,861,669
3	36,690,000	0.708347	25,989,268
4	36,690,000	0.616490	22,619,032
5	36,690,000	0.536545	19,685,842
6	36,690,000	0.466967	17,133,022
7	36,690,000	0.406411	14,911,246
8	36,690,000	0.353709	12,977,586
9	36,690,000	0.307840	11,294,679
10	36,690,000	0.267920	9,830,007
11	36,690,000	0.233177	8,555,272
12	36,690,000	0.202939	7,445,842
13	36,690,000	0.176622	6,480,280
14	36,690,000	0.153718	5,639,930
15	36,690,000	0.133784	4,908,555
16	36,690,000	0.116435	4,272,024
17	36,690,000	0.101336	3,718,036
18	36,690,000	0.088195	3,235,889
19	36,690,000	0.076758	2,816,265
20	36,690,000	0.066804	2,451,058
TOTAL	$733,800,000		$248,136,558

BEFORE TAXES

CASE 9-B HYPOTHETICAL DEEP BLOCK CAVE 40,000 TPD .8 PCT. GRADE $.70 CU

CALCULATION OF RETURN ON INVESTMENT

TABLE A

INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 29.9 PCT	VALUE AT COMPLETION DATE
1ST	4,000,000	3.27299	13,091,987
2ND	18,000,000	2.51962	45,353,304
3RD	22,000,000	1.93966	42,672,684
4TH	76,000,000	1.49320	113,483,238
5TH	80,000,000	1.14950	91,960,000
TOTAL	$200,000,000		$306,561,213

PRODUCTION CAPITAL

0 PRESENT VALUE = 0

TABLE B

EARNINGS FROM PROJECT

YEAR	CASH EARNINGS BEFORE TAXES	PRESENT VALUE DISCOUNTED AT 29.9 PCT FACTOR	DISCOUNTED VALUE
1	80,446,000	0.884911	71,187,588
2	80,446,000	0.681225	54,801,839
3	80,446,000	0.524422	42,187,712
4	80,446,000	0.403712	32,477,069
5	80,446,000	0.310787	25,001,593
6	80,446,000	0.239251	19,246,800
7	80,446,000	0.184181	14,816,628
8	80,446,000	0.141786	11,406,180
9	80,446,000	0.109150	8,780,739
10	80,446,000	0.084026	6,759,614
11	80,446,000	0.064685	5,203,706
12	80,446,000	0.049796	4,005,932
13	80,446,000	0.038334	3,083,859
14	80,446,000	0.029510	2,374,025
15	80,446,000	0.022718	1,827,579
16	80,446,000	0.017488	1,406,912
17	80,446,000	0.013463	1,083,073
18	80,446,000	0.010364	833,775
19	80,446,000	0.007978	641,859
20	80,446,000	0.006142	494,118
TOTAL	$1,608,920,000		$307,620,598

DIFFERENCE = 1,059,385

AFTER TAXES

CASE 9-B HYPOTHETICAL DEEP BLOCK CAVE 40,000 TPD .8 PCT. GRADE $.70 CU

CALCULATION OF RETURN ON INVESTMENT

TABLE A

INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 25.4 PCT ******	VALUE AT COMPLETION DATE
1ST	4,000,000	2.78685	11,147,412
2ND	18,000,000	2.22237	40,002,675
3RD	22,000,000	1.77222	38,988,962
4TH	76,000,000	1.41325	107,407,608
5TH	80,000,000	1.12700	90,160,000
TOTAL	$200,000,000		$287,706,656

PRODUCTION CAPITAL

0 PRESENT VALUE = 0

TABLE B

EARNINGS FROM PROJECT

YEAR	CASH EARNINGS AFTER TAXES	PRESENT VALUE DISCOUNTED AT 25.4 PCT FACTOR	DISCOUNTED VALUE
1	65,650,000	0.898724	59,001,236
2	65,650,000	0.716685	47,050,428
3	65,650,000	0.571519	37,520,277
4	65,650,000	0.455757	29,920,476
5	65,650,000	0.363442	23,860,029
6	65,650,000	0.289826	19,027,136
7	65,650,000	0.231121	15,173,155
8	65,650,000	0.184307	12,099,805
9	65,650,000	0.146975	9,648,967
10	65,650,000	0.117205	7,694,551
11	65,650,000	0.093465	6,136,006
12	65,650,000	0.074533	4,893,146
13	65,650,000	0.059436	3,902,031
14	65,650,000	0.047397	3,111,667
15	65,650,000	0.037797	2,481,393
16	65,650,000	0.030141	1,978,783
17	65,650,000	0.024036	1,577,976
18	65,650,000	0.019167	1,258,354
19	65,650,000	0.015285	1,003,472
20	65,650,000	0.012189	800,217
TOTAL	$1,313,000,000		$288,139,104

BEFORE TAXES

CASE 9-C HYPOTHETICAL DEEP BLOCK CAVE 40,000 TPD 1.0 PCT. GRADE $.70 CU

CALCULATION OF RETURN ON INVESTMENT

TABLE A

INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 38.8 PCT ******	VALUE AT COMPLETION DATE
1ST	4,000,000	4.43161	17,726,467
2ND	18,000,000	3.19280	57,470,534
3RD	22,000,000	2.30029	50,606,458
4TH	76,000,000	1.65727	125,952,672
5TH	80,000,000	1.19400	95,520,000
TOTAL	$200,000,000		$347,276,130

PRODUCTION CAPITAL

0 PRESENT VALUE = 0

TABLE B

EARNINGS FROM PROJECT

YEAR	CASH EARNINGS BEFORE TAXES	PRESENT VALUE DISCOUNTED AT 38.8 PCT FACTOR	DISCOUNTED VALUE
1	113,150,000	0.860230	97,335,087
2	113,150,000	0.619762	70,126,143
3	113,150,000	0.446514	50,523,158
4	113,150,000	0.321696	36,399,970
5	113,150,000	0.231769	26,224,762
6	113,150,000	0.166981	18,893,921
7	113,150,000	0.120303	13,612,335
8	113,150,000	0.086673	9,807,158
9	113,150,000	0.062445	7,065,676
10	113,150,000	0.044989	5,090,544
11	113,150,000	0.032413	3,667,539
12	113,150,000	0.023352	2,642,319
13	113,150,000	0.016824	1,903,688
14	113,150,000	0.012121	1,371,533
15	113,150,000	0.008732	988,136
16	113,150,000	0.006291	711,914
17	113,150,000	0.004532	512,906
18	113,150,000	0.003265	369,529
19	113,150,000	0.002352	266,231
20	113,150,000	0.001695	191,809
TOTAL	$2,263,000,000		$347,704,357

AFTER TAXES

CASE 9-C HYPOTHETICAL DEEP BLOCK CAVE 40,000 TPD 1.0 PCT. GRADE $.70 CU

CALCULATION OF RETURN ON INVESTMENT
TABLE A
INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 28.4 PCT	VALUE AT COMPLETION DATE
1ST	4,000,000	3.10403	12,416,128
2ND	18,000,000	2.41747	43,514,468
3RD	22,000,000	1.88276	41,420,833
4TH	76,000,000	1.46632	111,440,928
5TH	80,000,000	1.14200	91,360,000
TOTAL	$200,000,000		$300,152,358

PRODUCTION CAPITAL
0 PRESENT VALUE = 0

TABLE B
EARNINGS FROM PROJECT

YEAR	CASH EARNINGS AFTER TAXES	PRESENT VALUE DISCOUNTED AT 28.4 PCT FACTOR	DISCOUNTED VALUE
1	75,411,000	0.889408	67,071,154
2	75,411,000	0.692685	52,236,101
3	75,411,000	0.539474	40,682,322
4	75,411,000	0.420151	31,684,051
5	75,411,000	0.327220	24,676,053
6	75,411,000	0.254844	19,218,109
7	75,411,000	0.198477	14,967,375
8	75,411,000	0.154577	11,656,834
9	75,411,000	0.120387	9,078,531
10	75,411,000	0.093759	7,070,507
11	75,411,000	0.073021	5,506,626
12	75,411,000	0.056870	4,288,649
13	75,411,000	0.044291	3,340,069
14	75,411,000	0.034494	2,601,300
15	75,411,000	0.026865	2,025,935
16	75,411,000	0.020923	1,577,831
17	75,411,000	0.016295	1,228,840
18	75,411,000	0.012690	957,041
19	75,411,000	0.009883	745,359
20	75,411,000	0.007697	580,497
TOTAL	$1,508,220,000		$301,193,183

DIFFERENCE = 1,040,826

Feasibility

FINANCIAL ANALYSIS—HENDERSON PROJECT

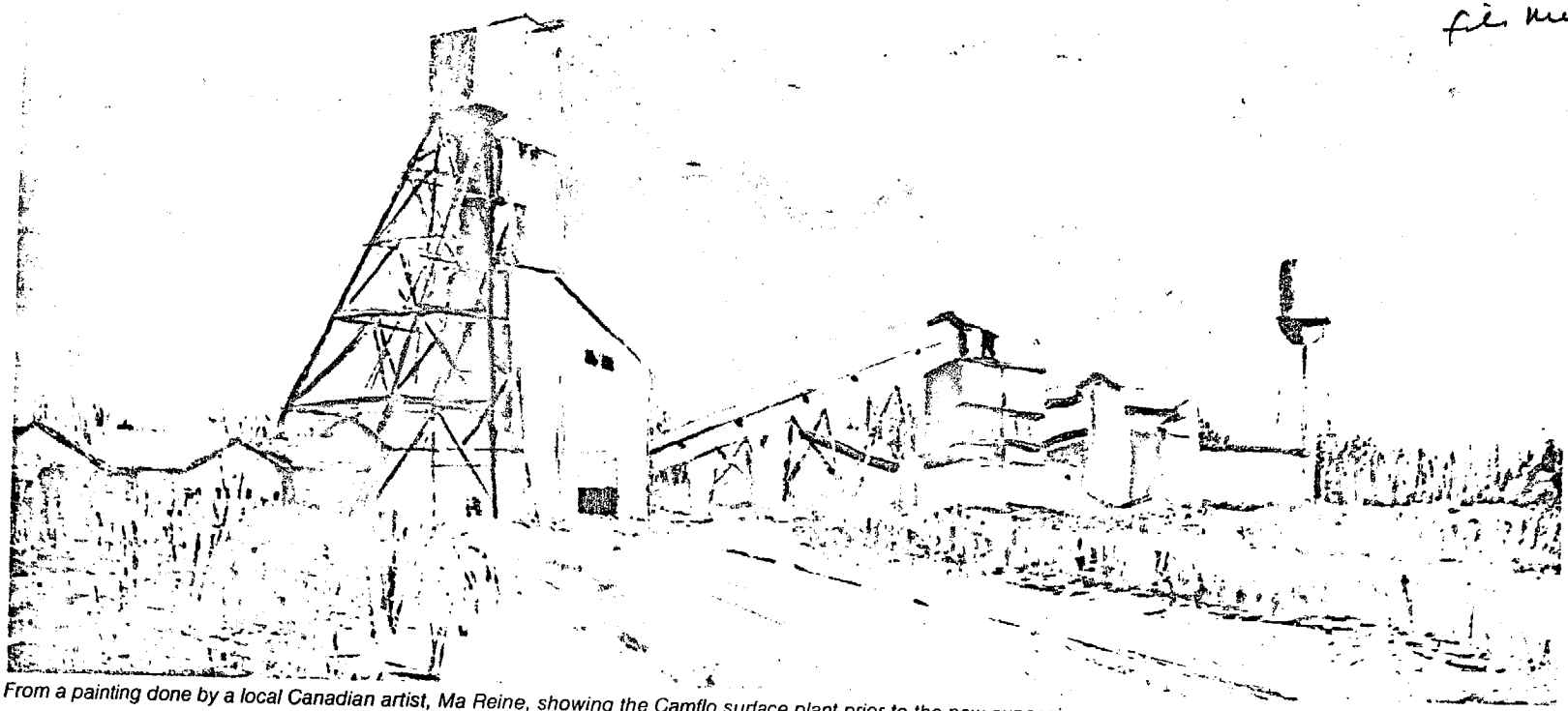
EDWIN W. PEIKER, JR. AND LEE FORSYTHE

CAPITAL CONTINUED

MACH. EQUIP	TOTAL CAPITAL	LESS DEPRE-CIATION	PROFIT BEFORE TAXES	LESS DEPLE-TION	TAXABLE INCOME	LESS F.I.T.	PLUS 0.7% INVEST. TAX CREO.	PROFIT AFTER TAXES	PLUS DEPRE-CIATION	OPERAT. CASH FLOW	LESS WORKING CAPITAL	LESS CAPITAL EXPEND.	NET CASH FLOW	CUMULA-TIVE NET CASH FLOW
4046.	13442.	400.	-9125.	0.	-9125.	-4380.	283.	-4462.	400.	-4062.	0.	13442.	-17504.	-17504.
3295.	7587.	1123.	-10295.	0.	-10295.	-4942.	231.	-5123.	1123.	-4000.	0.	7587.	-11587.	-29090.
6580.	10650.	2074.	-12724.	0.	-12724.	-6108.	461.	-6156.	2074.	-4082.	0.	10650.	-14732.	-43822.
10862.	14842.	3678.	-15659.	0.	-15659.	-7516.	760.	-7382.	3678.	-3704.	165.	14842.	-18711.	-62534.
11525.	15932.	5628.	-21340.	0.	-21340.	-10243.	807.	-10290.	5628.	-4662.	275.	15932.	-20869.	-83403.
25240.	27213.	8638.	-30756.	0.	-30756.	-14763.	1767.	-14226.	8638.	-5588.	550.	27213.	-33351.	-116754.
16535.	16535.	11592.	-1086.	0.	-1086.	-521.	1157.	593.	11592.	12184.	2521.	16535.	-6872.	-123626.
8650.	8650.	12559.	19436.	9718.	9718.	4665.	606.	15377.	12559.	27936.	2615.	8650.	16671.	-106955.
0.	0.	11794.	26056.	12090.	13966.	6703.	0.	19352.	11794.	31147.	0.	0.	31147.	-75808.
0.	0.	10201.	33482.	14155.	19327.	9277.	0.	24205.	10201.	34407.	0.	0.	34407.	-41401.
0.	0.	8528.	37024.	14086.	22938.	11010.	0.	26013.	8528.	34542.	0.	0.	34542.	-6860.
0.	0.	6972.	39348.	14723.	24625.	11820.	0.	27528.	6972.	34500.	0.	0.	34500.	27640.
0.	0.	5455.	43130.	14881.	28249.	13560.	0.	29570.	5455.	35025.	0.	0.	35025.	62665.
0.	0.	3986.	40310.	14229.	26081.	12519.	0.	27791.	3986.	31777.	0.	0.	31777.	94442.
0.	0.	2826.	42639.	14276.	28363.	13614.	0.	29025.	2826.	31851.	0.	0.	31851.	126292.
0.	0.	1548.	47441.	14872.	32569.	15633.	0.	31808.	1548.	33356.	0.	0.	33356.	159649.
0.	0.	816.	41449.	13817.	27632.	13263.	0.	28186.	816.	29001.	0.	0.	29001.	188650.
0.	0.	448.	45880.	14774.	31106.	14931.	0.	30949.	448.	31397.	0.	0.	31397.	220047.
0.	0.	396.	41841.	14125.	27717.	13304.	0.	28537.	396.	28933.	0.	0.	28933.	248980.
0.	0.	343.	47838.	14723.	33115.	15895.	0.	31943.	343.	32286.	0.	0.	32286.	281266.
0.	0.	290.	37038.	12142.	24896.	11950.	0.	25088.	290.	25378.	2042.	0.	23336.	304601.
0.	0.	237.	24012.	7890.	16122.	7739.	0.	16274.	237.	16511.	2042.	0.	14469.	319070.
0.	0.	185.	16127.	5579.	10547.	5063.	0.	11064.	185.	11249.	2042.	0.	9207.	328277.
86733	114851	99717	482076	206080	275998	132485	6071	355673	99717	455389	12252	114851		

EXHIBIT No. 9

WLK
~~for your cost file~~
file Min Cost



From a painting done by a local Canadian artist, Ma Reine, showing the Camflo surface plant prior to the new expansion program.

REPORT OF THE MINE MANAGER

CAMFLO MINES LIMITED

To the Chairman of the Board, President and Directors:

The following report details operations of the company's mine in the Malartic area, Quebec, for the year ended December 31st, 1974, together with comparative statistics for prior years, where applicable.

Summary:

During the year 81,589 ounces of gold worth $13,233,960 were produced.

Proven and indicated ore reserves were increased from 2,631,350 to 3,008,000 tons.

Deepening of the main shaft was started and the mill was enlarged and will treat 1,250 tons per day in March.

Production:

The mill treated 377,521 tons, an average of 1,034 tons per day, with a recovered grade of 0.216 ounces of gold per ton. Of this tonnage 9,486 tons of 0.071 came from the surface stock pile during the 13½ days in March that the mine was shut down due to electrical problems with the hoist. Part of the production, 2,462.8 ounces, did not reach the mint as it was robbed at gunpoint from the mill. This loss was fully covered by insurance and so had no effect on the Company's profits.

	1974	1973	1972
Tons of Ore Milled	377,521	389,622	380,682
Average Recovered Grade	0.216	0.251	0.263
Ounces Produced	81,589	98,228	100,101

Mine Operating Costs:

Mine labour rates in the area and costs of services and supplies increased sharply. This caused a 34% escalation in mining costs. The increased production rate forecast for 1975 should result in a much smaller increase in the cost per ton this year.

	1974		1973	
	Total Cost	Cost per Ton Milled	Total Cost	Cost per Ton Milled
Development	$ 308,424	$0.817	$ 263,463	$0.676
Mining	1,939,298	5.137	1,487,322	3.817
Milling	892,489	2.364	691,930	1.776
General	607,429	1.609	446,136	1.145
Marketing	71,959	0.191	53,818	0.138
Total	$3,819,599	$10.12	$2,942,669	$7.552

Summary of Stope Extraction by Levels:

Level	Tonnage	Ounces/Ton
750-900	5,467	0.157
900-1300	68,431	0.162
1300-1500	71,436	0.200
1500-1650	49,277	0.161
1650-1800	54,102	0.318
1800-1950	68,986	0.274
1950-2100	28,572	0.249
2100-2250	12,243	0.189
2250-2400	9,521	0.132

Mine Development:

In 1974 deepening of the main shaft was started. Two new stations at 2,850 and 3,000 and a new crusher station at 3,075 have been completed, and the shaft has reached a depth of 3,100′. This work is being done by our own employees and will not result in any production loss.

Most of the drifting and raising during the year was again to develop the new diorite ore but some of the stope preparation was for the porphyry ore on the 2100 and 2250 levels.

Diamond drilling outlined new porphyry ore between the 2400 and 2750 levels and new diorite ore between the 1800 and 2550 levels.

	1974	1973	1972
Feet of drifting and crosscutting	7,008	7,621	5,737
Feet of raising	2,364	1,718	1,171
Feet of diamond drilling	13,468	21,771	18,156
Stope preparation — Feet	6,473	3,956	5,823
— Tons	9,535	25,321	24,359
Shaft sinking — Feet	243	—	—

Ore Reserves:

Total proven and indicated ore reserves, including a 10% allowance for dilution, are 3,008,000 tons of 0.190 ounces of gold per ton. This is an increase of 376,650 tons after the milling of 377,521 tons during the year. The grade of the ore reserves decreased as lower grade ore which is profitable to mine at the higher price of gold has been included. All grades reported are for the estimated recoverable gold, and details of the reserves are as follows:

	Tons at Year end 1974	Tons at Year end 1973	Tons at Year end 1972
Broken Ore Underground	241,217	175,210	210,593
Stockpile Ore on Surface	6,705	2,367	5,766
Total Broken Ore	247,922	177,577	216,309
Drilled Off Ore	367,920	352,973	285,392
Total Broken and Drilled Off	615,842	530,550	501,701
Broken and Proven — Tons	1,943,250	1,822,450	1,559,000
— Oz/Ton	0.207	0.234	0.238
Indicated — Tons	1,064,750	808,900	688,000
— Oz/Ton	0.159	0.187	0.216
Total Proven and Indicated — Tons	3,008,000	2,631,350	2,247,000
— Oz/Ton	0.190	0.220	0.231

Construction and Equipment Additions:

The office, machine shop and warehouse were enlarged and a new surface change house, carpenter shop and storage building were erected.

At the mill a new 1,000 ton fine ore bin is nearly completed, and a 9′ × 12′ Marcy ball mill was installed and is now in operation. A third thickner, two agitators, a solution storage tank and two filters were installed in a new addition to the mill building. All design, equipment installation and electrical work is being performed by our own employees.

Exploration:

Under the direction of A. Makila, exploration in the general Val d'Or region was stepped up in 1974. Nine properties were examined and a diamond drilling program was carried out on the Golden Briar option. Nothing of economic interest was discovered. In 1975 a strong electromagnetic anomaly in Lamorandiere Township will be drilled, and two groups of claims in Vassan Township have been optioned.

Across Canada and the United States a greatly enlarged exploration program under the direction of M. E. Holt was carried out and details are included elsewhere in this report.

General:

Production will be increased to the planned 1,250 tons per day by March 1st, 1975.

Shaft sinking to the 3,350′ should be completed in June and will be followed by the construction of a new ore pass system and the start of development on the 2700 level.

The diligent and efficient work of the 152 employees is very much appreciated.

Respectfully submitted,

Armand Mailloux,
Mine Manager.

Brian Meikle, Ph.D.,
General Manager.

MINING COST

May 5, 1985 Metals Week

Cost	El Salvador	53.6¢/lb
	Chigoicamata	52.5¢/lb
	El Teniente	57.0
	Andina	39.2

SILVER BELL UNIT OUTCOME

T.E.S.
JUN 21 1974
MINING DEPT.

CONFID

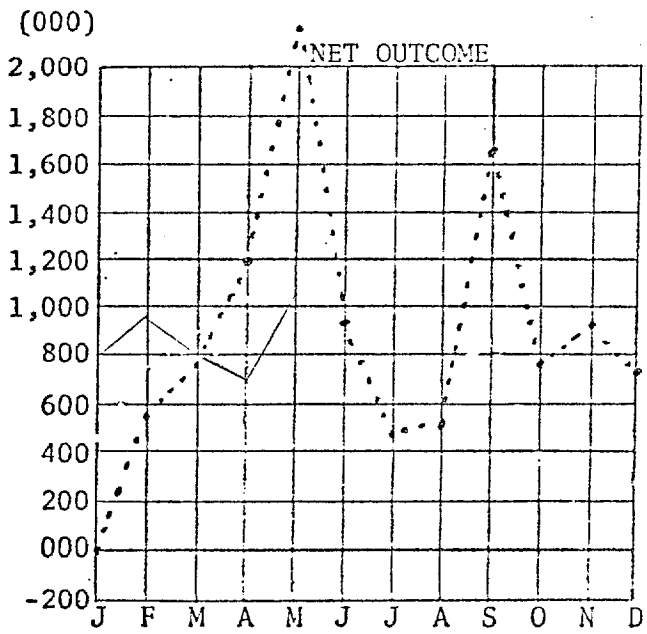
May 1974
PROFIT AND LOSS

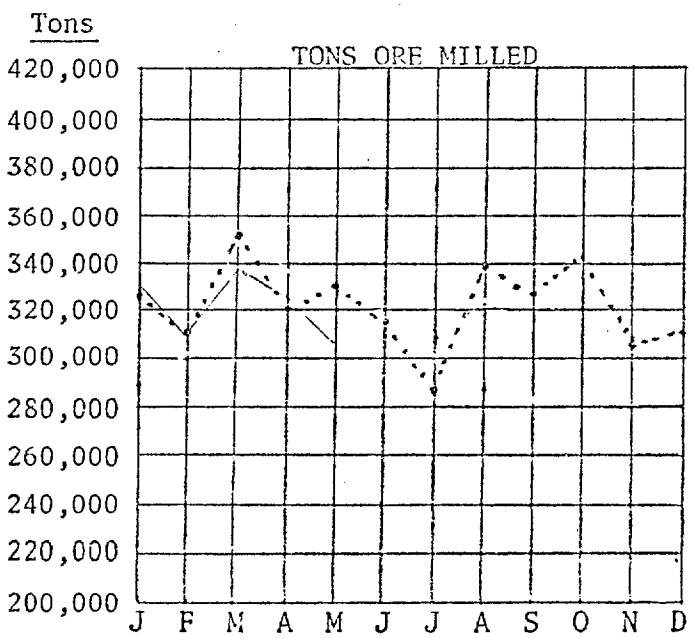
3-4-0.4
R. B. Meier
R.B.M.
JUN 20 1974

JUN 19 1974
TUCSON

	Year 1974		AVERAGE PER MONTH		
	May	5 Months	Year 1974	Year 1973	Year 1972
Copper Concentrates	$ 878,719	$3,813,214	$ 762,643	$ 793,832	$ 446,16,
Copper Precipitates	444,508	1,266,356	253,271	234,429	237,437
Molybdenum Concentrates				(510)	(4,959)
OPERATING PROFIT	$1,323,227	$5,079,570	$1,015,914	$1,027,751	$ 678,645
Other Income and Expense	(10,380)	(592)	(118)	(19,589)	(11,239)
SUB-TOTAL	$1,312,847	$5,078,978	$1,015,796	$1,008,162	$ 667,406
Less:					
General Administrative Expense	57,350	286,750	57,350	49,755	48,815
Southwestern Mining Dept. Exp.	13,000	66,645	13,329	15,466	10,618
State Income Tax	2,400	11,200	2,240	675	333
OUTCOME BEFORE DEPRECIATION AND DEPLETION	$1,240,097	$4,714,383	$ 942,877	$ 942,266	$ 607,640
Less:					
Depreciation	70,595	348,046	69,609	72,636	63,860
Depletion	9,609	49,601	9,920	9,778	8,736
NET OUTCOME	$1,159,893	$4,316,736	$ 863,348	$ 859,852	535,044

(Year 1973 ..... Year 1974 _____)





SILVER BELL UNIT OUTCOME

MINING ACTIVITY

	YEAR 1974		YEAR	YEAR	YEAR
	May	5 Months	1973	1972	1971
Tons Ore Mined	314,100	1,600,400	3,866,100	3,839,600	3,796,000
Operating Days	30	148	356	357	355
Tons Ore Mined/Operating Days	10,470	10,814	10,860	10,755	10,693
Tons Waste Moved	1,021,800	5,530,710	13,573,380	11,806,500	9,978,300
Total Tons Waste Plus Ore	1,335,900	7,130,110	17,439,480	15,646,100	13,774,300
Tons Waste & Ore Oper. Day	44,530	48,455	48,987	43,829	38,801
Ratio Tons Waste to Tons Ore	3.25	3.46	3.51	3.07	2.63

MINING COST PER TON ORE MINED

~ 33,000 tons per day material moved	YEAR 1974		YEAR	YEAR	YEAR
	May	5 Months	1973	1972	1971
Tons Ore Mined	314,100	1,600,400	3,866,100	3,839,600	3,796,000
Open Pit Mining Direct Cost	$ 1.52	$ 1.49	$ 1.13	$ .99	$ .93
Diamond Drilling Direct Cost			.01	-	-
TOTAL DIRECT COST	$ 1.52	$ 1.49	$ 1.14	$ .99	$ .93
per ton moved	0.357	0.33	0.25	0.24	0.25
TOTAL INDIRECT COST	.58	.58	.52	.58	.45
TOTAL MINING COST	$ 2.10	$ 2.07	$ 1.66	$ 1.57	$ 1.38
per ton moved	.494	.4664	.368	.3857	.3802

MILLING ACTIVITY

	YEAR 1974		YEAR	YEAR	YEAR
	May	5 Months	1973	1972	1971
Tons Ore Milled	308,100	1,600,400	3,865,100	3,830,600	3,798,000
Operating Days	30	148	347	357	355
Tons Ore Milled/Operating Day	10,270	10,814	11,139	10,730	10,698
Assay - Silver	.05	.05	.05	.08	.08
Copper	.64	.65	.64	.60	.64
Content of Ore Milled:					
Silver - Ounces	15,542	89,278	209,998	310,403	311,299
Copper - Tons	1,962	10,336	24,545	23,062	24,323

MILLING COST PER TON ORE MILLED

	YEAR 1974		YEAR	YEAR	YEAR
	May	5 Months	1973	1972	1971
Tons Ore Milled	308,100	1,600,400	3,865,100	3,830,600	3,798,000
Operations	$ .96	$ .81	$ .66	$ .61	$ .63
Maintenance	.23	.19	.19	.19	.18
TOTAL DIRECT COST	$ 1.19	$ 1.00	$ .85	$ .80	$ .81
TOTAL INDIRECT COST	.59	.52	.50	.56	.45
TOTAL MILLING COST	$ 1.78	$ 1.52	$ 1.35	$ 1.36	$ 1.26

SILVER BELL UNIT OUTCOME

COPPER CONCENTRATE PRODUCTION AND SALES

19[illegible]	COPPER CONCENTRATES PRODUCED					PERCENT RECOVERY IN CONCENTRATES	
	TONS	ASSAY		CONTENT			
		Ag	Cu	Silver Ounces	Copper Tons	Ag	Cu
January/March	15,917	2.25	32.06	33,951	5,105	64.1	81.0
April	5,931	2.42	27.45	14,377	1,633	69.4	78.7
May	5,195	1.83	27.51	9,484	1,429	61.0	72.8
5 Months	27,043	2.14	30.20	57,812	8,167	64.8	79.0
YEAR 1973	64,899	2.06	30.38	133,994	19,719	63.8	80.3
YEAR 1972	68,216	3.45	28.75	235,015	19,612	75.7	85.0
YEAR 1971	69,543	3.40	28.57	236,739	19,868	76.1	81.7

1974	SALES		PER POUND COPPER CONTENT				OUTCOME
	TONS	Tons Cu Content	Settlement Quotation	Net Revenue	Cost of Sales	Net Outcome	
January/March	15,100	4,927	67.5¢	54.4¢	30.9¢	23.5¢	$ 2,318,524
April	5,600	1,661	67.5	53.6	35.1	18.5	615,971
May	5,857	1,630	80.8	66.2	39.2	27.0	878,720
5 Months	26,557	8,218	70.1¢	56.6¢	33.4¢	23.2¢	$ 3,813,215
YEAR 1973	74,739	22,263	61.3¢	48.4¢	27.0¢	21.4¢	$ 9,525,987
YEAR 1972	76,394	21,936	50.1¢	38.8¢	26.6¢	12.2¢	5,354,004
YEAR 1971	52,019	14,863	51.3¢	41.9¢	25.1¢	16.8¢	4,985,683

COPPER PRECIPITATES PRODUCTION AND SALES

1974	Tons Produced	Assay Copper	Copper Content Tons
January/March	1,125	79.75	898
April	431	76.73	331
May	453	78.02	353
5 Months	2,009	78.71	1,582
YEAR 1973	5,004	80.86	4,046
YEAR 1972	4,801	82.24	3,949
YEAR 1971	3,948	80.49	3,178

1974	SALES		PER POUND COPPER CONTENT				OUTCOME
	TONS	Tons Cu Content	Settlement Quotation	Net Revenue	Cost of Sales	Net Outcome	
January/March	961	757	67.5¢	56.6¢	15.4¢	41.2¢	$ 624,213
April	328	257	67.5	55.8	17.4	38.4	197,635
May	566	444	80.8	68.6	18.5	50.1	444,508
5 Months	1,855	1,458	71.6¢	60.1¢	16.7¢	43.4¢	$1,266,356
YEAR 1973	4,535	3,690	59.1¢	49.1¢	11.0¢	38.1¢	$ 2,813,145
YEAR 1972	5,505	4,508	50.7¢	42.2¢	10.6¢	31.6¢	2,849,248
YEAR 1971	3,288	2,649	51.2¢	43.8¢	11.3¢	32.5¢	1,722,892

SILVER BELL UNIT OUTCOME

MOLYBDENUM CONCENTRATE PRODUCTION AND SALES

1974	MOLYBDENUM CONCENTRATE PRODUCED					PERCENTAGE OF MOLYBDENUM		
	TONS	Assay		Content		Recovered in Mo Concentrate	Lost in Copper Concentrate	Lost in Tailings
		Mo	Cu	Pounds	Pounds			
			SHUT DOWN 7 / 72					
YEAR 1973								
YEAR 1972	120	53.37	1.18	128,582	2,835	13.1	42.5	44.4
YEAR 1971	504	51.83	.52	522,448	5,283	54.8	20.0	25.2

1974	SALES		PER POUND - MOLYBDENUM CONTENT			
	TON	Pounds Mo Content	Net Revenue	Cost of Sales	Net Outcome	OUTCOME
YEAR 1973		(5,823)				$ (6,114)
YEAR 1972	270	282,903	$1.24	$1.45	$(.21)	(59,503)
YEAR 1971	405	420,352	$1.58	$ .74	$ .84	351,652

CONCENTRATES ON HAND AND IN TRANSIT

	May 31, 1974 TONS	December 31, 1973 TONS
Copper Concentrates	6,215	5,730
Copper Precipitates	772	619
Molybdenum Concentrates	-	-

D. R. Jameson

D. R. JAMESON

CFB, RLH, FHG, TAS, JCC, HQS (2),
NV, JEAM, RBM, DRJ, File

CONFID

MISSION UNIT OUTCOME
Profit and Loss

T.E.S
JUN 21 1974

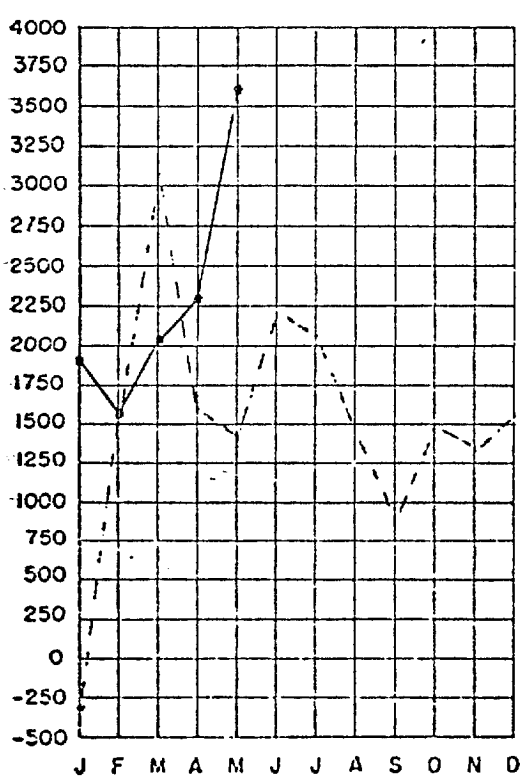
R. B. MEEN
MIS-4.04
May, 1974

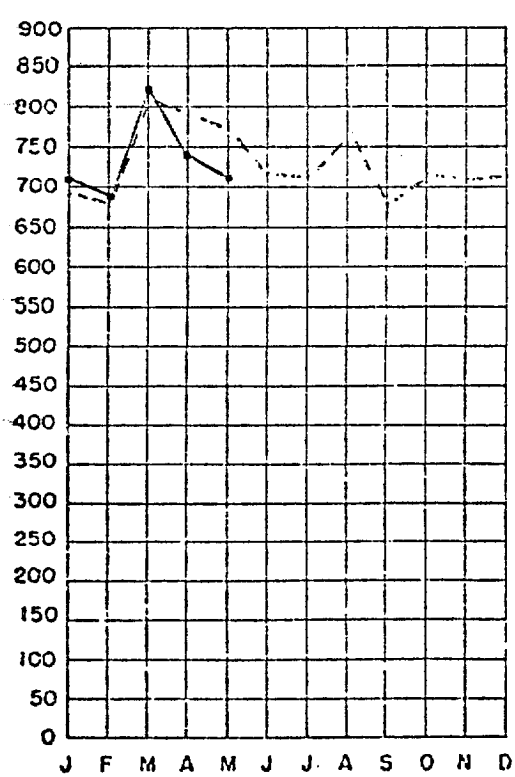
MINING DEPT.
JUN 20 1974
TUCSON

	YEAR 1974		AVERAGE PER MONTH		
	May	5 Months	Year 1974	Year 1973	Year 1972
Copper Concentrates	$ 4,017,898	$13,431,672	$ 2,686,334	$ 1,878,486	$ 1,314,65
Molybdenum Concentrates	72,593	114,013	22,803	72,895	56,61
Less Royalty - State	124,022	478,833	95,767	99,141	105,62
OPERATING PROFIT	3,966,469	13,066,852	2,613,370	1,852,240	1,265,64
Other Income and Expense	2,967	(5,321)	(1,064)	20,760	(72
Strike Expense Charged to P&L	-	-	-	-	-
SUB-TOTAL	3,969,436	13,061,531	2,612,306	1,873,000	1,264,92
Less:					
Gen. Adm. Exp. - N.Y.O.	87,540	437,700	87,540	87,470	88,49
Gen. Adm. Exp. - S.W.M.D.	22,000	98,837	19,767	24,695	19,00
Arizona Income Tax	8,900	44,700	8,940	2,525	83
OUTCOME BEFORE DEPRECIATION, DEPLETION & AMORTIZATION	3,850,996	12,480,294	2,496,059	1,758,310	1,156,59
Less: Depreciation	173,424	887,960	177,592	181,948	179,18
Depletion - M.L. No. 1	2,755	14,303	2,861	2,818	2,65
Depletion - M.L. No. 2	27,468	142,598	28,519	28,093	26,41
Amortization	-	-	-	143	41
NET OUTCOME	$ 3,647,349	$11,435,433	$ 2,287,087	$ 1,545,308	$ 947,92

R. E. M.
JUN 21 1974

(YEAR 1973 = ---------- YEAR 1974 = _____)





Mission

MINING ACTIVITY

May, 1974

	YEAR 1974 May	YEAR 1974 5 Months	Year 1973	Year 1972	Year 1971
Tons Ore Mined	715,600	3,715,000	8,782,500	8,363,800	6,724,900
Operating Days	30	148	356	357	302
Tons Ore Mined/Opr. Day	23,853	25,101	24,670	23,428	22,268
Tons Waste Removed	1,940,800	9,923,200	21,532,400	25,506,400	20,028,600
Total Tons Waste Plus Ore	2,656,400	13,638,200	30,314,900	33,870,200	26,753,500
Total Waste & Ore/Opr. Day	88,547	92,150	85,154	94,875	88,588
Ratio: Tons Waste/Tons Ore	2.71	2.67	2.45	3.05	2.98

Mining Cost Per Ton Ore Mined

≈ 85,000 TPD material moved

	YEAR 1974 May	YEAR 1974 5 Months	Year 1973	Year 1972	Year 1971
Tons Ore Mined	715,600	3,715,000	8,782,500	8,363,800	6,724,900
Open Pit Direct Mining Cost ...	$ 1.01	$ .95	$ .77	$ .81	$ .84
Common Boundary Waste Cost	-	(.03)	(.03)	-	.01
TOTAL DIRECT COST	1.01	.92	.74	.81	.85
TOTAL INDIRECT COST	.40	.38	.36	.48	.53
TOTAL MINING COST	$ 1.41	$ 1.30	$ 1.10	$ 1.29	$ 1.38
moved per ton Total	.380	.3592	.3188	.3185	.3467
moved per ton Direct	0.27	0.25	0.2145	.20	.21

MILLING ACTIVITY

	YEAR 1974 May	YEAR 1974 5 Months	Year 1973	Year 1972	Year 1971
Tons Ore Milled	715,600	3,715,000	8,782,500	8,363,800	6,724,900
Operating Days	30	148	356	357	302
Tons Ore Milled/Opr. Day	23,853	25,101	24,670	23,428	22,268
Assay - Silver - Oz.	.18	.16	.16	.12	.13
- Copper - %	.75	.63	.60	.61	.67
Content of Ore Milled:					
Silver - Oz.	125,783	603,336	1,411,849	958,086	869,495
Copper - Tons	5,381	23,497	52,692	51,403	45,385

Milling Cost Per Ton Ore Mined

	YEAR 1974 May	YEAR 1974 5 Months	Year 1973	Year 1972	Year 1971
Tons Ore Milled	715,600	3,715,000	8,782,500	8,363,800	6,724,900
Operations	$ 1.01	$ .78	$ .65	$ .59	$ .62
Maintenance	.33	.32	.26	.25	.26
TOTAL DIRECT COST	1.34	1.10	.91	.84	.88
TOTAL INDIRECT COST	.41	.37	.33	.34	.41
TOTAL MILLING COST	$ 1.75	$ 1.47	$ 1.24	$ 1.18	$ 1.29

MISSION UNIT OUTCOME (Continued)

COPPER CONCENTRATES PRODUCTION AND SALES

May, 1974

1974	COPPER CONCENTRATE PRODUCED					PERCENT RECOVERY IN CONCENTRATES	
		ASSAY		CONTENT			
	Tons	Ag	Cu	Silver Ounces	Copper Tons	Ag	Cu
Jan./March	44,362	3.72	27.10	165,243	12,023	45.9	87.7
April	14,111	3.77	28.03	53,253	3,956	45.2	89.9
May	18,112	3.86	26.56	69,991	4,811	55.6	89.4
5 Months	76,585	3.77	27.15	288,487	20,790	47.8	88.5
Year 1973	169,644	3.36	27.44	571,252	46,558	40.5	88.4
Year 1972	166,066	2.80	27.32	464,761	45,371	48.5	88.3
Year 1971	145,865	3.35	27.85	489,146	40,618	56.3	89.5

1974	SALES			PER POUND COPPER CONTENT			OUTCOME
	Tons	Tons Cu Content	Settlement Quotations	Net Revenue	Cost of Sales	Net Outcome	
Jan./March	40,307	10,874	67.5¢	54.5¢	23.8¢	30.7¢	$ 6,672,58
April	16,246	4,453	67.5	54.7	23.9	30.8	2,741,18
May	15,992	4,451	80.8	67.6	22.5	45.1	4,017,89
5 Months	72,545	19,778	70.5¢	57.5¢	23.5¢	34.0¢	$13,431,67
Year 1973	159,744	43,877	59.3¢	46.4¢	20.7¢	25.7¢	$22,541,83
Year 1972	161,876	44,246	50.6¢	39.4¢	21.6¢	17.8¢	$15,775,82
Year 1971	146,751	40,878	51.3¢	41.7¢	19.9¢	21.8¢	$17,845,55

MOLYBDENUM CONCENTRATES PRODUCTION AND SALES

1974	MOLYBDENUM CONCENTRATE PRODUCED					PERCENTAGE OF MOLYBDENUM		
		ASSAY		CONTENT		Recovered in Mo. Conc.	Lost in Copper Conc.	Lost in Tailings
	Tons	Mo	Cu	Mo Pounds	Cu Pounds			
Jan./March	218	51.96	.47	226,238	2,046	27.9	26.6	45.5
April	75	51.63	.66	77,467	990	22.6	31.3	46.1
May	87	51.58	.50	89,832	871	32.0	28.2	39.8
5 Months	380	51.81	.51	393,537	3,907	27.5	28.0	44.5
Year 1973	771	52.77	.55	813,742	8,525	26.7	25.0	48.3
Year 1972	1,809	52.57	.38	1,902,029	13,635	35.2	29.7	35.1
Year 1971	1,088	52.24	.66	1,136,561	14,301	36.5	26.7	36.8

1974	SALES		PER POUND MOLYBDENUM CONTENT			OUTCOME
	Tons	Pounds Moly Content	Net Revenue	Cost of Sales	Net Outcome	
Jan./March	208	214,411	$ 1.28	$ 1.11	$ .17	$ 37,3
April	52	54,272	1.28	1.20	.08	4,0
May	103	107,384	1.82	1.14	.68	72,5
5 Months	363	376,067	$ 1.43	$ 1.13	$ .30	$ 114,0
Year 1973	1,962	2,069,028	$ 1.26	$ .84	$ .42	$ 874,7
Year 1972	1,074	1,116,242	$ 1.23	$ .62	$ .61	$ 679,4
Year 1971	612	646,313	$ 1.68	$ .68	$1.00	$ 646,5

CONCENTRATE ON HAND AND IN TRANSIT

	May 31, 1974	December 31, 1973
	Tons	Tons
Copper Concentrates	19,062	15,022
Molybdenum Concentrate	59	42

ORIGINAL SIGNED BY
P. A. LEWIS

P. A. LEWIS
Superintendent

CFB, FGH, RLH, TAS, JEAM, JJC, HQS (2), NV, RBM, PAL

Date: June 19, 1974

A-25

From: J. J. Collins

To: Mr Kurly

CONFIDENTIAL

mining Costs

MINING ACTIVITY

March, 1972

	YEAR 1972 March	YEAR 1972 3 Months	Year 1971	Year 1970	Year 1969	Year 1966
ons Ore Mined.....	824,700	2,244,200	6,724,900	8,038,900	7,939,500	5,968,600
perating Days.....	31	90	302	357	357	357
ons Ore Mined/Oper. Day...	26,603	24,936	22,268	22,518	22,239	16,719
ons Waste Moved.....	2,403,500	7,271,600	20,028,600	18,549,000	20,478,100	29,179,200
otal Tons Waste Plus Ore..	3,228,200	9,515,800	26,753,500	26,587,900	28,417,600	35,147,800
ons Waste & Ore/Oper. Day.	104,135	105,731	88,588	74,476	79,601	98,453
atio: Tons Waste/Tons Ore.	2.91	3.24	2.98	2.31	2.58	4.89

Mining Cost Per Ton Ore Mined

	YEAR 1972 March	YEAR 1972 3 Months	Year 1971	Year 1970	Year 1969	Year 1966
ons Ore Mined.....	824,700	2,244,200	6,724,900	8,038,900	7,939,500	5,968,600
pen Pit Mining Direct Cost	$ .77	$ .79	$ .84	$ .78	$ .75	$ 1.22
ommon Boundary Waste Cost.	-	.05	.01	.13	-	-
TOTAL DIRECT COST.....	.77	.84	.85	.91	.75	1.22
TOTAL INDIRECT COST....	.45	.45	.53	.38	.32	.36
TOTAL MINING COST.....	$ 1.22	$ 1.29	$ 1.38	$ 1.29	$ 1.07	$ 1.58

MILLING ACTIVITY

	YEAR 1972 March	YEAR 1972 3 Months	Year 1971	Year 1970	Year 1969	Year 1966
'ons Ore Milled.....	824,700	2,244,200	6,724,900	8,038,900	7,939,500	5,968,600
'perating Days.....	31	90	302	357	357	357
'ons Ore Milled/Oper. Day..	26,603	24,936	22,268	22,518	22,239	16,719
.ssay - Silver - Oz.....	.11	.11	.13	.13	.12	.19
- Copper - %	.59	.64	.67	.67	.70	.90
'ontent of Ore Milled:						
Silver - Oz.....	88,498	250,966	869,495	1,019,577	955,677	1,106,967
Copper - Tons.....	4,842	14,261	45,385	53,586	55,611	53,471

Milling Cost Per Ton Ore Milled

	YEAR 1972 March	YEAR 1972 3 Months	Year 1971	Year 1970	Year 1969	Year 1966
'ons Ore Milled	824,700	2,244,200	6,724,900	8,038,900	7,939,500	5,968,600
'perations.....	$ .53	$ .53	$ .62	$ .60	$ .57	$ .57
laintenance.....	.22	.23	.26	.23	.24	.16
TOTAL DIRECT COST.....	.75	.76	.88	.83	.81	.73
TOTAL INDIRECT COST....	.35	.35	.41	.36	.34	.24
TOTAL MILLING COST.....	$ 1.10	$ 1.11	$ 1.29	$ 1.19	$ 1.15	$ .97

Silver Bell

MINING ACTIVITY

	YEAR 1972		YEAR	YEAR	YEAR	YEAR
	March	3 Months	1971	1970	1969	1966
Tons Ore Mined.....	372,100	959,300	3,796,000	3,787,700	3,874,100	3,576,600
Operating Days.....	31	90	355	356	346	306
Tons Ore Mined/Operating Days	12,003	10,659	10,693	10,640	11,197	11,688
Tons Waste Moved.....	982,080	2,838,090	9,978,300	10,092,240	8,560,950	8,844,100
Total Tons Waste Plus Ore....	1,354,180	3,797,390	13,774,300	13,879,940	12,435,050	12,420,700
Tons Waste & Ore Oper. Day...	45,139	42,193	38,801	38,989	35,939	40,591
Ratio Tons Waste to Tons Ore	2.64	2.96	2.63	2.66	2.21	2.47

MINING COST PER TON ORE MINED

	YEAR 1972		YEAR	YEAR	YEAR	YEAR
	March	3 Months	1971	1970	1969	1966
Tons Ore Mined.....	372,100	959,300	3,796,000	3,787,700	3,874,100	3,576,600
Open Pit Mining Direct Cost	$ 1.05	$ 1.09	$ .93	$ .85	$ .79	$ .61
Diamond Drilling Direct Cost	-	-	-	-	.04	.07
TOTAL DIRECT COST.....	$ 1.05	$ 1.09	$ .93	$ .85	$ .83	$ .68
TOTAL INDIRECT COST.....	.43	.51	.45	.37	.32	.31
TOTAL MINING COST.....	$ 1.48	$ 1.60	$ 1.38	$ 1.22	$ 1.15	$ .99

Silver Bell

Oct '73 C. Williams

210 million ore 330 million waste capital costs $160 million

40,000 TPD 0.45% Cu 80% recovery + $.25 credit MoS2

70¢ copper

Total Mining (Direct Indirect)	35¢ stripping	X 1.57	.55
	46¢ ore	x 1	.46
			1.01
Total Milling (Direct/Indirect)	1.35		1.35
Operating Costs			2.36

11% After Tax

Depth 13 M

200 million tons @ 0.45 @ 2:1 w/o

40,000 TPD x 360 = 14,400,000 TPY 15 yr life

Capital costs $200 million

1	50	+ 12%	56,000,000
2	100		174,720,000
3	50		250,970,000

Total operating costs - mining 35¢/T x 3 = 1.05 milling 1.35 = $2.40

NSR grade recov gross operating costs net royalty net

$1.55 x 0.45 x 80% x 20 = 3.96 - 2.40 = 1.56 + 50¢ credit = 2.06

Gross/yr 3.96 x 40,000 x 360 = $57,000,000 Net/yr 2.06 x 40,000 x 360 = $30,000,000

Depletion 15% gross = $8.5 million or 50% net $15 million

Depreciation 200 ÷ 15 = 13

~~Yearly after tax~~ = Net 30,000,000
— 8,500,000 depletion
— 13,000,000 depre
TAX = 8,500,000 x 50% $4,250,000

NET AFTER TAX ~~21,500,000~~ 25,750,000

calc. 21,500,000 / 250,970,000 = 0/8% 25,750,000 / 250,970,000 = ~~10.7~~ 9.75

~~NA%~~ 6%

100 with interest → 160,000,000 / 25,750,000 = ~~NA%~~

6.21 13.5%

SAVE
missouri

	2.67/1	2.45/1	3.05/1	2.94/1
	Jan-May 1974	1973	1972	1971
mining/T	1.30	1.10	1.29	1.38
milling/T	1.47	1.24	1.18	1.29
mining per ton mined	[.3542	.3188	.3185	.3467]
mining/lb Co/ore	1.30/12.4# = .103	11# .092	12.2# .106	13.4# .103
milling/lb Co/ore	.117	.103	.097	.096
cost/lb Co	.220	.195	.203	.199
Cost of Sales	.235	.207	.216	.199
− Min mining				
~~Cost mining~~	.015	.012	.013	0
× lb per ton				
= extra costs per ton	.189	.132	.159	
Cost/ton 1	2.963	2.47	2.63	
Cost/ton				
Gardiner NY	.118	.118	.127 ~~.118~~	~~.157~~ ~~.118~~ NA
Gardiner SWMD	.027	.034 ~~.027~~	.027	NA
Arizona Tan	.012	.004	.001	NA
	.157	.158	.155	
Cost/lb Co NY	.009	.011		
SWMD	.002	.003		
Arizona	.001			
Cost/ton	3.12	2.63	2.78	

Mining Costs ~~Feasibility~~

Mining Costs

Theoretical mining, pelletizing and shipping costs in North America

Company	Erie Mining	Reserve Mining	Empire C.C.I.	Grovel'd Hanna	Republic C.C.I.	Carol I.O.C.	Quebec Cartier
Capacity-million tpy	10.3	10.7	3.6	1.3	2.4	5.5	9.0
nvestment-$-million	438.0	337.0	100.0	37.0	75.0	255.0	450.0
Product % Fe	62.0	61.0	63.0	60.0	63.0	65.0	65.0
% SiO_2	8.0	8.0	7.0	8.0	7.0	5.0	5.0
Ore grade % Fe	30.0	30.0	34.0	33.0	39.0	37.0	31.0
Ratio of concentration	3.1:1	3.0:1	2.6:1	2.1:1	2.0:1	2.2:1	2.5:1
	Cost $/Ton	**Cost $/Ton**	**Cost $/Ton**	**Cost $/Ton**	**Cost $/Ton**	**Cost $/Ton**	**Cost $/Ton**
Mining							
Stripping	0.20	0.10	0.05	0.10	0.20	0.02	0.24
Drilling	0.09	0.09	0.05	0.08	0.10	0.06	0.06
Blasting	0.08	0.10	0.07	0.09	0.11	0.11	0.08
Loading	0.07	0.06	0.07	0.08	0.07	0.07	0.07
Haulage	0.14	0.14	0.06	0.08	0.15	0.18	0.17
Miscellaneous	0.06	0.05	0.07	0.07	0.07	0.05	0.07
Total $/ton ore	0.64	0.54	0.37	0.50	0.70	0.49	0.69
$/ton pellet	1.98	1.62	0.96	1.05	1.40	1.07	1.73
¢/unit Fe nat.	3.20	2.70	1.50	1.70	2.20	1.70	2.70
Beneficiation							
Coarse crushing	0.10	0.11	0.07	0.08	0.08	0.08	0.12
Fine crushing	0.16	0.17	—	0.20	0.20	—	—
Concentration	0.58	0.55	0.88	1.03	0.89	0.33	0.28
Total $/ton ore	0.84	0.83	0.95	1.31	1.17	0.41	0.40
$/ton pellet	2.60	2.49	2.47	2.75	2.34	0.90	1.00
¢/unit Fe nat.	4.20	4.10	3.90	4.60	3.70	1.40	1.50
Agglomeration	**Pellet**	**Pellet**	**Pellet**	**Pellet**	**Pellet**	**Pellet**	**Pellet**
Regrinding	—	—	—	0.65	0.96	0.65	0.70
Pelletizing	1.15	1.15	1.25	1.30	1.40	1.59	1.70
Total $/ton pellet	1.15	1.15	1.25	1.95	2.36	2.24	2.40
¢/unit Fe nat.	1.80	1.90	2.00	3.30	3.70	3.40	3.70
General costs							
Overhead	0.45	0.40	0.45	0.45	0.45	0.50	0.50
Loading and stockpiling	0.15	0.15	0.05	0.05	0.05	0.15	0.15
Rail transportation (Private)	0.22	0.39	—	—	—	—	0.57
Total $/ton pellet	0.82	0.94	0.50	0.50	0.50	0.65	1.22
¢/unit Fe nat.	1.30	1.50	0.80	0.80	0.80	1.00	1.90
Franchise payments							
Royalty	0.30	1.25	0.40	0.40	0.40	0.99	—
State and local taxes	0.39	0.44	0.20	0.20	0.20	*0.31	*0.95
Federal income tax	0.65	0.61	1.63	0.91	0.97	**0.61	**0.94
Total $/ton pellet	1.34	2.30	2.23	1.51	1.57	1.91	1.89
¢/unit Fe nat.	2.20	3.80	3.50	2.50	2.50	2.90	2.90
Amortization							
$/ton pellet	3.33	2.46	2.17	2.19	2.44	3.06	4.25
¢/unit Fe nat.	5.40	4.00	3.50	3.70	3.90	4.70	6.50
Total cost f.o.b. plant							
$/ton pellet	11.22	10.96	9.58	9.95	10.61	9.83	12.45
¢/unit Fe nat.	18.10	18.00	15.20	16.60	16.80	15.10	19.20
Transportation							
Chicago $/ton pellet	2.43	2.43	2.81	2.81	3.06	5.73	3.73
Pittsburgh $/ton pellet	4.93	4.93	5.56	5.60	5.56	7.23	5.23
Total cost delivered							
Chicago $/ton pellet	13.65	13.39	12.39	12.76	13.67	15.56	16.22
Chicago ¢/unit Fe nat.	22.00	22.00	19.70	21.30	21.70	23.90	25.00
Pittsburgh $/ton pellet	16.15	15.89	15.14	15.55	16.17	17.06	17.72
Pittsburgh ¢/unit Fe nat.	26.00	26.00	24.00	25.90	25.70	26.20	27.30

Note: These costs are estimates only and based on operating and financial data gathered from a wide variety of sources and are not company-reported costs. Their accuracy presents a composite structure for 1965-1966 conditions and is thought to be acceptable for comparing operations and areas. The compiler took certain liberties with respect to operating conditions at certain mines. For instance Quebec Cartier does not produce pellets. The cost basis for Empire was an assumed 3.6-million long tpy output. All figures are long tons. *Excludes Canadian provincial corporate tax. **Includes provincial income tax collected by either Federal or Provincial government.

Operating costs for loading ore and waste at 24 Western Hemisphere copper mines

Mine	Material	No. of Shovels	Size Cu. Yd.	Tons Per Shovel Shift	Operating and Maintenance Cost $/Ton
1	All Material	2	6	[3] 7,375-7,982	0.035
	All Material	1	15	[3] 12,704-14,096	0.021
2	Ore	3	4½	3,500	NA
	Ore	1	5	3,500	NA
	Leach Waste	1	4½	3,500	NA
	Waste	3	8	6,700	NA
3	[1] Ore	3	4½	2,762	Avg. Cost 0.105
	[1] Ore	8	6½	3,901	
	[1] Waste	2	4½	2,499	
	[1] Waste	1	8	4,684	
	[2] Waste	1	12	9,221	
	[2] Waste	1	8	7,654	
4	All Material	2	6	9,150	NA
5	All Material	4	9	10,000	0.035
6	Ore	1	7	7,000	0.025
	Ore	1	5	6,000	0.022
	Waste	3	5	6,000	0.022
7	Ore	3	9	7,000	Avg. Cost 0.043
	Leach Waste	1	3½	1,650	
	Waste	9	9	7,000	
8	All Material	1	4½	6,000	NA
	All Material	1	8	8,000	0.024
9	Ore	1	4½	4,500	Avg. Cost 0.020
	Waste	2	4½	5,600	
	Waste	1	5	6,000	
10	All Material	1	5	7,400	NA
	All Material	2	6	7,400	NA
	All Material	1	12	12,500	NA
11	All Material	4	8	8,150	NA
12	All Material	4	2½	1,398	NA
	All Material	2	4½	3,125	NA
13	All Material	1	1½	1,500	0.063
	All Material	1	2½	2,300	0.055
	Waste	1	4½	3,400	0.055
14	All Material	3	5	6,500	NA
	All Material	2	6	7,000	NA
	Waste	1	8	10,000	NA
15	All Material	3	4½	[3] 2,255-1,915	NA
16	All Material	1	3½	[3] 2,700-3,500	0.067
17	Ore	8	6	6,976	0.030
	Leach Waste			7,152	0.030
	Ore	1	8	9,080	0.020
	Leach Waste			8,784	0.020
18	All Material	1	3	NA	NA
	All Material	1	4½	[3] 4,407-5,069	0.038
	All Material	3	5	[3] 3,152-3,758	0.049
	All Material	1	6	[3] 5,482-5,874	0.035
	All Material	2	9	[3] 6,620-8,122	0.025
	All Material	1	15	[3] 6,494-10,724	0.038
19	All Material	3	6	[3] 7,160-3,515	0.373
	All Material	5	7	[3] 7,884-3,854	0.344
20	All Material	7	5	5,000	Avg. Cost 0.039
	All Material	19	6	5,500	
	All Material	9	7	6,200	
	All Material	2	8	7,200	
	All Material	2	12	11,000	
	All Material	1	15	13,000	
21	Ore	1	7	6,000	NA
	Leach Waste	2	7	5,500	NA
	Waste	2	9	8,000	NA
22	All Material	12	6	4,258	NA
	All Material	1	7	4,312	NA
	All Material	4	9	8,598	NA
23	All Material	8	6	[3] 3,807-4,154	NA
	All Material	3	7	[3] 4,276-4,653	NA
	All Material	3	9	[3] 4,261-4,258	NA
24	Ore	1	8	8,000	0.030
	Waste	1	8	8,000	0.030
	Alluvium	1	8	10,000	0.020

[1] Rail Haulage Only.
[2] Truck Haulage Only.
[3] First entry-tons/shift ore only; Second entry-tons/shift waste only.

Source: Michaelson, S. D., and Hammes, J. K., "Operating Data for Open Pit Copper Mines," January 1968, Mining Engineering.

Haulage costs at 24 Western Hemisphere open-pit copper mines

Mine	Material	Haulage Truck Nominal: Capacity (Short Tons)	Haulage Truck Nominal: Engine H P	Haulage Profile: Haul (Ft)	Haulage Profile: Max. Grade, Pct	Haulage Profile: Elevation Gained (+) Lost (−)	Operating Data: Tons Per Truck Shift	Operating Data: Availability (Pct)	Operating Data: Utilization (Pct)	Operating and Maintenance Cost $/Ton
1	Ore	65	635	5,500	7	+230	910	[1]70		0.220
	Ore	85	600	5,500	7	+230	1,266	80	[2]Average	0.099
	Ore	100	700	5,500	7	+230	1,357	90	70	0.075
	Waste	65	635	11,600	7	+216	859	70		0.233
	Waste	85	700	11,600	7	+216	1,216	80		0.104
	Waste	100	700	11,600	7	+216	1,642	90		0.077
2		65	525	3,500	2	−	NA	[1]80	[2]75	0.04
		35	450	10,000	5	+500	NA	90	75	0.06
3	Waste	25	300	4,700	5	±150	635	[1]45	[2]36	Avg. Cost
	Waste	75	600	4,700	8	±150	1,460	80	70	0.098
4	Ore	35	420	9,950	8	+460	852	[1]80-85	[2]75	NA
	Ore	45	525	9,950	8	+460	1,090	80-85	75	NA
	Waste	35	420	8,000	8	NA	852	80-85	75	NA
	Waste	45	525	8,000	8	NA	1,090	80-85	75	NA
5	Ore	60	720	5,280	9	+250	1,216	[3]86	[4]64	0.112
	Waste	60	720	11,500	9	+155	1,216	86	64	0.112
6	Ore	80	600	5,200	7	+47	1,420	[3]82	[4]45	0.123
	Waste	40	420	5,200	7	+47	1,430	84	52	0.072
7	All Material	25	250	6,120	4-8	−36	590	NA	[3]71	0.094
	Waste	37	525	5,760	4-8	−29	900	NA	84	0.090
	Waste	75	700	5,070	4-8	−34	2,450	NA	80	0.046
	Waste	100	700	5,540	4-8	−17	2,840	NA	60	0.051
	Waste	85	700	4,800	4-8	−50	2,910	NA	95	0.031
8	Ore	32	380	3,000	8	+205	1,320	NA	NA	0.065
	Ore	35	380	3,000	8	+205	NA	NA	NA	
	Waste	35	430	4,500	8	+205	1,320	NA	NA	0.089
	Waste	35	430	8,000	7	−145	1,100	NA	NA	
9	All Material	27	336	4,500	8	+40	1,300	NA	[5]56	0.054
	Waste	30	336	4,500	8	+40	1,350	NA	66	0.045
	Waste	35	400	4,500	8	+40	1,500	NA	83	0.037
10		35	380	Average	5	Average	980	[3]89	[4]14	NA
		40	470	All	8	All	1,050	75	45	NA
		50	300	Vehicles	5	Vehicles	1,130	85	17	NA
		65	635	Ore-10,300	8	−235	1,710	91	72	NA
		75	700	Waste-7,400	8	To +70	1,910	82	82	NA
11	Ore	65	635	5,800	8	−300	Avg. 2,030	NA	NA	NA
	Waste	65	635	2,500	10	+8 to −50		NA	NA	NA
12	Ore	25	320	9,400	8	−	386	[1]90	[2]50	NA
	Ore	30	320	9,400	8	−	448	87	66	NA
	Waste	25	320	4,800	12	−	384	90	50	NA
	Waste	30	320	4,800	12	−	448	87	66	NA
	Waste	40	525	4,800	12	−	872	88	60	NA
13	All Material	20	180	2,700	10	NA	937	[3]92	[4]80	0.100
		35	400	2,700	10	NA	471	91	76	0.065
15	Ore	30	275	3,700	10	+130	567	[3]94	[4]81	0.146
	Waste	28	275	4,200	10	+170	476	94	81	0.165
16	Ore	30	225	2,000	8	+250	950	[3]96	[4]90	Avg.
	Waste	27	225	1,300	8	+180	1,250	96	90	0.068
17	All Material	40	420	3,332	7	+81	1,320	[1]70	[2]57	0.070
		65	700	5,592	7	+86	1,464	77	70	0.070
		85	700	9,270	7	+276	1,480	70	70	0.090
		65	700	7,603	7	+129	1,400	67	67	0.080
18	All Material	22	300	2,667	8-9	+87	756	[1]57	[2]38	0.127
		40	600	3,041	8-9	+89	1,239	51	50	0.106
		60	600	3,171	8-9	+92	1,708	54	53	0.068
		65	700	3,726	8-9	+123	2,170	69	66	0.062
		65	700	3,729	8-9	+133	2,170	85	85	0.062
19	All Material	54	650	6,000	10	+245	1,144	[1]74	[2]63	0.106
	All Material	54	650	6,000	10	+245	1,216	70	58	0.112
	All Material	54	600	6,000	10	+245	1,040	68	62	0.098
	All Material	65	650	6,000	10	+245	1,328	69	65	0.088
	All Material	65	700	6,000	10	+245	1,256	55	47	0.122
	All Material	70	650	6,000	10	+245	1,448	70	64	0.067
	All Material	85	700	6,000	10	+245	1,464	79	79	0.046
20	Waste	65	700	9,230	12	+500	1,175	[1]45	[2]34	0.185
	Waste	68	635	9,230	12	+500	1,354	54	52	0.067
	Waste	110	700	9,230	8	+300	1,809	42	38	0.058
	Waste	85	700	9,230	12	+500	1,569	53	51	0.106
	Waste	65	635	9,230	12	+500	1,323	70	69	0.085
	Waste	68	700	9,230	12	+500	1,399	58	57	
21		35	550	8,400	8	+400	580	[1]85	[2]50	NA
		65	700	12,000	8	+340	900	82	81	NA
24	Ore	65	700	6,500	8	+350	937	[1]88	NA	0.110
	Waste	85	700	9,000	8	+430	1,070	92	NA	0.110
	Alluvium	85	700	7,000	8	+170	1,770	92	NA	0.060

[1] Availability equals percentage time truck actually available on an 8 hour per shift—3 shift per day basis.
[2] Utilization equals percentage time truck actually in production on an 8 hour per shift—3 shift per day basis.
[3] Availability equals percentage time truck actually available on a 7½ hour per shift—1, 2, or 3 shift per day basis.
[4] Utilization equals percentage time truck actually in production on a 7½ hour per shift—1, 2, or 3 shift per day basis.
[5] Method of calculation—N.A.

Source: Michaelson, S. D., and Hammes, J. K., "Operating Data for Open Pit Copper Mines," January 1968, Mining Engineering.

Drilling statistics at 24 Western Hemisphere open-pit copper mines

Mine	Material	No. Drills	Type Drill	Penetration Rate Ft/Hr	Hole Diameter Inches	Advance Blast Hole Drilling No. Holes
1	Ore	3	Rotary	60	9	300
	Leach Waste	2	Rotary			
		1	Rotary	58-80	9-9⅞	100
	Waste	2	Rotary	57	9	100
2	Ore	2	Rotary	40	9	10
	Leach Waste	2	Rotary	40	9	10
	Waste	2	Rotary	40	9	10
3	Oxide Ore	1	Rotary	40	10⅝-12¼	NA
		1	Rotary			
	Sulfide Ore	1	Rotary	36	10⅝	NA
		1	Rotary			
	Waste	2	Rotary	52	10⅝	NA
4	Ore	1	Rotary	48	7⅞	NA
	Waste	1	Rotary	48	7⅞	NA
5	Ore	1	Rotary	90	9	20
	Waste	2	Rotary	50	9	80
		1	Rotary			
6	Ore					30
	Leach Waste	2	Rotary	41	9	50
	Waste					50
7	Ore	3	Rotary	35	12¼	60
	Leach Waste	1	Rotary	35	12¼	10
	Waste	5	Rotary	35	12¼	100
8	Ore	1	Rotary	39	9	250
	Waste	1	Rotary	39	9	250
9	Ore			47		Nil
	Leach Waste	2	Rotary	55	9	Nil
	Waste			55		Nil
10	All Material	3	Rotary	43	9	NA
11	All Material	3	Rotary	55	6¾-9	NA
12	All Material	4	DTH	35	6½	NA
	All Material	4	Churn	8	9	NA
13	All Material	3	DTH	20	6½	100
14	All Material	2	Rotary	57	9	NA
16	Ore	1	Percussion	24	3	NA
	Waste	1	Percussion	36	3	NA
17	All Material	4	Rotary	32	12	NA
	All Material	1	Rotary	42	9	NA
18	Ore	4	Rotary	Avg.		25
	Leach Waste	1	Rotary	42	9	75
	Waste	1	Rotary			25
19	All Material	4	Rotary	40-45	9	70
20	Ore	[1] 9	Percussion	34-50	3	Total
	Waste	[1] 1	Rotary	28-44	6¾	40 Holes
	Ore	[2] 5	Rotary	35-41		
	Waste	[2] 3	Rotary	36-42	12¼	Total
		[2] 1	Rotary	51-57		100 Holes
21	All Material	3	Rotary	36	12	40
22	All Material	7	Rotary	43.2	12¼	NA
23	Ore & Waste	7	Rotary	26	12¼	NA
	Fanglomerate	5	DTH	20	7	NA
24	Ore	1	Rotary	100	9	20
	Alluvium	1	Rotary	50	9	30
	Waste	1	Rotary	60	9	30

[1] Pertains to upper pit-truck haulage only.
[2] Pertains to lower pit-rail haulage only.

Source: Michaelson, S. D., and Hammes, J. K., "Operating Data for Open Pit Copper Mines," January 1968, Mining Engineering.

Blasting patterns at 24 Western Hemisphere open-pit copper mines

Mine	Material	No. of Holes	Rows	Spacing Ft	Burden Ft	Tons Blasted	Powder Factor	Explosive Used*	Ore Density Cu Ft/Ton	Bench Height Ft	Subgrade Drilling Ft	Stemming Ft
1	Ore	12	2-3	25	25	21,600	0.18	ANFO	11.5	33	7	26
	Leach Waste	12	2-3	23	23	18,000	0.27	ANFO				
2	All Material	19	2	25	20	30,500	0.22	ANFO	12.5	35-40	7	20
3	Sulfide Ore	100 -200	3-4	28	21	400,000 -700,000	0.59	Varied	12.5	43	7	18
	Oxide Ore	100 -200	3-4	28	21	500,000 -1,000,000	0.53	ANFO & ADY		79	10	23
	Waste	150 -300	3-5	28	21	750,000 -2,000,000	0.48	SANFO				

4	All Material	30	3	25	22	30,000	0.20	ANFO	12.5	25	5	17
5	Ore Waste Alluvium	30 40 50	2 2 3	18 24 37	20 20 28	60,000 80,000 150,000	0.7 0.7 0.4	GDY & ANFO ANFO ANFO	11.8	40	12	25
6	Ore Waste	30 50	3 3	20 20	22 22	60,000 100,000	0.32 0.32	ANFO ANFO	10.5-12.5	40	10	27-30
7	Sulfide Capping	40-60 60-100	1 1-2	15-20 15-20		130,000 -190,000 190,000 -320,000	0.24 0.24	ANFO & HYD ANFO & HYD	12.5		14	39-45
8	All Material	40	3	27	27	97,000	0.2	ANFO & HYD	12.0	40	7	11
9	Ore Waste	20 40	2-3 2-5	16 18	18 20		0.4 0.3	ANFO ANFO	10.0	33 33	9-10 4	18 18
10	Ore & Leach W. Waste	10-30 10-30	1 1-3	22 20-22	20-30 20-30	1500/Hole 1500/Hole	0.23-0.28 0.23-0.28	ANFO ANFO	12.5	35	5	26
11	All Material	30-80	1-4	17-18	16-24	1000/Hole	0.23-0.48	ANFO	12.5	NA	NA	NA
12	All Material	30 110 130	2 2 2	23 20 16.5	26 17.5 17.5	49,800 110,000 110,000	1.7 1.8 1.8	ANFO SANFO ANFO	13.6	40	6	13
13	Ore Waste	60 100	5 7	12 17	12 17	40,000 65,000	0.37 0.41	ANFO ANFO	11.7	25	7	12
14	All Material	5	1	25	35	22,500	0.18	ANFO & S	12.5	50	8	30
16	Ore Waste	38 30	4 3	9 9	9 9	10,635 5,945	0.32 0.39	ANFO & GDY ANFO & GDY	9.0	30	5	5
17	12" Hole 9" Hole	15-40 15-40	1 1	30 26	52' Toe 48' Toe	6,800 5,400	0.25 0.23	ANFO & S ANFO & S	12.7	40	7-10	12-14
18	Porphyry	25	5	23	26	43,320	0.17	ANFO & GDY	12.5	40	7-10	12-14
19	All Material	10+	1	24	35	30,000	0.14	ANFO & S	12.5	40	5	35
20	Springing Soft Med. Hard	5-25 3-12 3-12 3-12	1 1 1 1	25 28 25 21	NA 20 20 18	NA 2154/Hole 1932/Hole 1661/Hole	Avg. 0.1 0.1	Varied 60% SGDY ANFO S	13.0	50	5	26
	Soft Med. Hard	30-60 30-60 15-30	Mult. Mult. Mult.	28 28 24	28 28 18	2413/Hole 2077/Hole 1558/Hole	Avg. 0.34	Varied 60% SGDY ANFO & S	13.0	40	5	24
21	Ore	10-15	1	24	52' Toe	4000/Hole	0.35	ANFO	12.5	50	10	30
22	All Material	40	1	36		260,000	0.21	ANFO & S	12.5	50	15	38
23	12¼" Hole 7" Hole	25 40	1 1	34 20	40 20	165,000 48,000	0.4 0.4	S	12.5	40	15	25
24	Alluvium Arkosite	20 20	1 1-2	27 21		63,000 19,000	0.19 0.47	Varied—GDY, ANFO, S&C Varied—GDY, ANFO, S&C	12.3	40	7	27

* Explosive Used: ANFO—Ammonium nitrate and fuel oil, GDY—Gelatin dynamite, ADY—Ammonia dynamite, S—Slurry, SANFO—Sodium nitrate and fuel oil, HYD—Hydromex, SGDY—Semi Gelatin dynamite, C—Carbomite.

Source: Michaelson, S. D., and Hammes, J. K., "Operating Data for Open Pit Copper Mines," January 1968, Mining Engineering.

Cost of rail haulage at six Western Hemisphere open-pit copper mines

Mine	Material	Locomotive		Railcar Data		Rail Profile			Tons Hauled Per Train Shift	Operating and Maintenance Cost $/Ton
		Deadweight	HP	Capacity (Short Tons)	Avg. Cars Per Train	Avg. Haul (Ft.)	Max. Grade Pct	Elevation Gained (+) Lost (−)		
3	All Material (Pushers on Grade)	120 Tons 190 Tons	1200 1750	68	14	10,000	3	+300	1580	0.161
7	Ore Waste	120 Tons 120 Tons	1800 1800	72 72	10 10	14,300 14,300	4 4	−213.4 −213.4	4800 4800	0.034
17	Ore	85 Tons	1250	75	12-17	2,000	2	+40	3818	0.030
20	All Material	85 Tons	1200	86 Ore 73 Waste	14-21 Ore 8 Waste	35,000 Ore 25,000 Waste	5	−450	2205	0.101
	All Material	125 Tons	1600	86 Ore 73 Waste	14-21 Ore 8 Waste	35,000 Ore 25,000 Waste	5	−70	1752	
22	All Material All Material	126 Tons 124 Tons	1750 1200	80 80	7-11 9	21,000 20,300	4 4	+200 to −600 −600	2477 2153	NA NA
23	All Material All Material	125 Tons 140 Tons	1750 2250	65 & 62 65 & 62	7 8	21,780 22,018	3 3	+398 +416	1860 1964	NA NA

Source: Michaelson, S. D., and Hammes, J. K., "Operating Data for Open Pit Copper Mines," January 1968, Mining Engineering.

For more information, Circle No. 86 on PEP card.

For more information, Circle No. 104 on PEP card.

Monthly Outcome
Heads Adjusted to Smelter Returns

Lewis Lee — Anderson

For Mining Costs — 1973

Month	Tons	Item	NSR Per Ton Crude Au	Ag	Pb	Zn	Co	Cu	Total	Per Ton Crude Cost	Royalty	P&L	D&D	P&L
Jan	19,100	Grade	.085776	2.5056	3.1106	8.2918		.1812						
		Metal Quot	69.15	2.1035	.15103	.187509	3.16	.5262						
		Pb Conc	3.48	1.94	4.71				10.13					
		Zn Conc.	.48	1.76		8.82	.90	.13	12.08					
		Total	3.96	3.70	4.71	8.82	.90	.13	22.21	13.69	.35	8.17	3.39	4.78
Feb	17,080	Grade	.085080	3.9025	3.9736	7.9085		.2984						
		Metal Quot	80.833	2.2632	.15795	.19606	3.4438	.58387						
		Pb Conc	5.00	4.57	6.45			.02	16.04					
		Zn Conc	.51	1.844		8.599	.95	.45	12.35					
		Total	5.51	6.41	6.45	8.599	.95	.47	28.39	14.44	.81	13.14	3.39	9.75
Mar	11,490	Grade	.054531	2.3336	2.9950	7.9890		.1800						
		Metal Quot	89.1979	2.2340	.16014	.20137	3.6832	.59181						
		Pb Conc	2.94	1.74	4.74				9.41					
		Zn Conc	.40	1.58		8.99	.99	.26	12.22					
		Total	3.34	3.32	4.74	8.99	.99	.26	21.63	22.51	.20	(-1.08)	3.39	(-4.47)
Apr.	17,490	Grade	.066081	2.9547	4.2919	9.2763		.1702						
		Metal Quot	97.583	2.32767	.16306	.203625	3.75							
		Pb Conc	4.18	3.27	7.54				14.99					
		Zn Conc	.22	1.86		11.35	1.22		14.64					
		Total	4.40	5.13	7.54	11.35	1.22		29.63	14.91	.85	13.87	3.39	10.48
May	18,205	Grade	.072902	3.53818	3.7442	9.2439		.3025						
		Metal Quot	111.600	2.5076	.16487	.20349	3.75	.59458						
		Pb Conc.	4.89	4.07	6.51			.11	15.58					
		Zn Conc	.83	2.20		10.53	1.16	.41	15.13					
		Total	5.72	6.27	6.51	10.53	1.16	.52	30.71	12.92	1.73	16.06	3.39	12.67
June	17,810	Grade	.0829605	3.38617	3.9487	8.2787		0.2607						
		Metal Quot	120.1466	2.71048	.1650	0.203278	3.75	.59458						
		Pb Conc	6.074	4.565	7.001			.112	17.75					
		Zn Conc	1.325	2.125		9.653	1.063	.314	14.48					
		Total	7.399	6.690	7.001			.426	32.23	14.98	1.37	15.88	3.39	12.49
1st Half	101,175	Grade	0.075800	3.140246	3.7089	8.531857		0.23475						
		Metal Quo	94.9236	2.38768	.16069	.19908	3.5815	.5851						
	4397.8157	Pb Conc	4.507	3.436	6.224			.043	14.21					
	15074.0694	Zn Conc	.643	1.914		9.694	1.049	.259	13.56					
		Total	5.15	5.35	6.224	7.694	1.049	.302	27.77	15.12	.93	11.72	3.39	8.33

~~Rick~~ — WLK The ~~[illegible]~~ [illegible]

make copy if you don't have one.

Question — ① how do you handle the depletion figure

② when does the smelting, refining and freight enter in.

Kurt

Check VEAM

J. H. C.

SEP 22 1972

Gibraltar Mines - 1st Quarter including June 30, 1972

Production	3,569,100 tons	0.45% Cu	
Concentrate	41,800 tons	30.70% Cu	
Recovery	80.67%		7.26#/ton
Concentrates contain	25,672,700 lb. Cu	=	7.193#/ton

		Per Ton	Per Lb. Cu
Production costs	$3,032,714	= $0.850	$0.1181
Adm. and Gen. Exp.	108,052	= 0.030	0.0042
Interest	1,137,654	= 0.319	0.0431
Depreciation	1,048,852	= 0.294	0.0409
Pre-Prod. Write-Off	121,553	= 0.034	0.0047
	$5,448,825	$1.527	$0.2110

$1.527 ÷ 7.193# = 21.1¢/lb. copper

lbs. Copper Sold During Quarter = 17,499,000 #'s (Less Smelter Losses)
Inventory " " = 8,166,200 #'s

Revenue $6,894,010 = .393 per lb.
Interest 22,264 = .0010 " "

Smelter charges
1,465,262 = .0837 → must include precious metals - AJK
.4777

Smelter charges include Freight, Refining & Smelting - Japan.

No TAXES until JAN. 1974
DEPLETION ALLOWANCE 33 1/3 % - Good until JAN. 1976.
Free Ride until JAN. 1974

COMINCO - Cariboo Smelter
Consortium of: PLACER DEV.
Newmont
Bethlehem
NORANDA

W. L. K.
SEP 28 1972

Mining Costs

14 x .50 = 700

Haddleston

Royalty	NSV
	$2.50
2%	
2.5%	3.60
3.0%	4.70
3.5%	5.80
	$20.00
10.0%	

White Cloud Mining costs

± 2.50 costs

(1.50 mining)

(1.50 main)

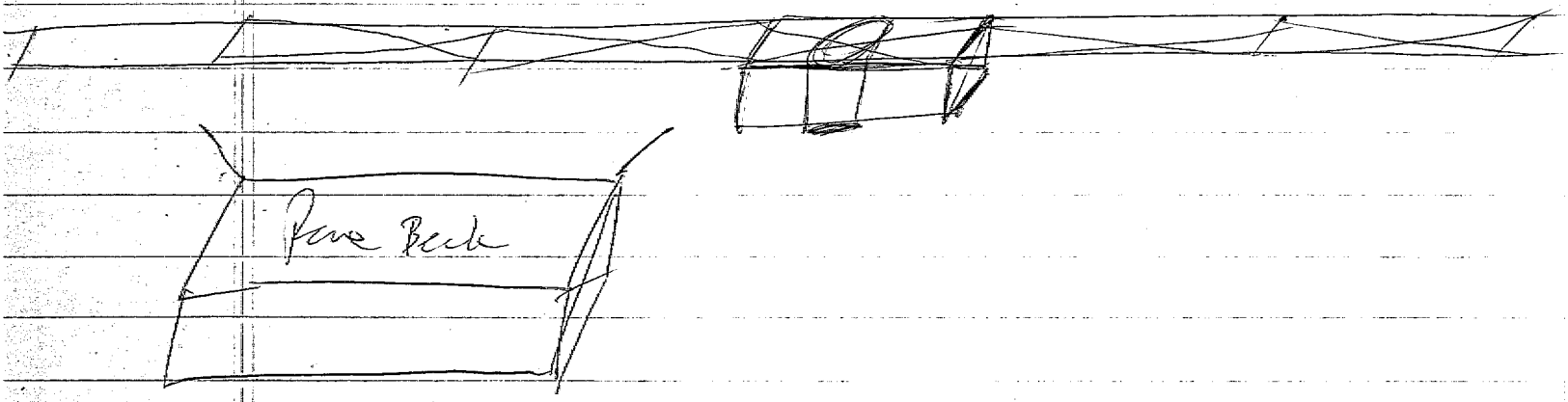
50 to railhead

2.50

1.70

July

Bald Mountain Project



Gen File Mining Costs

WLK

MINING ACTIVITY

March, 1972

	YEAR 1972 March	YEAR 1972 3 Months	Year 1971	Year 1970	Year 1969	Year 1966
ns Ore Mined.....	824,700	2,244,200	6,724,900	8,038,900	7,939,500	5,968,60
erating Days.....	31	90	302	357	357	357
ns Ore Mined/Oper. Day...	26,603	24,936	22,268	22,518	22,239	16,719
ns Waste Moved.....	2,403,500	7,271,600	20,028,600	18,549,000	20,478,100	29,179,20
tal Tons Waste Plus Ore..	3,228,200	9,515,800	26,753,500	26,587,900	28,417,600	35,147,80
ns Waste & Ore/Oper. Day.	104,135	105,731	88,588	74,476	79,601	98,453
tio: Tons Waste/Tons Ore.	2.91	3.24	2.98	2.31	2.58	4.89

Mining Cost Per Ton Ore Mined

	YEAR 1972 March	YEAR 1972 3 Months	Year 1971	Year 1970	Year 1969	Year 1966
ns Ore Mined.....	824,700	2,244,200	6,724,900	8,038,900	7,939,500	5,968,60
en Pit Mining Direct Cost	$ .77	$ .79	$ .84	$ .78	$ .75	$ 1.22
mmon Boundary Waste Cost.	-	.05	.01	.13	-	-
TOTAL DIRECT COST.....	.77	.84	.85	.91	.75	1.22
TOTAL INDIRECT COST....	.45	.45	.53	.38	.32	.36
TOTAL MINING COST.....	$ 1.22	$ 1.29	$ 1.38	$ 1.29	$ 1.07	$ 1.58

.31 .35 .39 .30 .37/ton

MILLING ACTIVITY

	YEAR 1972 March	YEAR 1972 3 Months	Year 1971	Year 1970	Year 1969	Year 1966
ns Ore Milled.....	824,700	2,244,200	6,724,900	8,038,900	7,939,500	5,968,60
erating Days.....	31	90	302	357	357	357
ns Ore Milled/Oper. Day..	26,603	24,936	22,268	22,518	22,239	16,719
say - Silver - Oz.....	.11	.11	.13	.13	.12	.19
- Copper - %	.59	.64	.67	.67	.70	.90
ntent of Ore Milled:						
Silver - Oz.....	88,498	250,966	869,495	1,019,577	955,677	1,106,967
Copper - Tons.....	4,842	14,261	45,385	53,586	55,611	53,471

Milling Cost Per Ton Ore Milled

	YEAR 1972 March	YEAR 1972 3 Months	Year 1971	Year 1970	Year 1969	Year 1966
ns Ore Milled	824,700	2,244,200	6,724,900	8,038,900	7,939,500	5,968,60
erations.....	$ .53	$ .53	$ .62	$ .60	$ .57	$ .57
aintenance.....	.22	.23	.26	.23	.24	.16
TOTAL DIRECT COST.....	.75	.76	.88	.83	.81	.73
TOTAL INDIRECT COST....	.35	.35	.41	.36	.34	.24
TOTAL MILLING COST.....	$ 1.10	$ 1.11	$ 1.29	$ 1.19	$ 1.15	$ .97

MINING ACTIVITY

	YEAR 1972		YEAR	YEAR	YEAR	YEAR
	March	3 Months	1971	1970	1969	1966
Tons Ore Mined.....	372,100	959,300	3,796,000	3,787,700	3,874,100	3,576,600
Operating Days.....	31	90	355	356	346	306
Tons Ore Mined/Operating Days	12,003	10,659	10,693	10,640	11,197	11,688
Tons Waste Moved.....	982,080	2,838,090	9,978,300	10,092,240	8,560,950	8,844,100
Total Tons Waste Plus Ore....	1,354,180	3,797,390	13,774,300	13,879,940	12,435,050	12,420,700
Tons Waste & Ore Oper. Day...	45,139	42,193	38,801	38,989	35,939	40,591
Ratio Tons Waste to Tons Ore	2.64	2.96	2.63	2.66	2.21	2.47

MINING COST PER TON ORE MINED

	YEAR 1972		YEAR	YEAR	YEAR	YEAR
	March	3 Months	1971	1970	1969	1966
Tons Ore Mined.....	372,100	959,300	3,796,000	3,787,700	3,874,100	3,576,600
Open Pit Mining Direct Cost	$ 1.05	$ 1.09	$ .93	$ .85	$ .79	$ .61
Diamond Drilling Direct Cost	-	-	-	-	.04	.07
TOTAL DIRECT COST.....	$ 1.05	$ 1.09	$ .93	$ .85	$ .83	$ .68
TOTAL INDIRECT COST.....	.43	.51	.45	.37	.32	.31
TOTAL MINING COST.....	$ 1.48	$ 1.60	$ 1.38	$ 1.22	$ 1.15	$ .99

.38 per Ton

29 per ton

CONFIDENTIAL W.E.S. FEB 18 1971 Mission Unit Mining Costs

MINING ACTIVITY

YEAR	Tons Ore Mined	Operating Days	Tons Ore Mined/ Oper.Day	Tons Waste Moved	Total Tons Waste Plus Ore	Tons Waste& Ore/Oper. Day	Ratio of Tons Waste to Tons Ore
1961	3,333,500	306	10,894	23,570,700	26,904,200	87,922	7.07
1962	5,223,500	311	16,796	23,810,200	29,033,700	93,356	4.56
1963	7,289,100	357	20,418	26,223,200	33,512,300	93,872	3.60
1964	7,579,800	358	21,173	27,941,600	35,521,400	99,222	3.69
1965	6,610,700	357	18,517	29,317,600	35,928,300	100,639	4.43
1966	5,968,600	357	16,719	29,179,200	35,147,800	98,453	4.89
1967	4,603,600	207	22,240	14,330,900	18,934,500	91,471	3.11
1968	6,009,700	283	21,236	16,119,800	22,129,500	78,196	2.68
1969	7,939,500	357	22,239	20,478,100	28,417,600	79,601	2.58
1970	8,038,900	357	22,518	18,549,000	26,587,900	74,476	2.31
TOTAL	62,596,900	3,250	19,261	229,520,300	292,117,200	89,882	3.67

MINING COST PER TON ORE MINED

YEAR	Tons Ore Mined	Open Pit Mining Direct Cost	Diamond Drilling Direct Cost	Total Direct Cost	Total Indirect Cost		Total Mining Cost
1961	3,333,500	$1.25	$ -	$1.25	$ .19		$1.44
1962	5,223,500	1.02*	.03	1.05	.22		1.27
1963	7,289,100	.92	.02	.94	.19	-25	1.13
1964	7,579,800	1.00	.03	1.03	.23		1.26
1965	6,610,700	1.06	.01	1.07	.29		1.36
1966	5,968,600	1.22	-	1.22	.36		1.58
1967	4,603,600	.77	.01	.78	.41		1.19
1968	6,009,700	.69	-	.69	.31		1.00
1969	7,939,500	.75	-	.75	.32	30¢ per ton	1.07
1970	8,038,900	.91 **	-	.91	.38	39¢ per ton	1.29
TOTAL	62,596,900	$ .94	$ .01	$ .95	$ .30		$1.25

*Includes $.01, Rehandling Stockpile Ore
**Includes $.13, Common Boundry Costs

Confidential

File - Mining Costs

OPERATING COSTS - MISSION UNIT

	Costs per Ton	
	1970 to Date	1966
Total Direct and Indirect Mining Costs	1.23	.99
70d direct? Direct and Indirect Milling	1.22	.99
General Administration Including SW Administration Costs, Depreciation and Depletion, State and Local Taxes	.40	
Total Operating Costs Before Federal Income Tax	$2.85	

November 19, 1970

To Dec. 1, 1970 Total Ore 7,447,600

Total Waste 16,944,500

gravel 5,005,400 w/o $\frac{2.275}{1}$ total

range 736,500

Rock 11,202,600 gravel/range $\frac{.771}{1}$

CONFIDENTIAL W.E.S. FEB 18 1971 Mission Unit

File W.L.K. Mining Costs

MINING ACTIVITY

YEAR	Tons Ore Mined	Operating Days	Tons Ore Mined/ Oper.Day	Tons Waste Moved	Total Tons Waste Plus Ore	Tons Waste& Ore/Oper. Day	Ratio of Tons Waste to Tons Or
1961	3,333,500	306	10,894	23,570,700	26,904,200	87,922	7.07
1962	5,223,500	311	16,796	23,810,200	29,033,700	93,356	4.56
1963	7,289,100	357	20,418	26,223,200	33,512,300	93,872	3.60
1964	7,579,800	358	21,173	27,941,600	35,521,400	99,222	3.69
1965	6,610,700	357	18,517	29,317,600	35,928,300	100,639	4.43
1966	5,968,600	357	16,719	29,179,200	35,147,800	98,453	4.89
1967	4,603,600	207	22,240	14,330,900	18,934,500	91,471	3.11
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1969	7,939,500	357	22,239	20,478,100	28,417,600	79,601	2.58
1970	8,038,900	357	22,518	18,549,000	26,587,900	74,476	2.31
TOTAL	62,596,900	3,250	19,261	229,520,300	292,117,200	89,882	3.67

MINING COST PER TON ORE MINED

YEAR	Tons Ore Mined	Open Pit Mining Direct Cost	Diamond Drilling Direct Cost	Total Direct Cost	Total Indirect Cost	Total Mining Cost
1961	3,333,500	$1.25	$ -	$1.25	$ .19	$1.44
1962	5,223,500	1.02*	.03	1.05	.22	1.27
1963	7,289,100	.92	.02	.94	.19	1.13
1964	7,579,800	1.00	.03	1.03	.23	1.26
1965	6,610,700	1.06	.01	1.07	.29	1.36
1966	5,968,600	1.22	-	1.22	.36	1.58
1967	4,603,600	.77	.01	.78	.41	1.19
1968	6,009,700	.69	-	.69	.31	1.00
1969	7,939,500	.75	-	.75	.32	1.07
1970	8,038,900	.91 **	-	.91	.38	1.29
TOTAL	62,596,900	$ .94	$ .01	$ .95	$ .30	$1.25

*Includes $.01, Rehandling Stockpile Ore
**Includes $.13, Common Boundry Costs

Mission Unit 1970 production

$$\frac{8{,}000{,}000 \text{ TPY}}{22{,}518 \text{ TPD}} = 355 \text{ days/yr.}$$

$$\frac{22{,}518 \times 355 \times X \ (\#/\text{TON})}{2000} = 47{,}678 \text{ Ton Cu}$$

$$X = \frac{(47{,}678)(2000)}{(22518)(355)} = 11.93 \ \#\text{rec}/\text{ton}$$

$$\frac{11.93}{20} = 0.6\% \text{ Cu rec.}$$

$$\frac{0.6}{.92 \text{ rec}} = 0.65\% \text{ Cu Avg mill head}$$

File — General Mining Costs

ATT. D

LEACH-PRECIPITATION CEMENT COPPER $.50/LB 02/16/71

CALCULATION ON RETURN OF INVESTMENT

TABLE A

INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 48.3 PCT	VALUE AT COMPLETION DATE
1ST	5000000.	2.68277	13413890.
2ND	6200000.	1.80780	11208372.
3RD	9693000.	1.21819	11807967.
TOTAL	20893000.		36430230.

TABLE B

EARNINGS FROM PROJECT

YEAR	CASH EARNINGS BEFORE TAXES	PRESENT VALUE DISCOUNTED AT 48.3 PCT FACTOR	DISCOUNTED VALUE
1	19077000.	0.673854	12855121.
2	18357000.	0.454079	8335543.
3	17659000.	0.305983	5403366.
4	16981000.	0.206188	3501286.
5	16324000.	0.138941	2268073.
6	15687000.	0.093626	1468711.
7	15068000.	0.063090	950644.
8	14468000.	0.042513	615088.
9	13868000.	0.028648	397291.
10	13322000.	0.019304	257176.
11	12775000.	0.013008	166183.
12	12244000.	0.008765	107328.
13	11729000.	0.005906	69281.
14	11229000.	0.003980	44695.
15	10757000.	0.002682	28852.
TOTAL	219545000.		36468645.

SOLVENT EXTRACTION / ELECTROWINNING $.50/ LB 02/16/71

CALCULATION ON RETURN OF INVESTMENT

TABLE A

INVESTMENT INVOLVED IN PROJECT

YEAR OF CONSTRUCTION	EXPENDITURES FOR CONSTRUCTION	FACTOR AT 47.3 PCT	VALUE AT COMPLETION DATE
1ST	6000000.	2.63781	15826866.
2ND	9941000.	1.78955	17790014.
3RD	14400000.	1.21408	17482809.
TOTAL	30341000.		51099690.

TABLE B

EARNINGS FROM PROJECT

YEAR	CASH EARNINGS BEFORE TAXES	PRESENT VALUE DISCOUNTED AT 47.3 PCT FACTOR	DISCOUNTED VALUE
1	26077000.	0.678426	17691316.
2	25177000.	0.460261	11588014.
3	24304000.	0.312253	7589013.
4	23457000.	0.211841	4969155.
5	22636000.	0.143718	3253211.
6	21839000.	0.097502	2129353.
7	21066000.	0.066148	1393476.
8	20316000.	0.044876	911713.
9	19589000.	0.030445	596396.
10	18884000.	0.020654	390049.
11	18200000.	0.014012	255034.
12	17536000.	0.009506	166709.
13	16892000.	0.006449	108946.
14	16268000.	0.004375	71181.
15	15662000.	0.002968	46492.
TOTAL	307903000.		51160065.

new File Mining Costs

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 29, 1970

Mr. J. J. Collins
New York Office

Dear Sir:

Subject: Property Agreement
Continental Materials Corp.
Margaret Group
Superior East Project
Pinal County, Arizona

I am enclosing a memo from Mr. J. E. A. McDonald covering his estimates of capital and operating costs for the hypothetical primary replacement copper deposit in limestone (Magma-Superior). These figures correspond to the Case 3 hypothetical deposit for our Superior East project evaluation. This memo from Mr. McDonald should be incorporated with my letter to you of December 24 on the same subject.

Mr. McDonald's figures are of the same magnitude as those provided by Mr. J. W. Still. An outcome analyses using McDonald's figures would be approximately the same as that which has been calculated using the Still figures. Accordingly, the outcome analyses for the hypothetical replacement copper deposit will not be modified at this time.

Very truly yours,

W. E. Saegart

W. E. Saegart

WES:mw
Enc.
cc: W. L. Kurtz ✓
R. B. Crist
J. D. Sell
File - Route to
J. H. Courtright
S. I. Bowditch

AMERICAN SMELTING AND REFINING COMPANY
MINING FOR NORTH AMERICA
P. O. BOX 5777, TUCSON, ARIZONA 85703

W.E.S.
DEC 29 1970

December 29, 1970

T. A. SNEDDEN
GENERAL MANAGER

1150 NORTH 7TH AVENUE
TELEPHONE 602-792-3010

Memorandum to Mr. W. E. Saegart

Hypothetical primary replacement copper deposit in limestone

25,000,000 tons @ ± 6% Cu

Allow 20% mining dilution

30,000,000 tons @ ± 5% Cu

Assumed mining rate 3,500 TPD (should be 4000)
Yearly mining rate 3,500 x 350 = 1,225,000 tons
15 years mining 1,225,000 x 15 = 18,375,000 tons

$$\frac{18}{30} \times 2100 = 1260$$

Depth of shafts 1260 + 1000 + 2000 + 240 = 4500

9000' of shafts required @ $1000/ft	$ 9,000,000
stations, pockets, crusher, sumps	500,000
10000' of drifts, x cuts and decline @ $125/ft	1,250,000
mine and surface plant (West Fork + 50%)	2,880,000
mine and surface equipment (West Fork + 50%)	3,600,000
	$17,230,000
Stope preparation 4000 ft @ $125/ft	500,000
	$17,730,000
Contingencies at 10%	1,770,000
Total	$19,500,000

Mining cost assume 10' x 10' slots filled with cemented fill on a production basis should be able to do this for same price as development that is $125/ft advance.

If ore is 10 cu ft in place to the ton, the mining cost will be approximately $12.50/ton.

J.E.A. MacDonald

JEAM:dh

File Mining Cost ~~Ad-16A.19.13~~

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 28, 1970

TO: W. E. Saegart

FROM: J. D. Sell

Re: Production and Operating Costs
Magma Copper Company
Pinal County, Arizona

Attached are excerpts from a May 5, 1969 report to the Newmont Mining Corporation stockholders giving the five year (1964-1968) production and cost figures for the San Manuel and Superior operations of Magma Copper Company.

James D. Sell

JDS:mw
Att.
cc: J. H. Courtright
W. L. Kurtz

Newmont Mining Corporation
Notice of Annual Meeting of Stockholders ; Excerpt from:
May 5, 1969.

BUSINESS AND PROPERTIES OF MAGMA

Magma Copper Company was incorporated in Maine in 1910. It has been engaged in the business of producing copper from its Magma mine near Superior, Arizona, since 1911 and from its San Manuel mine near San Manuel, Arizona, since 1956.

The Company's subsidiaries are the San Manuel Arizona Railroad Company, which serves the San Manuel Division, and the Magma Arizona Railroad Company, which serves the Superior Division. Both railroads provide the Company with rail transportation to the lines of the Southern Pacific Railroad.

Total copper production of the two mines for 1966, the last full year of uninterrupted operation, was approximately 242,041,000 pounds, which is the current rated annual capacity and on the basis of which the Company ranked as the fourth largest copper producer in the United States.

The industry-wide labor strike, which shut down all Magma's operations from July 15, 1967 to March 15, 1968, greatly reduced production in both those years. Total copper production for 1967 was approximately 127,027,000 pounds, and for 1968 was 173,561,000 pounds. In 1967, the Company sold 155,863,000 pounds, the excess over production coming from inventories. Sales in 1968 were 23,081,000 pounds less than production as the depleted inventories were restored to normal levels.

Gold and silver are recovered as by-products of the copper production at both mines, and molybdenum concentrates also are recovered at San Manuel.

Blister copper produced at Superior is sold f.o.b. the Superior smelter to a single buyer under a long-term contract, which provides for payment on the basis of market or agreed-upon prices for the copper, gold and silver content less freight, refining and marketing allowances. San Manuel's copper is custom refined and marketed by an independent sales agent. The molybdenum concentrates are sold under a contract extending through 1971 at prices based on market quotations.

A Statement of Income of the Company and its subsidiaries for the past five years appears on page 15, while its other financial statements are set forth on pages 55 through 59 hereof.

The earnings for 1967 and 1968, as shown by the summary, were adversely affected by the long labor strike. Fluctuations in copper prices have an important impact on Magma's net income. For example, a 1¢ increase or decrease in average annual price would increase or decrease at present capacity Magma's annual earnings by approximately $0.55 per share (presently outstanding) before income taxes.

Domestic refinery copper prices over the last ten years ranged from a high of 42.22¢ in 1968 to a low of 28.00¢ per pound in 1961, and the averages of such prices for each such year were as follows:

	1968	1967	1966	1965	1964	1963	1962	1961	1960	1959
Average Copper Price, ¢ per lb.	41.85	38.23	36.17	35.02	31.96	30.60	30.60	29.92	32.05	31.18

On March 20, 1969, the domestic refinery copper price was 44.44 cents per pound.

The new labor agreements with the United Steelworkers of America and other unions made at the settlement of the strike in March 1968, extend to July 1, 1971, and provide for an average total wage increase of 55.3 cents per hour over the 39½ months of the contract, of which approximately 14.5 cents became effective at once, with subsequent increases becoming effective January 1, 1969, November 1, 1969 and September 1, 1970. Monthly pensions were increased by the agreements from $2.50 to $5.00 times years of service, with some increases for employees already retired and with new pension benefits to widows of employees who die after age 55. Vacations, health and welfare, unemployment, death and disability, and other benefits also were increased.

The federal income tax returns filed by Magma Copper Company and its subsidiaries have been examined by and settled with the Internal Revenue Service through 1962. In subsequent years, the operating results of Magma have been included in the consolidated federal income tax returns filed by Newmont Mining Corporation. Newmont's returns for the years 1963, 1964 and 1965 are currently being examined.

The Company's long-term debt at December 31, 1968 was $36,000,000, consisting of the $15,000,000 bank debt referred to below, and the $21,000,000 balance of a 5½% unsecured note payable to The Prudential Insurance Company of America which is due in semi-annual installments of $1,500,000 from June 1, 1972 to December 1, 1978, with certain rights of prepayment available to the Company. The note agreement requires that the Company maintain at least $10,000,000 of consolidated working capital and also contains certain restrictions on dividend payments. At December 31, 1968, approximately $37,140,000 of retained earnings were unrestricted as to the payment of dividends.

In March 1968, in connection with the purchase of the Kalamazoo property hereinafter mentioned, the Company borrowed a total of $15,000,000 in equal amounts from two New York banks. The loans mature in March 1970. The Company anticipates that these loans will be paid from cash flow from operations or will be refinanced, possibly when financing is arranged for the Magma expansion program hereinafter described.

Two legal actions against the Company have been pending since 1959 and 1960. The first is a patent infringement suit involving smelter converter practices at San Manuel, in which the federal court has held the patent valid and infringed, and in March, 1969 found the amount of damages due for the infringement to be approximately $983,000, plus interest, attorneys fees and costs. The interest to date plus attorneys fees and costs aggregate approximately $453,000. In the second action, which claims compensation for use of the same invention prior to the issuance of the patent in 1959, a jury verdict for $400,000 against the Company in the Arizona state court was set aside on appeal by the Company, and a new trial was held in February, 1969, resulting in a jury verdict of $165,000 plus interest and costs. The interest to date and costs in this case amount to approximately $106,000. The Company is taking further action in both cases preliminary to possible appeals.

San Manuel Division

The San Manuel mine and plant is currently producing and treating approximately 40,000 tons of ore per day.

The mine is a large underground mine worked by block caving methods. The major part of the orebody, from which production has been obtained, is sulphide ore. There is in addition an area of oxide ore overlying a portion of the sulphide ore which may be leached in place or mined and leached or otherwise treated at some future time. A small part of the orebody lies in State lands held under long-term mineral leases, and another small part is held under a long-term lease and option from The Anaconda Company. The latter requires future payment of rent or royalty in the total sum of $4,350,000 in annual installments through 1988 and, if the purchase option is exercised, an additional payment of $1,500,000.

The surface plant consists of a mill, power plant, smelter, transportation and other facilities required for the current rate of operations. Townsite housing and facilities for San Manuel employees are owned and maintained by San Manuel Townsite Division of the Company, and a fully-equipped hospital is owned and maintained by the Company at San Manuel. The lands occupied by these facilities and ranch and other lands in the area are owned or held under lease by the Company.

Mine production to date has been obtained from the first and second levels. The first level was about 1,400 feet below the surface, and mining there has been completed. The second level, about 2,000 feet below surface, is now being mined. A third level about 600 feet below the second and an intermediate level half way between, will be prepared for start of production about mid-1974. Mining from the second and third levels will be accelerated to 60,000 tons of ore per day when the expansion program described below is completed, and while development work is done on the adjacent Kalamazoo orebody to prepare

it for future production. The Company has spent approximately $5,487,000 annually for the past five years in mine development expenditures. These expenses, together with costs capitalized in prior years with respect to shaft sinkings and attendant installations for the San Manuel orebody, are being charged to operating costs ratably as copper is produced from the ore developed and mined.

Sulphide ore reserves of the San Manuel mine as of December 31, 1968 are estimated, using an average 0.50% sulphide copper cut-off, to be 496,800,000 tons of 0.728% net sulphide copper, before dilution, of which 228,500,000 tons of 0.71% sulphide copper are above and can be mined from the second level. In addition, the estimated oxide ore reserves are 130,000,000 tons of 0.70% total copper (0.47% oxide copper), before dilution, all lying above the second level.

In March 1968, the Company purchased from Quintana Minerals, Ltd., under an agreement with that company and Newmont Mining Corporation, the Kalamazoo copper property adjoining the San Manuel mine in Arizona for $27,000,000 in cash and stock equivalent. Quintana received from Magma $15,000,000 in cash and 42,478 shares of Magma common stock, and from Newmont 78,208 shares of Newmont common stock and $4,800,000 in cash, and Newmont received from Magma 169,912 shares of Magma common stock. The Kalamazoo property is estimated to contain 565,000,000 tons of sulphide ore averaging 0.72% net sulphide copper, before dilution. This orebody is believed to be similar to the San Manuel orebody though lying at a considerably greater depth with the top of the orebody approximately 2,500 feet below the surface of the ground.

San Manuel's production and costs for the past five years have been as follows:

	1968	1967	1966	1965	1964
Ore mined:					
Tons	11,367,640	7,891,854	14,391,355	13,504,024	12,442,752
% Sulphide copper	0.701	0.758	0.772	0.773	0.828
Payable metal content:					
Copper (tons)	72,074	53,963	101,390	93,767	92,589
Molybdenum sulphide (tons)	2,298	2,001	3,544	2,863	2,486
Silver (ounces)	245,316	166,893	311,699	273,610	282,334
Gold (ounces)	14,303	10,534	22,396	21,550	20,746
Gross value per ton ore mined	$ 5.97	$ 6.18	$ 6.47	$ 5.66	$ 5.46
Operating costs(1) per ton ore mined	$ 3.72	$ 4.03	$ 3.33	$ 3.42	$ 3.39
All other costs(2) per ton ore mined	$ .85	$ 1.08	$ 1.26	$ .83	$ .69

(1) Including all operating costs, all Arizona taxes, federal social security taxes, and amortization of deferred development, but excluding depreciation, depletion and interest. Includes effect of strike expenses in 1968 and 1967.

(2) Includes depreciation, depletion, interest and federal income taxes.

The above results for the years 1967 and 1968 reflect the adverse effect of the prolonged labor strike already mentioned.

Superior Division

The Magma mine at Superior is an underground mine having replacement or bedded-type orebodies. It is provided with access, transportation and aircooling facilities required for current operations. The surface plant includes a concentrator, smelter and related auxiliary facilities.

Production and costs at the Magma mine for the past five years have been as follows.

	1968	1967	1966	1965	1964
Ore mined:					
Tons	333,607	219,510	431,913	439,911	377,575
% Copper	4.63	4.77	4.70	4.65	4.78
Payable metal content:					
Copper (tons)	14,706	9,551	19,631	19,452	17,064
Silver (ounces)	347,119	197,419	466,334	408,366	306,269
Gold (ounces)	7,263	4,970	12,802	12,748	11,078
Gross value per ton ore mined	$42.38	$45.37	$44.02	$38.48	$31.51
Operating cost,(1) per ton ore mined	$45.47	$54.01	$40.34	$35.50	$37.58
Other costs,(2) per ton ore mined	$ 0.43	$ 0.93	$ 0.48	$ 0.18	$ 0.18

(1) Including all operating costs, all Arizona taxes and federal social security taxes, but excluding depreciation and depletion. Includes strike expenses in 1968 and 1967.

(2) Includes depreciation, depletion and federal income taxes.

Operating costs have been high principally due to extensive timbering required to support the underground workings, high temperatures and humidity underground requiring expensive cooling facilities, long distances underground from existing shafts to the working areas, and to the obsolescence of much of the surface and underground facilities, and also in 1967 and 1968 costs were adversely affected by the eight months labor strike.

Extensive diamond drilling has developed additional replacement orebodies in beds lying stratigraphically above the areas presently being mined, and has increased the ore reserves to the highest tonnage in this mine's long history. As of December 31, 1968, total reserves at Superior were estimated at 10,100,000 tons of ore averaging 5.88% copper, before dilution.

The increased ore reserves have made feasible the commencement of an expansion program at Superior as described below.

Expansion Programs

As a result of the Kalamazoo acquisition, the Company has commenced a program to increase capacity at the San Manuel mine and plant from 40,000 to 60,000 tons of ore per day. This will require additional shaft sinking, mine development and plant expansion. Completion of the program is planned for 1971.

At Superior an expansion program also is underway to double the ore production there from 1,500 to 3,000 tons per day. The program includes an additional 4,800 foot mine ore shaft, a 9,100 foot tunnel on the 500 foot level, and modernization and expansion of the mine, mill and related facilities. The Superior smelter, however, will be abandoned, and the mill concentrates shipped to the expanded San Manuel smelter for smelting. Completion of the Superior expansion is scheduled for late 1972 with the production increase being gradual and fully accomplished two years after the program is completed.

Contracts for certain phases of the expansion programs at both mines have been negotiated. The cost of the two programs is expected to be in excess of $100,000,000. The amount and nature of such

File - mining cost
Buchanan - Confidential

OCTOBER 1970

Mining Activity

	YEAR 1970 October	YEAR 1970 10 Months	Year 1969	Year 1968	Year 1967
Tons Ore Mined - Development	916	6,878	6,802		
Tons Ore Mined - Ore Breaking	9,682	97,417	39,636		
Total Tons Ore Mined	10,598	104,295	46,438		
Operating Days	27	257	198		
Tons Ore Mined/Operating Day	393	406	235		
Tons Waste Hoisted	-	1,612	1,298		
Tons Waste Gobbed	350	2,250	1,844		
Total Tons Waste Moved	350	3,862	3,142		
Total Tons Waste Plus Ore	10,948	108,157	49,580		
Tons Waste & Ore/Operating Day	405	421	250		
Ratio of Tons Waste to Tons Ore	.03	.04	.07		

MINING COST PER TON ORE MINED

	YEAR 1970 October	YEAR 1970 10 Months	Year 1969	Year 1968	Year 1967
Tons Ore Mined	10,598	104,295	46,438		
Direct Mining Cost	$ 10.66	$ 10.42	$ 12.27	$	$
Indirect Mining Cost	2.59	2.34	3.29		
Total Mining Cost	$ 13.25	$ 12.76	$ 15.56	$	$

MILLING ACTIVITY

	YEAR 1970 October	YEAR 1970 10 Months	Year 1969	Year 1968	Year 1967
Tons Ore Milled	11,281	104,453	44,667		
Operating Days	22	236	164		
Tons Ore Milled/Operating Day	513	443	272		
Assay - Silver	1.63	1.62	1.73		
- Lead	2.79	3.26	4.47		
- Copper	.51	.53	.59		
- Zinc	9.84	12.94	15.49		
Content - Silver, ounces	18,345	169,434	77,387		
- Lead, tons	314	3,407	1,996		
- Copper, tons	57	553	262		
- Zinc, tons	1,110	13,514	6,919		

MILLING COST PER TON ORE MILLED

	YEAR 1970 October	YEAR 1970 10 Months	Year 1969	Year 1968	Year 1967
Tons Ore Milled	11,281	104,453	44,667		
Operations	$ 2.34	$ 2.42	$ 2.79	$	$
Maintenance	.49	.53	.63		
Total Direct Cost	$ 2.83	$ 2.95	$ 3.42	$	$
Total Indirect Cost	.76	.84	1.16		
Total Milling Cost	$ 3.59	$ 3.79	$ 4.58	$	$

File - Mining Costs WLK

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 24, 1970

PERSONAL AND CONFIDENTIAL

TO: Mr. John J. Collins
New York Office

FROM: W. E. Saegart

Subject: Property Agreement
Continental Materials Corp.
Margaret Group
Superior East Project
Pinal County, Arizona

Dear Sir:

Last week Jim Sell and I, together with three members of our exploration staff, visited several of the operating mines and prospects in the Miami and Superior districts. Considerable new information was obtained which contributes to our over-all knowledge of the mineral potential along this porphyry copper lineament. Pertinent new information concerning mines and the more important prospects is summarized below.

Inspiration Consolidated Copper Company

A tour was made of the Thornton, Live Oak and new Oxhide open pit mines. Inspiration geologists were particularly glib during discussions regarding their ore deposits and regional structural controls. Current production rates include 25,000 tons per day from the Thornton and Live Oak pits. Grade is averaging 0.7% Cu and production is divided as follows: 40% oxide, 20% mixed oxide and sulfide, and 40% sulfide. Five thousand tons per day are being mined by open pit from the Black Copper (Warrior) Mine, located one-half mile north of the Thornton pit. This ore consists of high grade copper oxides occurring as matrix cement in post-mineral Whitetail Conglomerate.

Twelve thousand tons per day of oxide copper averaging 0.5% Cu is currently being mined by rippers and scrapers from the new Oxhide property located one mile southwest of the Live Oak pit. Ore occurs in two separate deposits, one in granite porphyry and the other in Pinal schist. Judging from the size of the area being developed, reserves must be in excess of 50 million tons.

Inspiration is also developing a northern extension of the Live Oak pit known as the Red Hill area. Several thousand tons of additional production per day will be realized sometime later this year.

Miami Copper Company - Occidental Petroleum

The down faulted segment of the Miami-Inspiration ore body known as Miami-East is covered by a thick (± 2500) section of Gila Conglomerate. Based on drill hole patterns and information published in a Cities Service prospectus dated October 1, 1969, we estimate reserves of the Miami-East deposit at 130 million tons averaging 1.5% Cu. This ore body has recently been extended under the town of Miami and further south on ground controlled by Occidental Petroleum (the Van Dyke property). Occidental has completed some 18-20 holes on their portion of the deposit and five drill rigs are currently working. No information is available regarding Occidental's results, but the outcome of this exploration will probably add significantly to the ore reserves of the district.

Miami has drilled out a major ore extension of their original caved ore body--extending north 2,000 ft. or more and underlying the upper circle townsite of ICC. According to Inspiration geologists, this Miami ore extension is economically feasible and negotiations are in progress concerning relocation of the townsite.

Miami Copper completed measurement and metallurgical sample drilling of their Pinto Project (Castle Dome) in 1970. Reported reserves are 350 million tons at 0.45% Cu. According to the Inspiration geologists, the reserve is actually 550 million tons at this grade. This appears to be a realistic figure since the ultimate pit perimeter shown on Miami Copper maps is 6,000 feet in diameter.

Bluebird Mine - Ranchers Exploration & Development Co.

A visit was made to the Bluebird operation which is now producing one million pounds of cathode copper per month. Mining rate is 20,000 tons per day which is 50% ore and 50% waste. Total ore reserves, including all production to date, are 30 million tons averaging 0.5% copper (all oxide). Present reserves have not been extended more than 250 to 300 feet below the original surface where almost all holes ended in ore. Ultimate reserves will no doubt be far in excess of 30 million tons.

Magma-Superior

An underground visit was made of the stacked replacement ore bodies which have recently been placed in production. Replacement ore has now been discovered and partially developed in a fairly thick portion of the Paleozoic limestone sequence. Early discoveries of replacement ore at Superior were limited to the Devonian Martin limestone. During the past few years, three major replacement horizons have been discovered in the overlying Mississippian Escabrosa formation and one in the basal member of the Pennsylvanian Naco formation. In composite form, these ore replacement beds of the Escabrosa

and Naco formations can be described as a 30% dipping tabular body having dimensions of 2500' x 700' x 350' (thick) which is 50% ore. This generalization is based on a brief examination of Magma Copper Company ore sections. The ore replacement beds have been explored down-dip to the 4300' level with no limits yet established. We estimate present reserves at 25 million tons averaging 6% copper. A greater ultimate reserve is likely as the ore beds are developed down-dip and exploration extended higher in the thick Naco section.

The new discoveries and additions to reserves in the Miami and Superior Districts are indeed impressive. This prophyry copper lineament, as heretofore understood, was grossly underrated. Ultimate production will probably rival that of the Morenci-Metcalf District. The growing importance of the Miami-Superior belt firmly reinforces the exploration objectives and expectations of the Superior East project.

I am enclosing a one-inch = one-mile map showing the distribution of copper deposits which is an up-dated version of the map which accompanied my December 3rd letter to Mr. C. P. Pollock. This revised addition includes the new Miami East, Bluebird, and Oxhide deposits and also shows a western extension of the Cactus deposit to include the old Carlota Mine area.

Regional Structure

Considerable information was obtained during these discussions and examinations concerning the wide-spread importance of low-angle post-mineral, post-enrichment faulting. Most of the copper deposits in the eastern half of the district are terminated in depth by low angle post-mineral, post-enrichment faults. Inspiration geologists confirmed that the Live Oak and Thornton ore bodies are bottomed at depth by flat or low-angle faults. Faulting probably occurs along multiple imbricate surfaces rather than on a single fault plane. A vertical column through the hanging wall ore block and related imbricate slivers consists of alternating repetitions progressing downward of oxides-chalcocite-primary-oxides-chalcocite-primary, etc. This sequence is probably the result of fault slivers of chalcocite ore overriding oxidized blocks.

The Bluebird, Oxhide and Cactus-Carlota deposits are all terminated at depth by low-angle faults. Evidence of flat faulting is also pronounced along the eastern margin of the dacite plateau in the Powers Gulch zone of exotic copper.

We are now theorizing the existence in the Miami district of a gravity slide basement fault or faults of the Mission-Pima type. There is evidence in the Powers Gulch and Cactus-Carlota area that the flat faulting is pre-dacite in age. A reasonable possibility exists that some or most of the

copper deposits in the eastern part of the district were moved by gravity slide action from the area of the dacite plateau. This line of thinking is difficult if not impossible to confirm by outcrop evidence alone and supporting information from the many holes which have been drilled in the district is generally not available to ASARCO. Nevertheless, the possibility exists that a root of the Miami-Inspiration and related adjacent deposits does exist under the dacite cover in our Superior East project area. Such a root constitutes an important additional target for our pending exploration program. A primary disseminated copper deposit would likely be too low grade to be economic at the depths which exist on the dacite plateau. To be economic, a root deposit would probably have to have been exposed for a considerable period after the fault truncation to permit the development of a new chalcocite enriched blanket. There are at least two other known examples of chalcocite enrichment which has formed in footwall segments after the upper portion had been displaced by gravity sliding. These are La Caridad and Sacaton-Santa Cruz (Santa Cruz being the enriched footwall segment). Santa Cruz chalcocite, unfortunately, was mostly destroyed by oxidation.

In addition to exploring for a possible root of the Miami-Inspiration deposits, we also believe there is a good chance that the vein and replacement ore bodies at Superior represent lateral passage of hydrothermal fluids from an adjacent porphyry stock. An enriched porphyry copper deposit adjacent to the replacement ore beds on the eastern projection of the Magma vein systems is another important target objective of our Superior East program.

Any ore deposit occurring beneath the post mineral cover rocks of the dacite plateau would top out at depths ranging from a minimum of 2,000 feet to a maximum of perhaps 4,500 feet. To establish the feasibility of underground mining at these depths, we have developed two hypothetical ore deposits of the type we might reasonably expect to exist. Capital and operating costs and outcome analyses have been developed for these two hypothetical deposits. The first deposit is a replica of the Inspiration to Miami East ore deposit which has been limited to include only the higher grade oxide and chalcocite portions. This deposit is assumed to have a reserve of 400 million tons averaging 1.25% copper. Information sources for this reserve figure are tabulated as follows:

Deposit	Source	Tonnage and Grade
Miami	USGS PP 342 (Actual Production to 1962)	135 million tons @ 1.0% Cu
Inspiration	USGS PP 342 (Actual Production to 1962)	140 million tons @ 1.21% Cu
Miami-East	ASARCO Estimate (Data from 10/1/69. Cities Service Prospectus.)	130 million tons @ 1.51% Cu
Occidental	--	? ?
	TOTAL	405 million tons @ 1.24% Cu

The second theoretical deposit is a replica of the stacked replacement ore bodies at Superior. Ore reserves are estimated at 25 million tons, grading 6% copper.

Two hypothetical situations were developed for the Miami-Inspiration type deposit which represent the anticipated extremes of depth to top: Case One, depth of 2,000 feet; and Case Two, depth of 4,500 feet. For the hypothetical replacement deposit, a depth of 3,000 feet to the up-dip extremity of ore was assumed. The down-dipped portion would extend to a depth somewhat below 5,000 feet.

Approximate mine plans, capital costs and operating costs were obtained for both hypothetical deposits from J. W. Still, and a similar estimate was prepared by Carl Williams for the Miami-Inspiration type. Milling capital and operating costs were supplied by G. W. Bossard. Freight, smelting and refining costs were obtained from A. J. Kroha. Outcome analyses were computer developed by Bob Crist and Carl Williams for each ore body type using both 45 and 50 cent copper. Capital and operating cost estimates prepared independently by Messrs. Still and Williams exhibit reasonably close comparisons. In each case, the highest estimated cost figures were used for the outcome analyses.

The outcome calculations were prepared assuming the existence of a profit sharing agreement of the type which has been negotiated with Continental Materials Corporation. Accordingly, the earnings cash flow includes only 80% of net profits after capital recovery. A 3% net smelter return royalty was added to operating costs to correspond to the underlying agreement between Continental and CanUS.

Reports by J. W. Still and memorandum from Carl Williams are enclosed, together with summary information of cost figures for each hypothetical mining scheme and the computer outcome print-outs. Return on investment is acceptable for all cases. The outcome (ASARCO's 80% of net profits) before taxes for the replacement (Superior) type deposit would be 28% at 45 cent copper. The deep (4,500 foot - Case 2) Miami-Inspiration type yields 15.5% R of I at 45 cent copper.

I am enclosing another copy of Mr. S. I. Bowditch's letter of December 3 to Mr. C. H. Reynolds of Continental Materials Corporation which outlines the basic terms we have negotiated for acquisition of their Margaret claim group. Mr. Reynolds advised me on December 11 that these terms are acceptable to his management. Acquisition of the Margaret claim group is essential since it covers a large part of the area we consider to be most favorable at our Superior East project. If you agree, please request approval in principle of the agreement format summarized in Mr. Bowditch's letter. If approved, Mr. Bowditch will prepare a complete agreement draft for submittal to Continental Materials Corporation.

Yours truly,

W. E. Saegart

W. E. Saegart

WES:mw
Enc.
cc: W. L. Kurtz
R. B. Crist
J. D. Sell
File - Route to
J. H. Courtright
S. I. Bowditch

NOTE For All Cases I, II, and III

Hypothetical reserves will be mined under the terms contained in the suggested Net Profits Lease.

Net profits to be shared 20%-80%, after all operating and post mining capital expenses are deducted, but excluding depreciation, depletion and Federal Income Tax.

Net Profits will not be shared until all pre-mining capital and exploration costs are returned plus interest at 8%.

Dec. 23, 1970

CASE I

Enriched Porphyry Copper
Miami-Inspiration Type

2,000 Ft. to Top

Reserves: 400,000,000 tons @ 1.25% Cu
90% grade extraction)
110% tonnage extraction) 440,000,000 tons @ 1.13% Cu

Mining: Block cave
40,000 tons/day
350 days per year - 14,000,000 tons/year
31 year life

Milling: 40,000 tons/day 85% rec 35% conc grade

Capital Cost: (5 year period)

		Period Applied
Mine	$ 51,000,000	Last 4 years
Mill*	80,000,000	Last 2 years
Water-Power	10,000,000	Last 3 years
Explor. Drilling	3,000,000	First 2 years
	$144,000,000	

Net Smelter Return:

Gross Value per ton

$.50 Cu	(1.13)(20)(.38)(.85) =	$7.29
.45 Cu	(1.13)(20)(.33)(.85) =	6.34

Operating Costs:

	.50 Cu	.45 Cu
Mining (Direct & Indirect)	$2.19	$2.19
Milling - Direct	.65	.65
- Indirect	.30	.30
Admin.: NY & SW	.05	.05
Royalty 3% NSR	.22	.19
	$3.41	$3.38

* Assumes $2000/ton/day capital cost

Dec. 23, 1970

CASE II

Enriched Porphyry Copper
Miami-Inspiration Type

4,500 Ft. to Top

Reserves: 400,000,000 tons @ 1.25% Cu
90% grade extraction) 440,000,000 tons @ 1.13% Cu
110% tonnage extraction)

Mining: Block cave
40,000 tons/day
350 days per year - 14,000,000 tons/year
31 year life

Milling: 40,000 tons/day 85% rec 35% conc grade

Capital Cost: (6 year period)

		Period Applied
Mine	$ 76,000,000	Last 5 years
Mill*	80,000,000	Last 2 years
Water-Power	10,000,000	Last 3 years
Explor. Drilling	6,000,000	First 2 years
	$172,000,000	

Net Smelter Return:

Gross Value per ton

$.50 Cu	(1.13) (20) (.38) (.85) =	$7.29
.45 Cu	(1.13) (20) (.33) (.85) =	6.34

Operating Costs:

	.50 Cu	.45 Cu
Mining (Direct & Indirect)	$2.36	$2.36
Milling - Direct	.65	.65
- Indirect	.30	.30
Admin.: NY & SW	.05	.05
Royalty 3% NSR	.22	.19
	$3.58	$3.55

* Assumes $2000/ton/day capital cost

Dec. 23, 1970

CASE III

Replacement Ore
Magma (Superior) Type

Reserves: 25,000,000 tons @ 6% Cu
5,000,000 tons Dilution
30,000,000 tons @ 5% Cu

Mining: Deep underground
Strike Slot Cut - Sand fill stoping
3,500 tons per day
350 days per year - 1,225,000 tons/year
24 year life

Milling: 3,500 tons/day 90% rec 25% conc grade

Capital Cost: (5 year period)

		Period Applied
Mine	$26,000,000	Last 3 years
Mill*	10,500,000	Last 2 years
Water-Power	1,500,000	Last 3 years
Explor. Drilling	3,000,000	First 2 years
	$41,000,000 -	5 Year lead time

Net Smelter Return:

Gross Value per ton conc

$.50 Cu	(5.00)	(20)	(.38)	(90%)	= $34.20
.45 Cu	(5.00)	(20)	(.33)	(90%)	= 29.70

Operating Costs:

	.50 Cu	.45 Cu
Mining (Direct & Indirect)	$11.50	$11.50
Milling - Direct	1.10	1.10
- Indirect	.50	.50
Royalty 3% NSR	1.03	.89
NY & SW	.10	.10
	$14.23	$14.09

* Assumes $2000/ton/day capital cost

Dec. 23, 1970

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

W.E.S.
DEC 22 1970

December 22, 1970

MEMORANDUM TO: W. E. Saegart

SUBJECT: ESTIMATE OF A HYPOTHETICAL 40,000 TPD PRODUCTION BLOCK CAVE MINE, 400 MILLION TON ORE RESERVE

Case #1: 2500 foot shaft

Summary of capital expenditures for the mine

Mine surface plant	$ 9,000,000
Mine development	25,505,500
Mine equipment	11,500,000
Total preproduction	$46,005,500

Mining costs (directs and indirects)	$1.40/ton
Further development	.79/ton
Total Mining cost	$2.19/ton

Case #2: 5000 foot shaft

Summary of capital expenditures for the mine

Mine surface plant	$9,000,000
Mine development	37,505,500
Mine equipment	11,500,000
Total preproduction	$58,005,500

Mining costs (directs and indirects)	$1.57/ton
Further development	.79/ton
Total mining cost	$2.36/ton

Carl E. Williams
Carl E. Williams
Supervisor, Technical Systems

CEW:rms
cc: JEA MacDonald

J. W. STILL
Consulting Mining Engineer
5213 N. ORACLE RD. 602 887-5341
TUCSON, ARIZONA 85704

December 16, 1970

RECEIVED
DEC 18 1970
S. W. U. S. EXPL. DIV.

Mr. William E. Saegart
American Smelting & Refining Co.,
1150 North 7th Avenue
Tucson, Arizona 85705

Dear Sir:

Pursuant to your request, the following brief study was made on an assumed orebody to estimate the probable capital and operating costs. Attached, as Appendix "A", is a copy of the sketch your furnished me that shows the assumed depths and lay of this orebody. It is assumed to be a primary replacement copper deposit in limestone with 20 to 25 million tons of ore @ a grade of 6% copper. The top of the ore is assumed to be some 3000' below surface, overlain by 1000' of moderately indurated tuff and 2000' of dacite. The ore bed is assumed to dip at 30 degrees, be 350 feet thick and be about 50% ore. Also this ore bed is assumed to extend over 2100' vertically.

The next page shows a sketch on the general mining entry scheme that I have assumed to open up the upper half of this orebody. If it is assumed that an operation of 3500 tons/day is the proper size, this indicates on a 25 million ton reserve a life of some ~~20~~ 24 years. (30,000,000 tons after dilution) The capital estimate that follows covers only the upper half of the assumed 2100 vertical feet orebed, as I feel that this would provide for 10 years mining - and in the latter part of this 10-year period the production and ventilation shafts could be deepened and a start made on opening up the levels below the 4000 Level.

As this sketch shows, the production and service shaft (4 compartments, cage, 2 skips & manway-counterweight) would be sunk so as to be about 500' distance from the ore-bed footwall at the top of this ore bed. From this shaft, at 300' intervals, four haulage drifts would be carried into the bed (3100, 3400, 3700, 4000). To open up levels at 100' intervals between the main haulages, ore pass and service elevators would be installed just under the footwall of the bed. These intermediate levels would be serviced by the 6-ton capacity elevators and ore and waste passed

to the haulage below. The ventilation shaft would be offset 500' distant from the edge of the ore - and major ventilation drifts run over to the hanging-wall edge of the ore on each of the four haulage levels.

On the mine equipment required, I am assuming that part of the mining (in the worst ground) will be cut and fill, using the continuous stringer-cement-sand fill scheme as now in use at Superior. In better ground I would assume some open stoping can be done by rock bolting the back (panel and pillar) with sand fill and subsequent pillar extraction. To make the 3500 t/d demand on a three-shift basis would require hoisting 1167 tons per shift - and assuming that four levels would be active at any one time, would require a production from each level of 292 tons per level per shift. I am also assuming that for the first ten years mining, 7-ton skips, hoisting in balance would be used. The original hoist design for this service should permit deeper hoisting at a later date (the additional 1050', below the 4000 Level) by larger motors and an increase in the hoisting speed.

ESTIMATED CAPITAL & OPERATING COSTS

The detail on these estimated capital costs will be found in Appendix "B" and the following section of this report. In summary, these estimates follow:

Shafts, 2	$10,925,000	
Mine Surface Plant	3,550,000	
Mine Equipment	5,102,200	
UG Work: Entries to orebody	1,571,675	
Stope preparation in ore	2,400,000*	
		$23,548,875
Contractors fee (10% on $14,350,000)		1,435,000
Design & Engr. (5% " $14,350,000)		717,500
Total Capital Cost Estimate		$25,701,375
Operating Costs Estimate		$8.50 to $11.50/t

*This item part of later mining cost, not properly capital, but money would be rquired.

PERTINENT FACTORS

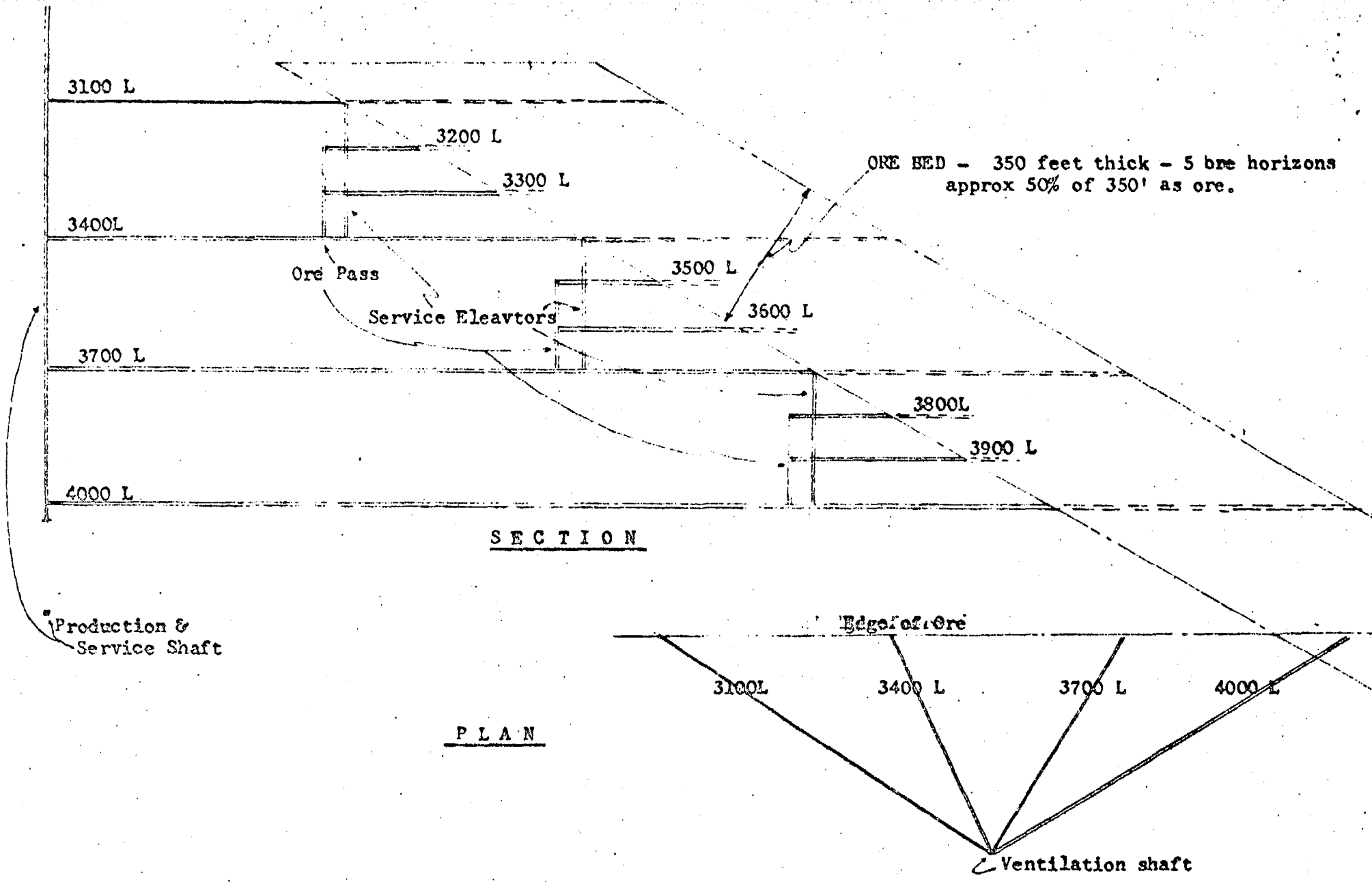
The current operation that resembles, in some degree, this assumed orebody, is the Magma operation at Superior, Arizona. Attached hereto as Appendix "C" and "D" is cost data over the years '64 thru '68 taken from a Newmont Prospectus dated 3/29/69. This is a hot mine with refrigeration cooling, with the active workings a long distance from surface, this distance being such that the company gets only about 4.5 hours work per 8-hour shift from the underground crew. It is also an old mine, somewhat locked in with rather small-size equipment, interior shafts and an extended ventilation and cooling setup. A good deal of the production in the past has been high-cost square set mining. The new expansion, now underway, will change many of these adverse factors and in the new orebody, it is hoped the ground conditions will be somewhat better. Just what costs they may make some three to four years from now, under the new conditions, is really impossible to say.

From the prospectus data, shown in Appendix "D", it appears that in a normal 350-day year, the Superior mill will handle about 1250 t/d (see years '65 and '66). It is quite apparent that in strike years, such as '67 and '68, this operation is quite vulnerable. In any event, using these prospectus figures and estimating the costs other than mining, the mining costs can be roughly estimated for the two normal years of '65 and '66 as follows:

	'65	'66
Operating costs, total/ton	$35.00	$40.34
Less, milling, est @	- 2.50	- 2.50
" Adm & Gen'l, est @	- 1.50	- 1.50
" Freight, smelting & ref @ 6.5¢/lb	- 5.75	- 5.90
Indicated mining cost/t	$25.75	$30.44

These costs indicate an extremely low tons/manshift efficiency, probably something under 3 tons/manshift.

A new and planned operation, not burdened with the locked-in factors at the present Superior operation - and with ground conditions



MINING SCHEME
For
Hypothetical replacement Copper
Deposit in Limestone.

Scale 1" = 300'

Scale 1" = 300'

somewhat better, and a mining layout where the mining done is in a somewhat reasonably condensed area (not spread out laterally or coming from numerous levels) - should make a much better tons/manshift efficiency. Inasmuch as this is a hypothetical orebody, with no data on the rock conditions, it is almost impossible to estimate a mining cost. However, under the conditions spelled out above - fair ground conditions, the mining area not spread out over too great an area, with proper design to accelerate ore handling (face to surface) - I would judge that an efficiency of 6 to 8 tons per manshift can be had. Assuming a $40/manshift cost, with labor at 60% of the mining cost, this would mean a mining cost of from $8.50 to $11.25 per ton.

As you are aware - and at your request - not too much time has been spent on this study. As a consequence it should be considered on a "general order of magnitude basis." Obviously, many of the assumptions I have had to make may have to be altered when and if such an orebody is drilled out. In addition, some of the equipment I have assumed may be changed with improved new equipment, such as the raise drills currently being used in ventilation and ore pass work. In any event, for your present purpose, I feel it is reasonably realistic.

This will not be too large a mine, and on the manshift efficiencies estimated, the mine department crew will run from 450 to 580 men, with perhaps 20 to 30 mine foremen and bosses included in this group. Staffing a new underground operation with competent bosses under present conditions is a sizeable chore and some 2 to 5 years will be required to shake the operation down to where reasonable costs can be had.

I trust the above will cover the information you desired. In the event that you have any further questions, I would appreciate your so advising me.

J. W. Still - Mining Engineer
Tucson, Arizona - 12/16/70

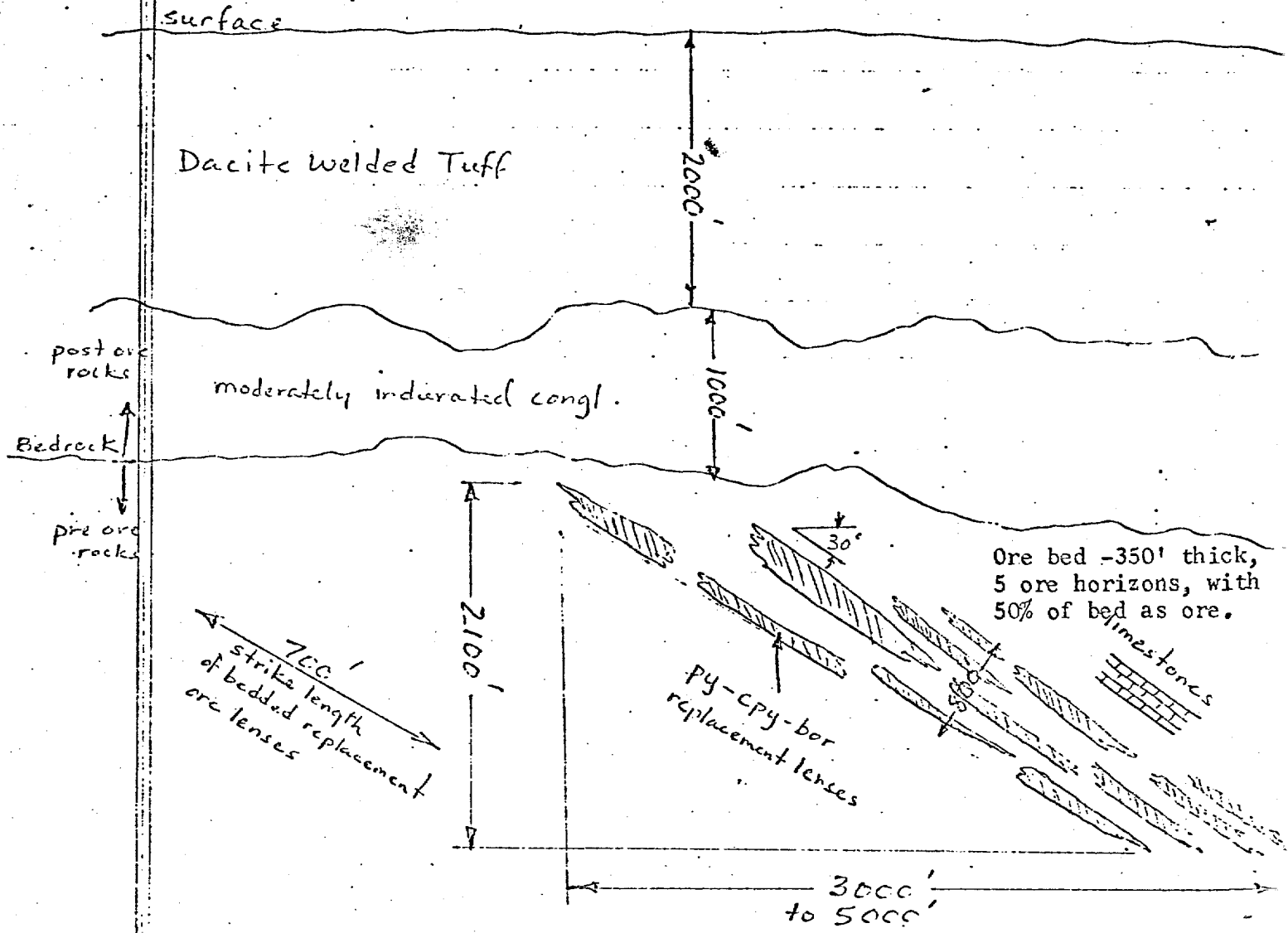
JWS:h

Hypothetical primary replacement Copper Deposit in limestone

Assume: 15,000,000 tons @ ± 6% Cu
allow 20% mining dilution
or. mined reserve 18,000,000 tons @ ± 5% C

Above later altered to 20-25 million tons, @ ± 6.00% Cu

Longitudinal Section



mining method: Horizontal transverse slots (undercut) with cemented sand fill

Shafts

Pro Shaft - 4050' @ $1266		$ 5,129,000
" " - 4 stations, pockets, loading station, etc.		1,000,000
Vent Shaft - 3700' @ $1255		4,646,000
" " - 4 stations, vent doors, etc.		150,000
		$10,925,000

Entry to Orebody

3 - 300' Elevator shafts	$225,000	
4 - Haulage entries	730,625	
6 - Entries for elevator	151,050	
3 - 300' Ore passes	67,500	
1 - 300' Vent raise	37,500	
4 - Connections, vent shaft to orebody	360,000	$ 1,571,675

Mine Surface Plant

Site preparation	$100,000	
Hoist for skip, headframe, bins, etc., production shaft	450,000	
Hoist for man-supply cages	300,000	
Hoist for vent shaft, headframe, etc.	200,000	
2 - hoist houses	150,000	
Compressors	975,000	
Compressor house, cooling towers, etc.	150,000	
Service shops	300,000	
Change room & mine office	175,000	
Mine surface power layout	250,000	
5 - 7-ton skips	50,000	
2 - man & supply cages	50,000	
Power & water development	400,000	$ 3,550,000

Underground Mine Equipment

35 Jackleg outfits @ $1800	$ 63,000	
25 Stoper outfits @ $1800	45,000	
4 - 6-ton trolley motors @ $28,500	114,000	
6 4 1/2-ton battery motors @ $28,500	171,000	
150 - 90 cu ft Granby type ore cars @ $3300	495,000	
10 - Granby type car dumps	50,000	
Ventilator equipment, main & auxiliary	125,000	
Air cooling equipment	1,250,000	
3 Elevator shaft layouts @ $85,000 ea	255,000	
4 Emco 21 muckers @ $7100	29,600	
6 " 12B " @ $5600	33,600	
10 DD air slushers	36,000	
40 Supply cars @ $1500	60,000	
2 Raise boring machines, 5'-7' raises	400,000	
1 Tunnel " " , 12'	500,000	
Major pumps, pump columns, etc.	300,000	
Gathering and auxiliary pumps	75,000	
UG electrical layout	1,000,000	
Mine lights, safety, fire equip. phones, etc.	100,000	$ 5,102,200

Shafts	$10,925,000	
Mine Surface Plant	3,550,000	
Underground Mine Equipment	5,102,200	
UG Work - Entry to Orebody	1,571,675	
Stope preparation - 4 levels	2,400,000	
		$23,548,875
Contrators Fee on $14,350,000 (10%)		1,435,000
Design & Eng. " $14,350,000 (5%)		717,500
		$25,701,375

Production and costs at the Magma mine for the past five years have been as follows.

	1968	1967	1966	1965	1964
Ore mined:					
Tons	333,607	219,510	431,913	439,911	377,575
% Copper	4.63	4.77	4.70	4.65	4.78
Payable metal content:					
Copper (tons)	14,706	9,551	19,631	19,452	17,064
Silver (ounces)	347,119	197,419	466,334	408,366	306,269
Gold (ounces)	7,263	4,970	12,802	12,748	11,078
Gross value per ton ore mined	$42.38	$45.37	$44.02	$38.48	$31.51
Operating cost,(1) per ton ore mined	$45.47	$54.01	$40.34	$35.50	$37.58
Other costs,(2) per ton ore mined	$ 0.43	$ 0.93	$ 0.48	$ 0.18	$ 0.18
of margin	-30%	-56%	+3.6%	+2.3%	-6%

(1) Including all operating costs, all Arizona taxes and federal social security taxes, but excluding depreciation and depletion. Includes strike expenses in 1968 and 1967.

(2) Includes depreciation, depletion and federal income taxes.

Operating costs have been high principally due to extensive timbering required to support the underground workings, high temperatures and humidity underground requiring expensive cooling facilities, long distances underground from existing shafts to the working areas, and to the obsolescence of much of the surface and underground facilities, and also in 1967 and 1968 costs were adversely affected by the eight months labor strike.

Extensive diamond drilling has developed additional replacement orebodies in beds lying stratigraphically above the areas presently being mined, and has increased the ore reserves to the highest tonnage in this mine's long history. As of December 31, 1968, total reserves at Superior were estimated at 10,100,000 tons of ore averaging 5.88% copper, before dilution.

The increased ore reserves have made feasible the commencement of an expansion program at Superior as described below.

Expansion Programs

As a result of the Kalamazoo acquisition, the Company has commenced a program to increase capacity at the San Manuel mine and plant from 40,000 to 60,000 tons of ore per day. This will require additional shaft sinking, mine development and plant expansion. Completion of the program is planned for 1971.

At Superior an expansion program also is underway to double the ore production there from 1,500 to 3,000 tons per day. The program includes an additional 4,800 foot mine ore shaft, a 9,100 foot tunnel on the 500 foot level, and modernization and expansion of the mine, mill and related facilities. The Superior smelter, however, will be abandoned, and the mill concentrates shipped to the expanded San Manuel smelter for smelting. Completion of the Superior expansion is scheduled for late 1972 with the production increase being gradual and fully accomplished two years after the program is completed.

Contracts for certain phases of the expansion programs at both mines have been negotiated. The cost of the two programs is expected to be in excess of $100,000,000. The amount and nature of such

SUPERIOR OPERATION
5 years -'64 thru '68

Data from Newmont Prospectus dated 3/28/69

	'64	'65	'66	'67	'68
Tons Mined (1000's)	377.6	439.9	431.9	219.5	333.6
% Cu	4.78	4.65	4.70	4.77	4.63
Lbs Cu Rec/t	90.4	88.4	90.9	87.02	88.16
Ozs Ag Rec/t	.811	.928	1.08	.899	1.04
Ozs Au Rec/t	.0293	.0289	.0296	.0226	.0218
Rec Value/ton	$31.51	$38.48	$44.02	$45.37	$42.38
Op Cost/ton	37.58	35.50	40.34	54.01	45.47
Ind Operating Margin/t	$6.07D	$2.98	$3.68	$8.64D	$3.09D
Deduced from above:					
Ind Tons/day -350 dy	1078	1257	1234	627	953
Av Selling price/lb Cu (includes Ag & Au Cr)	34.86¢	53.52¢	48.42¢	52.13¢	48.07¢
Value/t - Ag	$1.05	$1.20	$1.40	$1.39	$2.23
" " - Au	1.03	1.01	1.04	0.79	0.86
" " - Cu(by diff)	29.43	36.27	41.58	43.19	39.29
" " -Total	$31.51	$38.48	$44.02	$45.37	$42.38
Ind sales/lb Cu	32.55¢	41.03¢	45.74¢	49.63¢	44.57¢
E&MJ Domestic Price	31.96¢	35.02¢	36.17¢	38.23¢	41.85¢
Indicated price over domestic	+0.59¢	+6.01¢	+9.57¢	+11.40¢	+2.72¢

J. W. STILL
Consulting Mining Engineer
5213 N. ORACLE RD. 602 887-5341
TUCSON, ARIZONA 85704

December 14, 1970

RECEIVED
DEC 15 1970
S. W. U. S. EXPL. DIV.

Mr. William E. Saegart
American Smelting & Refining Co.
1150 North 7th Avenue
Tucson, Arizona

Dear Sir:

Attached hereto is the brief study on costs on the assumed large disseminated orebody.

For your information, I have attached hereto the latest prospectus costs on both Superior and San Manuel--these having been xeroxed from the NEWMONT prospectus dated 3/28/69.

On the San Manuel costs, you will note that the "operating cost" for 1968 was given as $3.72/ton. I would break this down (approximately) into the following items:

Mining	$1.87	
Milling	0.65	
Gen'l & Adm	0.38	
To concentrate	2.90	
F, S & R	0.82	(6.5¢/lb on 12.68 lbs rec)
Total Operating	$3.72	

They are doing a first-class job at San Manuel, with a ton per manshift efficiency (everyone in the mine department) of something over 30 t/MS. Obviously no new operation is going to get up to this efficiency until several years after the operation gets going. In this connection you will also find attached a sheet headed "SAN MANUEL OPERATION '56 thru '65" which shows that they sweat a little blood with unduly high costs for the first 4.5 years of the operation.

With all of the best,

Sincerely,

J. W. Still

P.S. The experience at Urad with Induced Caving and an air blast is in the Mining Congress Journal, October 1970, page 39.

it for future production. The Company has spent approximately $5,487,000 annually for the past five years in mine development expenditures. These expenses, together with costs capitalized in prior years with respect to shaft sinkings and attendant installations for the San Manuel orebody, are being charged to operating costs ratably as copper is produced from the ore developed and mined.

Sulphide ore reserves of the San Manuel mine as of December 31, 1968 are estimated, using an average 0.50% sulphide copper cut-off, to be 496,800,000 tons of 0.728% net sulphide copper, before dilution, of which 228,500,000 tons of 0.71% sulphide copper are above and can be mined from the second level. In addition, the estimated oxide ore reserves are 130,000,000 tons of 0.70% total copper (0.47% oxide copper), before dilution, all lying above the second level.

In March 1968, the Company purchased from Quintana Minerals, Ltd., under an agreement with that company and Newmont Mining Corporation, the Kalamazoo copper property adjoining the San Manuel mine in Arizona for $27,000,000 in cash and stock equivalent. Quintana received from Magma $15,000,000 in cash and 42,478 shares of Magma common stock, and from Newmont 78,208 shares of Newmont common stock and $4,800,000 in cash, and Newmont received from Magma 169,912 shares of Magma common stock. The Kalamazoo property is estimated to contain 565,000,000 tons of sulphide ore averaging 0.72% net sulphide copper, before dilution. This orebody is believed to be similar to the San Manuel orebody though lying at a considerably greater depth with the top of the orebody approximately 2,500 feet below the surface of the ground.

San Manuel's production and costs for the past five years have been as follows:

	1968	1967	1966	1965	1964
Ore mined:					
Tons	11,367,640	7,891,854	14,391,355	13,504,024	12,442,752
% Sulphide copper	0.701	0.758	0.772	0.773	0.828
Payable metal content:					
Copper (tons)	72,074	53,963	101,390	93,767	92,589
Molybdenum sulphide (tons)	2,298	2,001	3,544	2,863	2,486
Silver (ounces)	245,316	166,893	311,699	273,610	282,334
Gold (ounces)	14,303	10,534	22,396	21,550	20,746
Gross value per ton ore mined	$ 5.97	$ 6.18	$ 6.47	$ 5.66	$ 5.46
Operating costs(1) per ton ore mined	$ 3.72	$ 4.03	$ 3.33	$ 3.42	$ 3.39
All other costs(2) per ton ore mined	$ .85	$ 1.08	$ 1.26	$ .83	$ .69

(1) Including all operating costs, all Arizona taxes, federal social security taxes, and amortization of deferred development, but excluding depreciation, depletion and interest. Includes effect of strike expenses in 1968 and 1967.

(2) Includes depreciation, depletion, interest and federal income taxes.

The above results for the years 1967 and 1968 reflect the adverse effect of the prolonged labor strike already mentioned.

Superior Division

The Magma mine at Superior is an underground mine having replacement or bedded-type orebodies. It is provided with access, transportation and aircooling facilities required for current operations. The surface plant includes a concentrator, smelter and related auxiliary facilities.

Production and costs at the Magma mine for the past five years have been as follows.

	1968	1967	1966	1965	1964
Ore mined:					
Tons	333,607	219,510	431,913	439,911	377,575
% Copper	4.63	4.77	4.70	4.65	4.78
Payable metal content:					
Copper (tons)	14,706	9,551	19,631	19,452	17,064
Silver (ounces)	347,119	197,419	466,334	408,366	306,269
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Other costs,(2) per ton ore mined	$ 0.43	$ 0.93	$ 0.48	$ 0.18	$ 0.18

(1) Including all operating costs, all Arizona taxes and federal social security taxes, but excluding depreciation and depletion. Includes strike expenses in 1968 and 1967.

(2) Includes depreciation, depletion and federal income taxes.

Operating costs have been high principally due to extensive timbering required to support the underground workings, high temperatures and humidity underground requiring expensive cooling facilities, long distances underground from existing shafts to the working areas, and to the obsolescence of much of the surface and underground facilities, and also in 1967 and 1968 costs were adversely affected by the eight months labor strike.

Extensive diamond drilling has developed additional replacement orebodies in beds lying stratigraphically above the areas presently being mined, and has increased the ore reserves to the highest tonnage in this mine's long history. As of December 31, 1968, total reserves at Superior were estimated at 10,100,000 tons of ore averaging 5.88% copper, before dilution.

The increased ore reserves have made feasible the commencement of an expansion program at Superior as described below.

Expansion Programs

As a result of the Kalamazoo acquisition, the Company has commenced a program to increase capacity at the San Manuel mine and plant from 40,000 to 60,000 tons of ore per day. This will require additional shaft sinking, mine development and plant expansion. Completion of the program is planned for 1971.

At Superior an expansion program also is underway to double the ore production there from 1,500 to 3,000 tons per day. The program includes an additional 4,800 foot mine ore shaft, a 9,100 foot tunnel on the 500 foot level, and modernization and expansion of the mine, mill and related facilities. The Superior smelter, however, will be abandoned, and the mill concentrates shipped to the expanded San Manuel smelter for smelting. Completion of the Superior expansion is scheduled for late 1972 with the production increase being gradual and fully accomplished two years after the program is completed.

Contracts for certain phases of the expansion programs at both mines have been negotiated. The cost of the two programs is expected to be in excess of $100,000,000. The amount and nature of such

SAN MANUEL MINE OPERATION - 1956 thru 1965

Year	Pounds of Copper		Net/lb	Net $'s	E&MJ Cu Price	Indicated Cost/lb Cu	
1956	78,152,000	@	5.92¢	$4,626,598	41.82¢	35.90¢	
57	119,798,000	@	2.09¢D	- 2,503,778	29.58¢	31.67¢	
58	149,402,000	@	0.67¢	1,000,993	25.76¢	25.09¢	(1)
59	92,340,000	@	1.89¢D	- 1,745,226	31.18¢	33.07¢	(2)
60	163,448,000	@	5.05¢	8,254,124	32.05¢	27.00¢	
	603,140,000	@	1.60¢	$9,632,711	31.13¢	29.53¢	
1961	165,223,000	@	6.01¢	$9,929,902	29.92¢	23.91¢	
62	168,416,000	@	6.15¢	10,357,584	30.6 ¢	24.45¢	
63	177,072,000	@	5.93¢	10,500,369	30.6 ¢	24.67¢	
64	185,177,000	@	11.88¢	21,999,028	31.96¢	20.08¢	
65	187,534,000	@	10.08¢	18,903,427	35.02¢	24.94¢	(3)
	883,422,000	@	8.11¢	$71,690,000	31.70¢	23.59¢	

Notes: (1) During this year some part of the production was sold on the loan floor price, which was greater than the 25.76¢ E&MJ price shown. If exact data were known on these sales, this would up the indicated cost.

(2) Operation was down part of year - on strike.

(3) This was first year any federal income tax was paid.

From the above data, it would appear that it took to the end of 1960 to shake the operation down and get up to plant capacity.

Also from the above data, the costs/lb of copper during the shake-down period ('56 thru '60) were about 6¢ per pound higher than were had when the operation was running smoothly from '61 thru '65.

The table above was worked up from such data as were available. A Newmont prospectus, dated 4/13/62, gave San Manuel costs and other data for the years '57 thru '61. For the years '62 thru '65, the Magma Copper Annual Report was used. The above data are not intended to be microscopically accurate, but in my opinion are a close approximation.

J. W. STILL
Consulting Mining Engineer
5213 N. ORACLE RD. 602 887-5341
TUCSON, ARIZONA 85704

December 12, 1970

RECEIVED
DEC 15 1970
S. W. U. S. EXPL. DIV.

Mr. William E. Saegart
American Smelting & Refining Co.
1150 North 7th Avenue
Tucson, Arizona

Dear Sir:

INTRODUCTION

Pursuant to your request, the following brief study was made on an assumed orebody to estimate the probable capital and operating costs. Attached, as Appendix "A", is a copy of the sketch you furnished me that shows the assumed depths and lay of this orebody. It is further assumed that it will have an ore reserve of 400,000,000 tons at a grade of 1.25% copper, and that it will be mined by block caving.

The shallow location assumption is that the top of the ore will lie 2000 feet below surface, with a vertical thickness of ore varying from 450 to 250 feet. Immediately overlying the ore will be some 600 feet of capping and conglomerate, which it is assumed will cave as readily as the ore. Overlying the conglomerate and extending to surface will be about 1400 feet of dacite which, it is assumed, will be difficult to cave.

The second assumption is that the ore bed will be of about the same thickness, but that it will lie some 2500 feet deeper, or some 4500 feet from the surface to the top of the ore. The material overlying the ore will be the same as noted in the preceding paragraph.

It is further assumed that the proposed operation would be at the rate of 40,000 tons/day, or on a 350-day year, 14,000,000 tons/yr - with an operation life of about ~~28.5~~ 31 years. (440,000,000 tons after dilution)

ESTIMATED CAPITAL & OPERATING COSTS

The detail on the basis of these costs will be found in the body of this report. In summary, the items estimated follow:

On shallow ore (top of ore 2000' below surface)

Mine capital costs, estimated	$50,914,735
Mine operating costs, estimated	$2.00 to $2.15/ton

On deep ore (top of ore 4500' below surface)

Mine capital costs, estimated	$76,045,485
Mine operating costs, estimated	$2.15 to $2.30/ton

PERTINENT FACTORS

On an operation of this size, some six years or so would be required to bring the mine to production. During the first 2- to 3-year period, I am assuming that two development shafts will be sunk, one outside a 45-degree crack line and the other (which will ultimately be lost) inside the orebody. During this time and working thru these two shafts, the orebody will be sufficiently explored (drifting and diamond drilling on any two levels) to ascertain the orebody stoping limits and establish the location of the ultimate mining sills or undercut levels. With this information in hand, a mining plan can be fitted to the orebody. Large samples for metallurgical testing will also be available from this work. Then over the next three years, the final production and service shafts can be finished, entries from these shafts driven into the orebody and the stope preparation work done.

The stop preparation costs are made up to cover 150' square stopes, with the undercut 25' above the draw or grizzly level and the haulage level 100' below this draw level. The draw lines are 37.5' apart and each draw line has 9 pair of draw raises, these draw points being spaced on the undercut level 18.75' x 16.67'. Each stope would require 4 four-branch and 4 five-branch transfer raises. This follows the old Miami underground pattern. It is assumed that both the fringes and draw lines would be concreted. The tally on this work for one stope is as follows:

Haulage lines, 180' @ $125/ft	$ 22,500
Pony sets & chutes 4 @ $1000	4,000
Transfer raises 8 - 1820' @ $32.50	59,150
Griz dfts, concrete, 720' @ $205	147,600
Griz fringes, " 180' @ $205	36,900
Draw raises, 1584' @ $10	15,840
Undercut, 22,500 sq ft @ $2.77	62,250
Total	$348,240

At a 300' head of ore,
one stope = 540,000 tons + 10% overdraw = 594,000 t or 58.6¢/ton

At a 400' head of ore,
one stope = 720,000 tons + 10% overdraw = 792,000 t or 43.9¢/ton

At a 500' head of ore,
one stope = 900,000 tons + 10% overdraw = 990,000 t or 35.2¢/ton

Assuming a draw of 15" of rock in place vertically per day in the stopes, each stope would produce 2250 tons. On a 40,000 t/d demand this means some 17.8 stopes in production. At the time 40,000 t/d production had been reached, considerable haulage and grizzly level fringes and transfer raise work on the next stopes coming up will have been done. To cover all this up to the start of production, I have estimated the "stope preparation" costs for 23.5 stopes.

I am assuming that the shafts and shaft facilities work will be done under contract, with the company taking over at the completion of the shafts and shaft stations.

In a block caving operation, all permanent structures (shafts, mine plant shops, etc.) must be placed outside the 45-degree crack line, that will ultimately result from the deepest ore caved. On the shallow ore assumption, with the bottom of the ore at a depth of 2450 feet, this means that the entries from the shafts to the orebody will be about 2600 feet in length. I would assume that with a gently dipping ore bottom, that two lifts would serve. This, assuming load and return lines on both haulage levels and two service entries, would total - for this entry work- 5200 feet of service drifts and 10,400 feet of haulage to get to the edge of the orebody.

On the deeper ore, this same factor would place the shaft some 5100 feet away from the edge of the orebody, and on the same two lift assumption, require 10,200 feet of service drifts and 20,400 feet of haulage drifting.

Obviously the shafts would be deeper for this deeper ore, the five shafts for this deeper ore totaling some 25,200 feet as against the 12,700 feet for the more shallow ore.

The mine capital costs I have estimated on the shallow ore are tabulated as follows - and a more detailed list will be found in Appendix "B" attached hereto.

Shafts (5)	$15,816,000	
Mine Surface plant	7,587,425	
UG Mine equipment	13,123,670	
" Work: expl. drifts & D Drill	1,560,000	
entries to orebody (2 lifts)	1,794,000	
stope preparation	8,183,640*	
		$48,064,735
Contractors' fees (10% on $19,000,000)		1,900,000
Design & Engineering (5% on $19,000,000)		950,000
Total Capital Cost		$50,914,735

*This item is actually a deferred mining cost - and not properly capital - but the money will be required.

The operating costs on this shallow ore would, I would estimate, run from $2.00 to $2.15/ton. The main factor that influences this cost is the tons/manshift efficiency. This figure assumes about a 27 tons/MS factor and average mine department manshift costs @ $40/MS. This also assumes an average vertical head of ore at about 400 feet. In a new underground operation of this size gathering an experienced crew of the various foremen and bosses will be difficult and it may take 3 to 5 years to shake the operation down to an efficient cost.

For the deeper ore, more shaft work will be necessary as well as larger hoists, more ventilation, cooling and pumping equipment. The total estimated capital costs on this being as follows:

Shafts (5)	$33,745,000	
Mine Surface plant	8,287,425	
Mine equipment	15,133,670	
UG Work: expl. drfts & D Drill	1,560,000	
entries to orebody	3,519,000	
stope preparation	8,183,640*	
		$70,428,735
Contractors' fees (10% on $37,445,000)		3,744,500
Design & Engineering (5% on $37,445,000		1,872,250
Total Capital Cost		$76,045,485

*This item similar to that noted above.

The operating costs on the deeper ore will be somewhat more expensive, and I would estimate this cost at from $2.15 to $2.30 per ton. The greater depth will require more ventilation and cooling, may make considerable more water, and will increase the hoisting cost slightly.

General Comments

In converting from in-place grade to mineable, block caving experience shows a 110% tonnage extraction (this dilution factor being inherent in the mining scheme) and an 89% to 91% grade extraction. On the 1.25% assumed in-place grade, this would mean 10% more tonnage and a grade reduction to about 1.13%.

As you are aware, this is a rather brief study - as you requested - and should be considered on a "general order of magnitude" basis. Obviously I have had to make numerous assumptions which may well be changed in the future as some mining techniques change. For example, large and efficient machines may be available to drill the size of shafts needed, as well as similar machines to do the major rather long drifts from the shafts to the orebody. In any event, for the present purpose, I feel that the estimates used are reasonably realistic.

The major problems on this hypothetical orebody is the cavability of the thick layer of dacite overlying the ore. While this will be likely to eventually cave when sufficient area is opened below it, the possible air blast hazard poses a large question mark. The thickness assumed on this dacite (1400 to 2400 feet) rubs out costwise any type of induced caving. Drilled 4' to 5' uncased holes, thru which dry fill could be passed and which would act as vents to surface in the event of a small air blast might be a solution to the problem. This might be thought at first glance to be too expensive, but if the hoped-for orebody drills out at 1.25% grade, costs on this dacite problem would not be too great a burden.

I trust the above will cover the data you desired. If you have any questions, I would appreciate your so advising me.

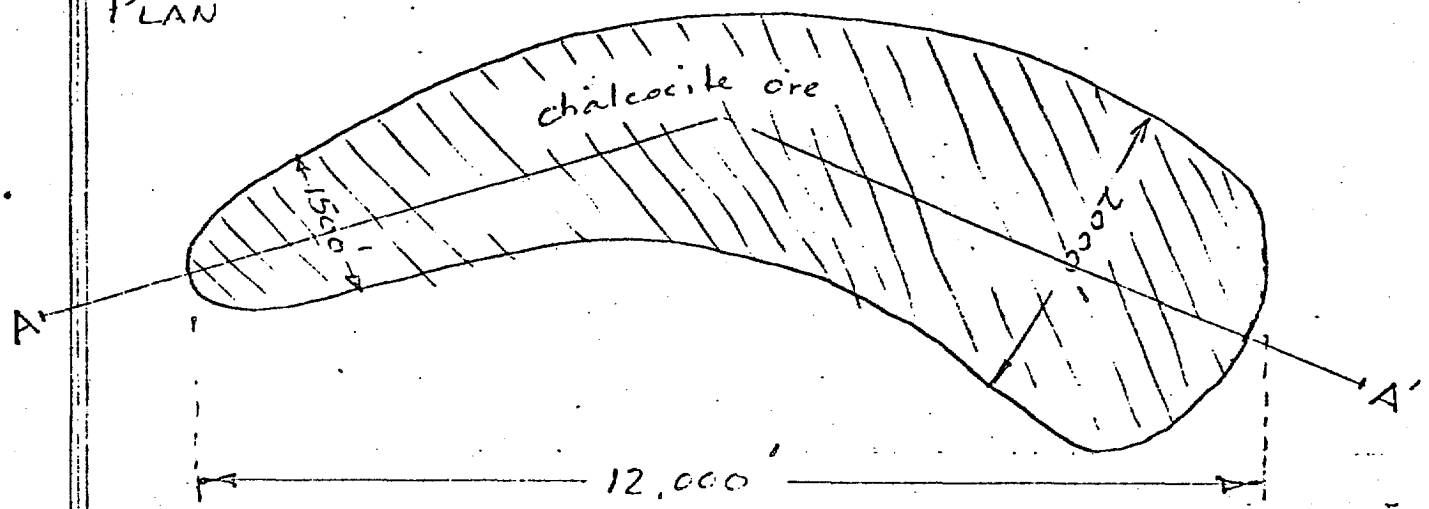
J. W. Still - Mining Engineer
Tucson, Arizona 12/12/70

JWS:h

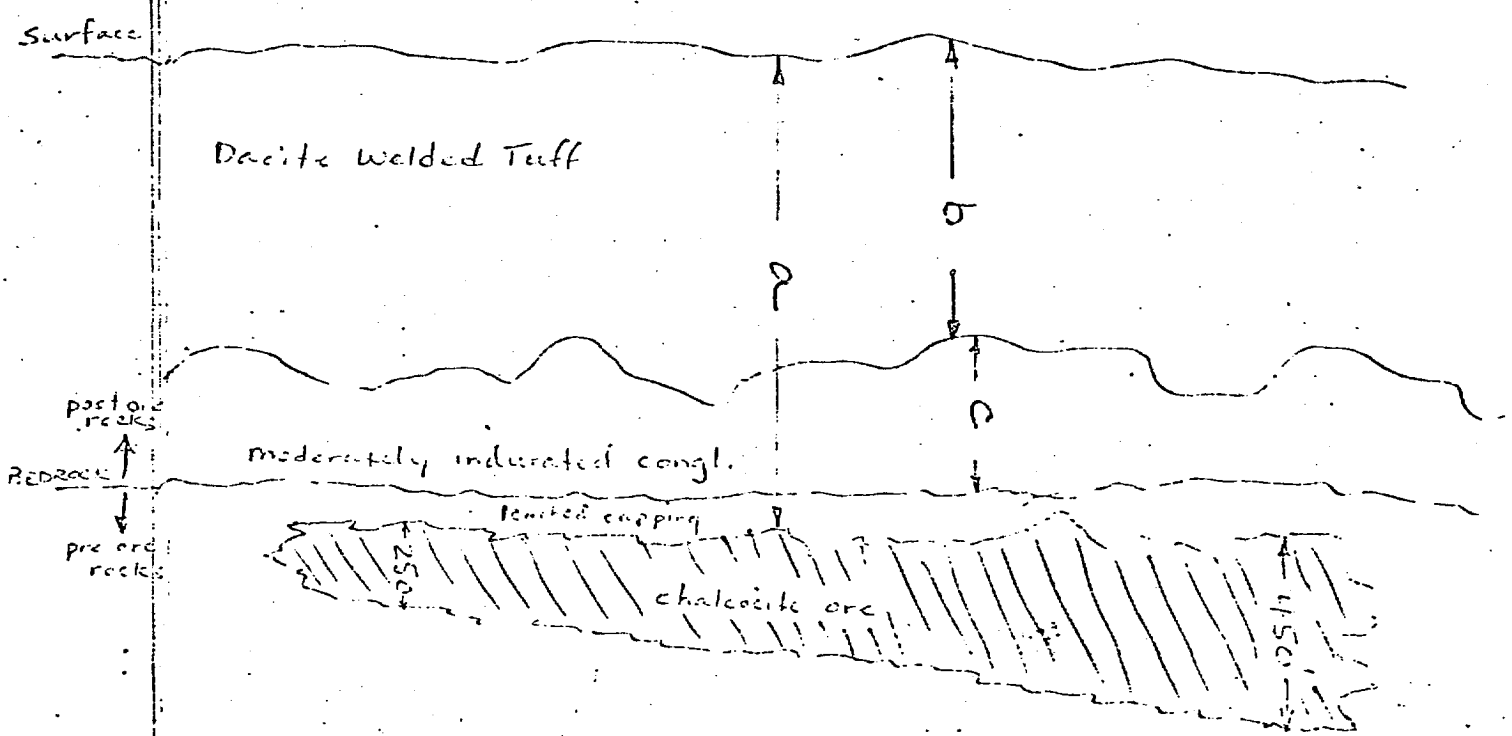
Hypothetical chalcocite enriched Por. Cu Deposit # 1

Assume: 400,000,000 tons @ 1.25 % Cu

PLAN



Section A-A'



	Case I	Case II
a	2000'	4500'
b	1400'	2400'
c	500'	2000'

ESTIMATED CAPITAL COSTS

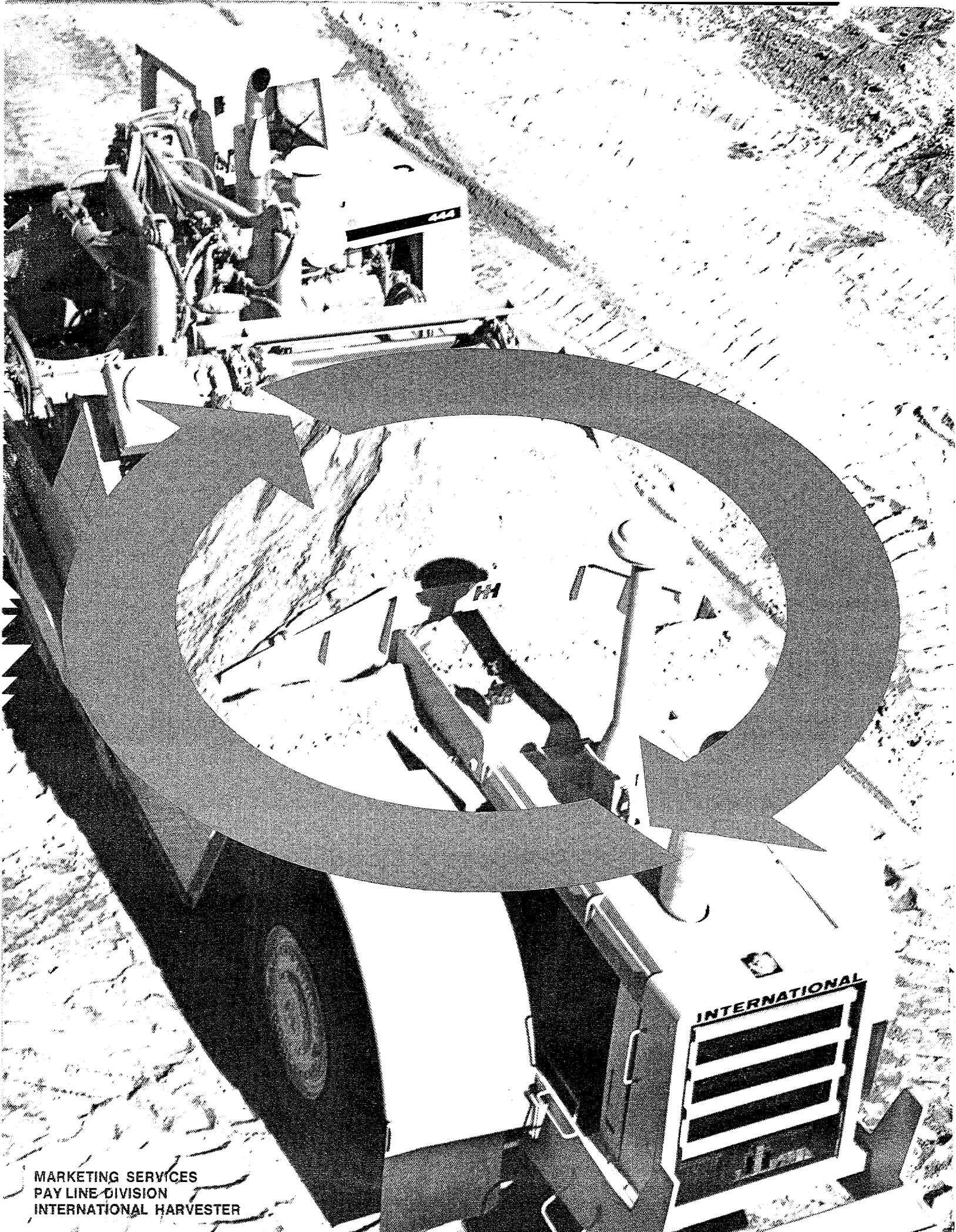
	Shallow Ore	Deep Ore
Shafts		
Development shafts (2) 5000' @ $ 874	$ 4,370,000	
(2) 10000' @ $1173		$11,730,000
" " , Stations, etc	750,000	750,000
Service Shaft (1) 2500' @ $1040	$ 2,990,000	
(1) 5000' @ $1180		5,900,000
" " , Stations, etc	450,000	450,000
Hoisting Shafts (2) 5200' @ $1203	$ 6,256,000	
" " (2) 10200' @ $1364		13,915,000
" " , Stations, etc.	1,000,000	1,000,000
Total Shafts	$15,816,000	$33,745,000
Mine Surface Plant		
Site Preparation	$ 150,000	same
Hoist, headframe, bins, Dev Shafts	400,000	$ 500,000
" " " Ser "	250,000	350,000
" " " Pro "	2,700,000	3,200,000
3 hoist houses	300,000	same
Compressors, 5 3500 cfm	850,000	"
2 1600 cfm	124,000	"
Compressor house, cooling towers, etc.	150,000	"
Service shops, whse, shop tools, etc.	500,000	"
Change room & mine office	250,000	"
Mine surface power layout	550,000	"
5 25 ton skips	172,000	"
3 4 ton skips	18,975	"
3 man & supply cages	72,450	"
Power & water development	1,000,000	"
	$ 7,587,425	$ 8,287,425
Underground Mine Equipment		
18 30 ton trolley locomotives	$ 1,283,400	same
200 320 cu ft cars	1,380,000	"
3 track cleaning machines	86,250	"
Block signal, radio phones, etc.	55,000	"
2 sets rotary car dumps	230,000	"
Permanent track & trolley inst.	655,000	"
Ventilation equipment, main & aux.	160,000	$ 320,00
Air colling equipment	1,250,000	2,500,000
UG electrical layout	2,450,000	same
50 Jaclegs outfits	91,500	"
50 Stoper "	90,000	"
15 Jumbo outfits	825,000	"
40 Jackhammers	13,500	"
16 40 H Eimco loaders	348,800	"
8 630 " "	101,200	"
8 24 " "	65,600	"

	Shallow Ore	Deep Ore
16 GD air slusher outfits	$ 54,400	same
30 10 ton battery motors, chargers, etc.	1,552,500	"
96 200 cu ft dev cars	397,920	"
8 man cars	59,600	"
120 supply cars	330,000	"
Concrete form jumbos	69,000	"
" forms	600,000	"
" placers	125,000	"
Major pumps, pump columns, etc.	600,000	$ 1,200,000
Gathering and auxiliary pumps	100,000	same
Mine lights, safety and fire equipment, etc.	150,000	"
Total Underground Mine Equipment	$13,123,670	$15,133,670

WLK

EARTHMOVING PRINCIPLES:

A GUIDE TO PRODUCTION AND COST ESTIMATING



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EARTHMOVING PRINCIPLES

Profitable earthmoving is consistently achieved by those who are willing to work at it. The amount of profit generally depends on how well you estimate the job in question. Accurate estimating, in turn, calls for close calculations of earthmoving production and its related costs. Before discussing production figures and specific costs, let's take a moment to define just what we'll be talking about. There are two major factors to consider: Material Carried and Cycles per Hour.

Imagine that you are planting a tree in your back yard. You decide to use excess dirt from the hole to fill in a low spot along the fence. You start to dig, noting that each shovel full contains about one cubic foot of earth. It takes you 30 seconds to dig, carry, dump your shovel and return for another load. That's two loads per minute, or 120 loads per hour. If you work a full hour, you move 1 cubic foot x 120 cycles or 120 cubic feet per hour.

Earthmoving projects basically involve the same principle. Your shovel may become a scraper, with a capacity measured in cubic yards, not feet. And the haul distance is considerably longer, so time is measured in minutes instead of seconds. Now you carry 22 cubic yards on a 3-minute haul-and-return cycle. That's 20 loads in 60 minutes (60 ÷ 3). So your production is 20 loads x 22 yards, or 440 cubic yards per hour.

Or maybe you have a bulldozer that could do the job just as well, in which case you might move 10 cubic yards on a 1.5-minute cycle, or 400 yards per hour. How did we come up with 400 yards? Exactly the same way we figured the other jobs. Your dozer has a blade capacity of 10 cubic yards, and it covers the shuttle in 1.5 minutes. That's 40 cycles per hour x 10 yards per cycle, or 440 cubic yards per hour.

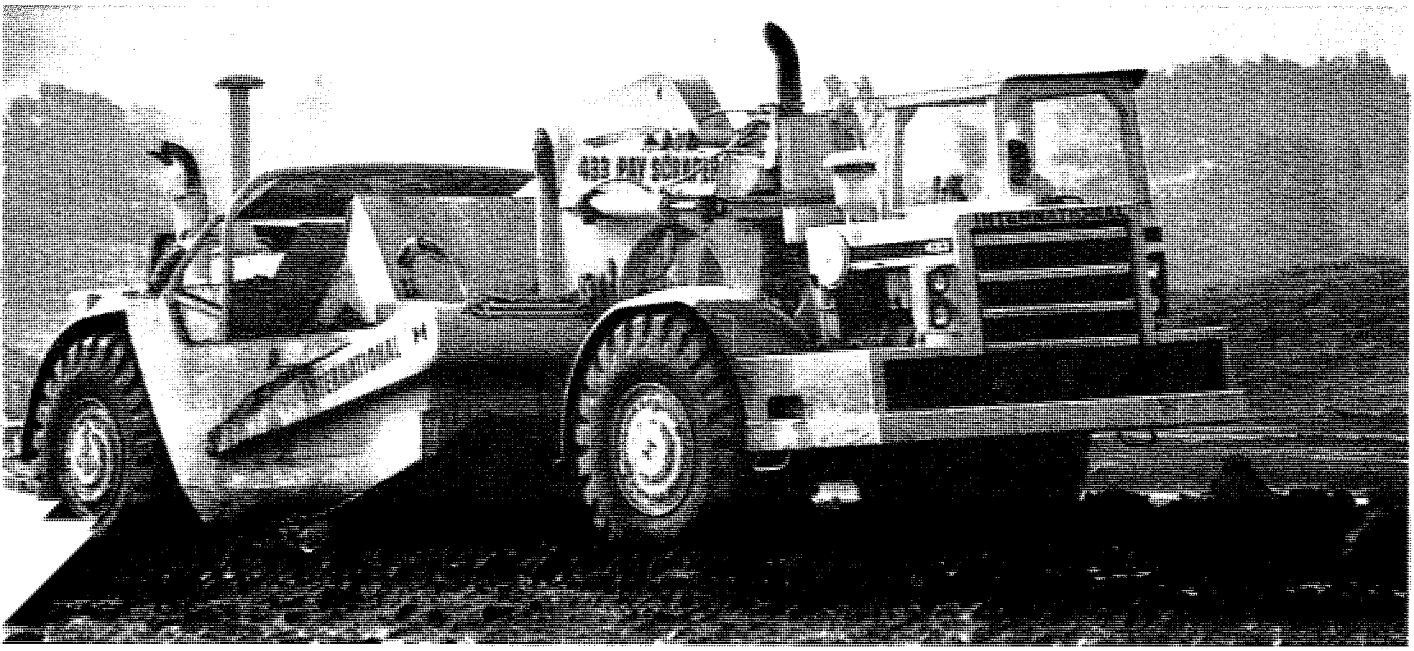
Obviously, there's more to it than that. Many factors that influence capacity and time will be considered as your estimate develops. But remember, every time you figure earthmoving production for a specific project, your calculations will be based on this simple proposition. . . .

Material Carried × Cycles per Hour

This book is not intended to make you an instant expert in the business of earthmoving. Rather, it will give you the general knowledge and basic skills necessary to accurately estimate machine performance, production capability, and the cost-per-hour of that production.

With a basic understanding of earthmoving principles, you will be able to analyze equipment application, and thereby maximize equipment efficiency in earthmoving operations.

It should be understood that a guarantee is neither made nor implied that the production and cost figures cited herein will be matched in actual instances.



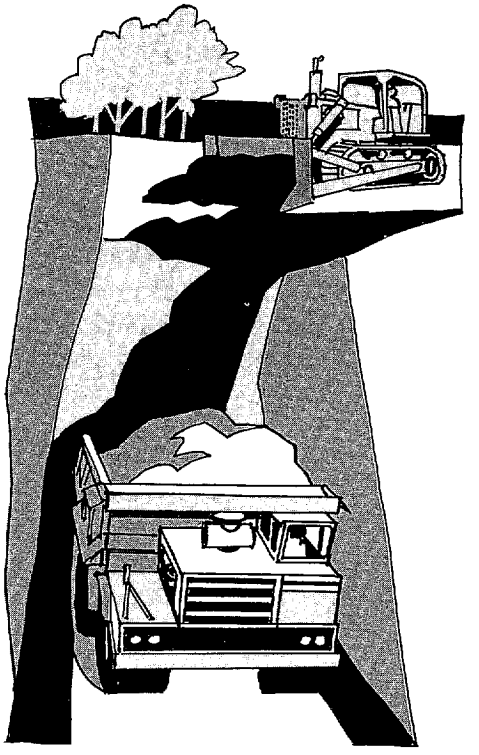
EQUIPMENT AND CONDITIONS

Many different sizes and types of equipment have been developed to maximize earthmoving efficiency. The open bowl, push-loaded scraper, for example, is a high volume producer under many common earthmoving conditions. Modification of conditions signals a corresponding modification of machines, with more specialized scrapers taking preference, such as elevating or dual powered models.

Or maybe greater efficiency could be achieved with top loaded machines. Here again, the various models are designed to match conditions, with rear dump or bottom dump haulers to consider, as well as a variety of loading methods. Crawler tractors, too, offer a model to match the job, and every one has a long list of dozer blades and auxiliary attachments from which to choose. Faced with such an array of big-ticket items, it is often difficult to decide what type of equipment to use — or with an existing fleet, what kind of performance to expect.

For this reason it is absolutely essential to thoroughly investigate prospective job conditions and material characteristics. Considerations should include total volume, type of material, its loadability and weight, the distance to move, characteristics of the haul road, and auxiliary equipment needs. Find out how much time you have to complete the job, with an eye to those factors that may affect your earthmoving schedule, such as altitude, climate and temperature.

When you have established a certain understanding and familiarity with equipment and conditons, you are ready to consider the production that can be expected from each machine in a specific earthmoving situation.



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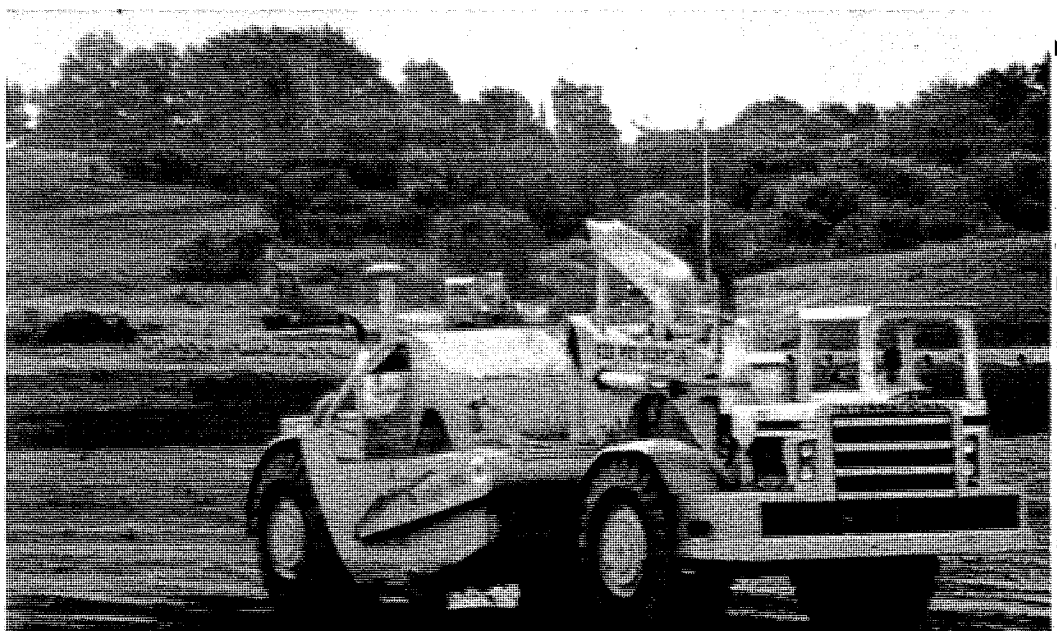

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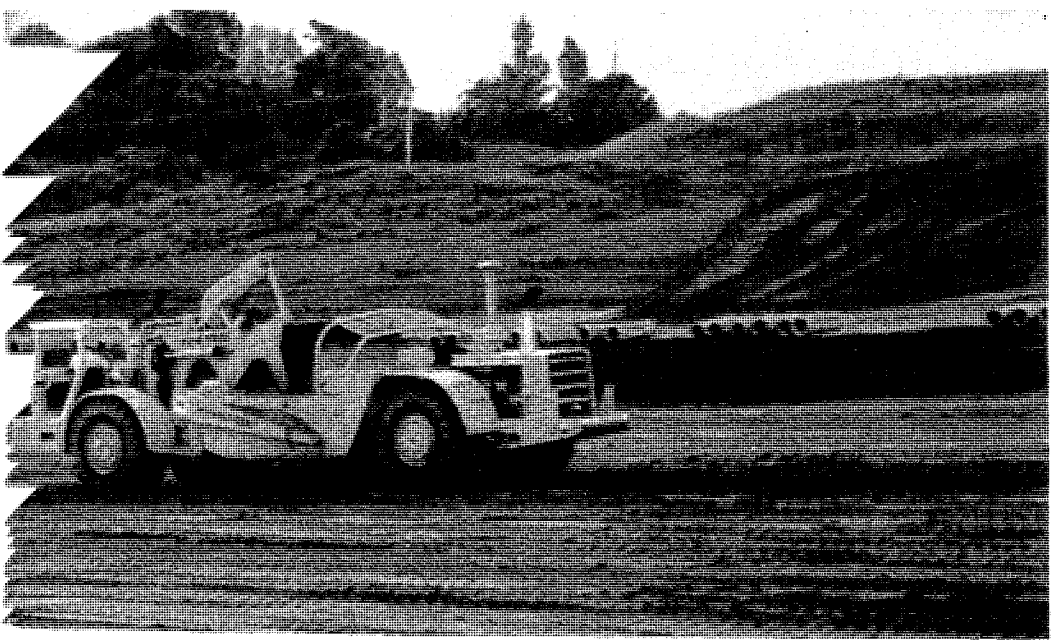


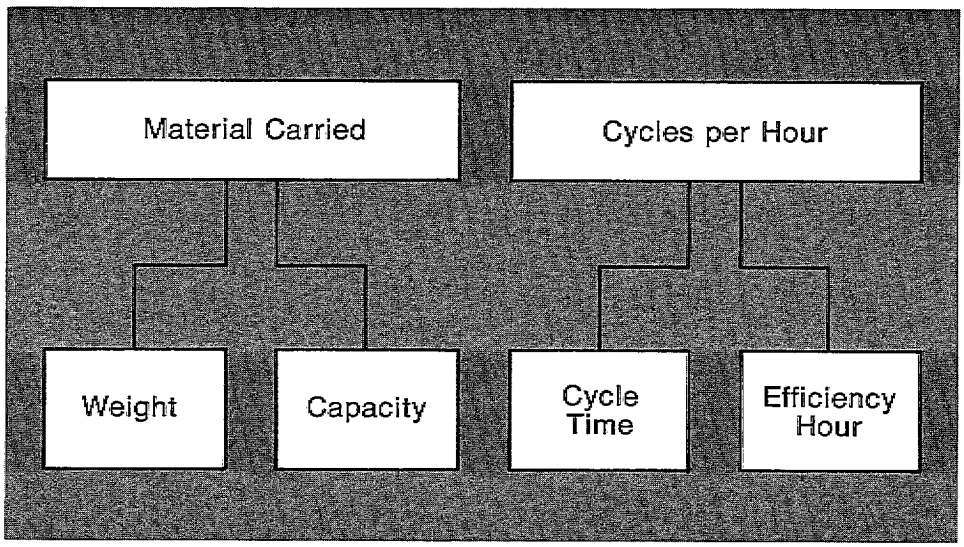
BASIC FACTORS IN ESTIMATING PRODUCTION

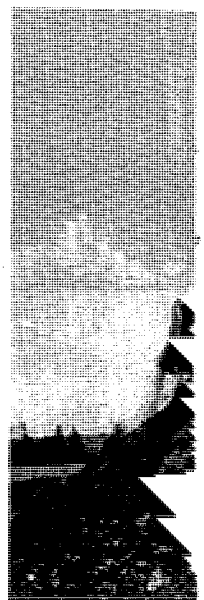
There is nothing difficult or mysterious about estimating the production of earthmoving equipment. It's simply a matter of logic and a little arithmetic. Two separate job parameters are analyzed and defined to represent capacity and time. Or yards and minutes. Or loads and cycles. Perhaps the best way to say it, as already noted, is . . .

Production = Material Carried x Cycles per Hour

To find out how much material is being carried, Material Weight and Machine Capacity must be considered.

To determine how many cycles per hour can be made, Cycle Time and the Efficiency Hour must be considered.





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WEIGHTS AND MATERIALS

Material can be measured in In-Bank Cubic Yards (BCY), Loose Cubic Yards (LCY) and Tons. The difference between BCY and LCY is important because most materials reveal a considerable difference in volume once they have been disturbed or moved from their original state.

A cubic yard of wet clay in its natural, or in-bank state weighs approximately 3,000 pounds. When loaded into a scraper bowl or loader bucket, the same 3,000-lb load swells to occupy 1-1/3 cubic yards. This occurs because the cutting edge breaks up and loosens the material, creating air voids. It's easy to see how this difference will affect production on a job involving large volumes.

Table I shows the weight/volume difference between BCY and LCY for a variety of materials. The number in the second column represents the Swell Factor (SF) and the next column gives the In-Bank Correction Factor (IBCF). These are used to convert bank measurement to loose measurement and vice-versa, by merely multiplying the appropriate factor and the cubic yard figure.

Weight Conversions

Bank Weights (lbs/BCY) x In-Bank Correction Factor (IBCF) = Loose Weight (lbs/LCY)

Loose Weight (lbs/LCY) x Swell Factor (SF) = Bank Weight (lbs/BCY)

Volume Conversions

Bank Cubic Yards (BCY) x Swell Factor (SF) = Loose Cubic Yards (LCY)

Loose Cubic Yards (LCY) x In-Bank Correction Factor (IBCF) = Bank Cubic Yards (BCY)

Most jobs are bid according to the BCY measurement. All earthmoving machines, however, are rated in LCY. Keep in mind that a conversion will be necessary so that final production can be stated in bank cubic yards (BCY).

Certain jobs figure production in tonnage or tons per hour (TPH), and that calls for another conversion. This is a matter of simple arithmetic. You can convert cubic yard production to tons per hour (TPH) by dividing the material weight by 2,000 (pounds per ton). For example, if you are working in material that weighs 3,000 pounds per BCY, you know that each bank cubic yard equals 3,000 ÷ 2,000, or 1.5 tons. First, however, we must determine LCY production, and that brings us back to the basic factors in estimating.

Material Carried x Cycles Per Hour

NOTE: In order to have an accurate estimate always be sure to keep your bank and loose weights consistent.

EXAMPLE:

An elevating scraper with a heaped capacity of 22 cu yds is loading dry earth. From Table I we see that the bank weight and the in-bank correction factor for dry earth are 2,700 lbs/BCY and 0.8 respectively. To find the actual payload in lbs that the machine will be carrying, use the formula . . .

Bank Weight × IBCF = Loose Weight

Loose weight of dry earth is (2,700 × 0.8) 2,160 lbs/LCY.

The actual payload, therefore, is . . .

Heaped Capacity × Loose Weight

Or in this case (22 LCY × 2,160 lbs/LCY) 47,520 lbs.

If the total job consists of 100,000 BCY, how many loose cubic yards are to be moved? The table reveals a Swell Factor (SF) of 1.25 for this material. Our formula becomes . . .

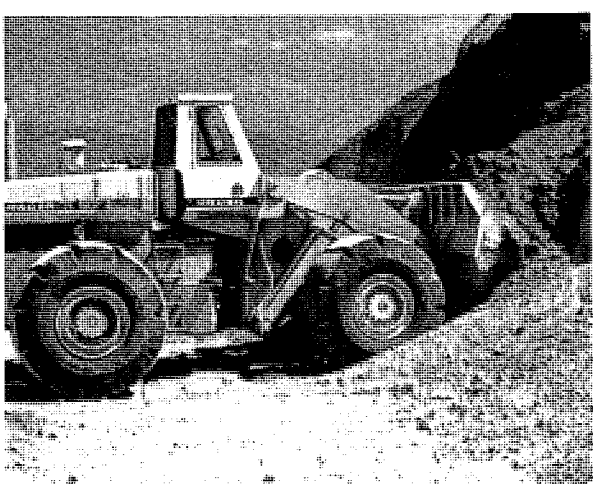
Bank Cubic Yards (BCY) × Swell Factor (SF) = Loose Cubic Yards (LCY)

So . . .

100,000 BCY × 1.25 or 125,000 LCY must be moved.

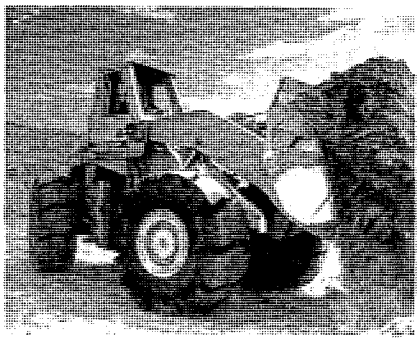
TABLE I

Material	Bank Unit Weight lbs/BCY	Swell Factor SF	In-Bank Correction Factor IBCF	Slope in Repose
Ashes (hard coal)	700-1000	1.08	0.93	2.0:1
Ashes (soft coal)	1080-1215	1.08	0.93	3.0:1
Bauxite	2700-4325	1.33	0.75	1.0:1
Clay, Dry	2300	1.18	0.85	2.0:1
Clay, Light	2800	1.25	0.80	2.0:1
Clay, Wet	3000	1.33	0.75	1.0:1
Coal, Anthracite	2450	1.35	0.74	1.2:1
Coal, Bituminous	2000	1.35	0.74	1.2:1
Coal, Steam (compacted)	1890	1.39	0.72	1.2:1
Copper Ore	3800	1.35	0.74	1.0:1
Earth, Dry	2700	1.25	0.80	2.0:1
Earth, Moist	3000	1.25	0.80	1.0:1
Earth, Wet	3370	1.18	0.85	2.0:1
Earth, with sand and gravel	3100	1.11	0.90	2.0:1
Gypsum	4300	1.75	0.57	—
Gravel, Dry	3250	1.12	0.89	2.0:1
Gravel, Wet	3600	1.14	0.88	2.0:1
Granite	4600	1.49-1.79	0.67-0.56	1.0:1
Iron Ore, Hematite	6500-8700	2.22	0.45	1.0:1
Limestone, Blasted	4200	1.67-1.75	0.60-0.57	2.0:1
Loam	2700	1.22	0.83	2.0:1
Mud, Dry	2160-2970	1.22	0.83	1.0:1
Mud, moderately packed	2970-3510	1.22	0.83	1.0:1
Rock & Stone, crushed	3240-3920	1.35	0.74	2.0:1
Sand, Dry	3050	1.12	0.89	3.0:1
Sand, Wet	3500	1.15	0.87	2.0:1
Shale, Soft Rock	3000	1.68	0.60	1.0:1
Slate	4590-4860	1.68	0.60	1.0:1
Trap Rock	5075	1.64	0.61	1.0:1



CAPACITY OF MACHINES

The heaped capacity of earthmoving equipment is rated in loose cubic yards, or tons, or both, and is usually given as an SAE figure in the specification sheets. SAE standard heaped capacities, as shown on the spec sheets, are based on a 1:1 slope in repose of the loaded material for scrapers, and a 2:1 slope for hauler bodies and loader buckets. Slope in repose simply refers to the angle, or the slope at which a given material will heap.



Notice that both heaped and struck capacities are listed in the specification sheets. The struck capacity is simply the amount of material measured straight across the top of the bowl, bucket or body. Imagine a truck body filled to the rails with water,

the load flat across the top. A heaped load, of course, rises above the rails.

The Society of Automotive Engineers has developed standard methods for rating power and capacities. These methods are used throughout the industry, thereby creating a consistency in ratings.

There are no SAE approved ratings for dozer blades, so capacity must be determined by formulas supplied by the manufacturers. To calculate blade capacities for International dozers, use the formulas shown here.

Semi "U" Bulldozer $C = \frac{H^2W}{52{,}500}$

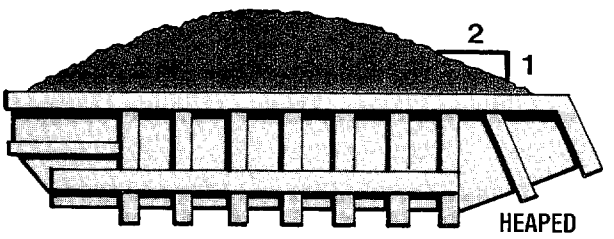
Straight Bulldozer $C = \frac{H^2W}{57{,}800}$

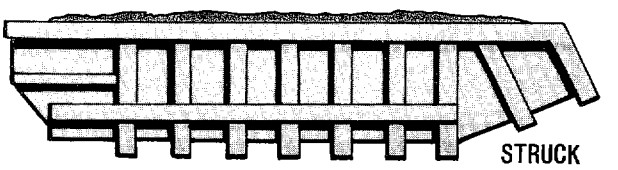
Angling Bullgrader $C = \frac{H^2W}{44{,}900}$

Full "U" Bulldozer $C = \frac{H^2W}{49{,}400}$

"H" represents the height of the blade, "W" is the overall width of the blade, 52500, 57800, 44900, and 49400 are constants developed through test data.
For example, a semi-U blade that is 57.7 inches high and 158.8 inches wide would have a capacity of . . .

$$\frac{57.7^2 \times 158.5}{52{,}500} = 10.1 \text{ cubic yards}$$





EXAMPLE:
Actual capacity of the machine in pounds may vary, due to different weights of materials. To find the payload in pounds, simply multiply cubic yard capacity of the machine by the loose weight of the material. Loose weight is found as follows . . .
Bank Weight x IBCF = Loose Weight
Then . . . Heaped Capacity x Loose Weight = Payload as demonstrated in the example on Page 10.

EXAMPLE:
A front-end loader with a 6½ yd bucket is loading poorly blasted limestone into a hopper. What is the actual load obtained per pass?
The factor for poorly blasted material is 0.65, so the actual payload would be . . .

SAE capacity x Load factor

6.5 cu yd x 0.65 = 4.2 cu yd

Rated bucket capacities for front-end loaders are listed in the specification sheets. In many cases, however, the machine will not be able to obtain rated heaped capacity, because the actual payload is affected by loading characteristics of the material. To accommodate the variety of characteristics encountered, and to help you determine the actual load per cycle, apply the appropriate factor in Table II.

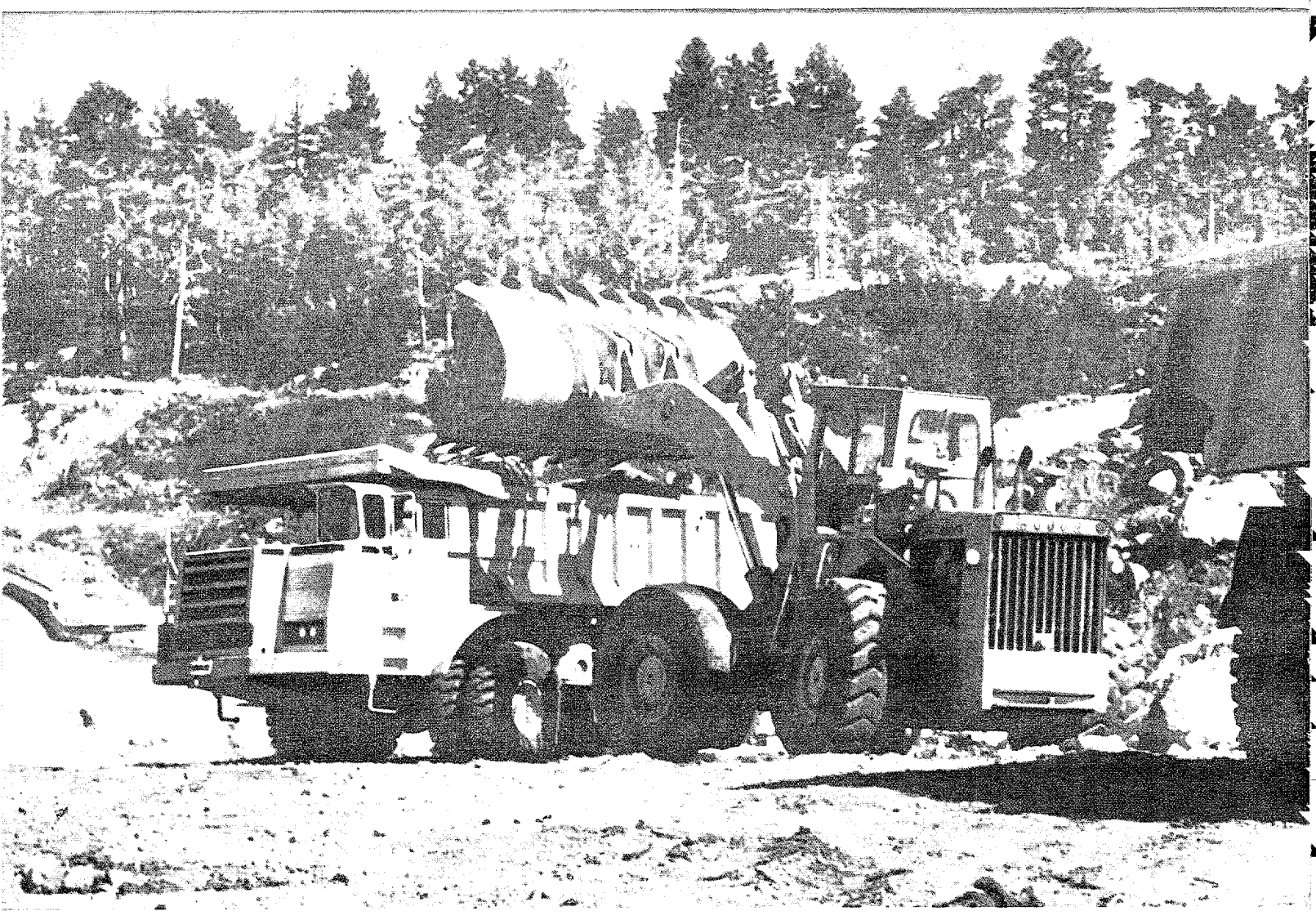
TABLE II

Front-end Loader Bucket Capacity Factors

Material	Factor
Fine, uniform	0.95-1.0
Medium, coarse	0.90
Well blasted	0.85
Medium blasted	0.80
Poorly blasted	0.65

CYCLE TIME

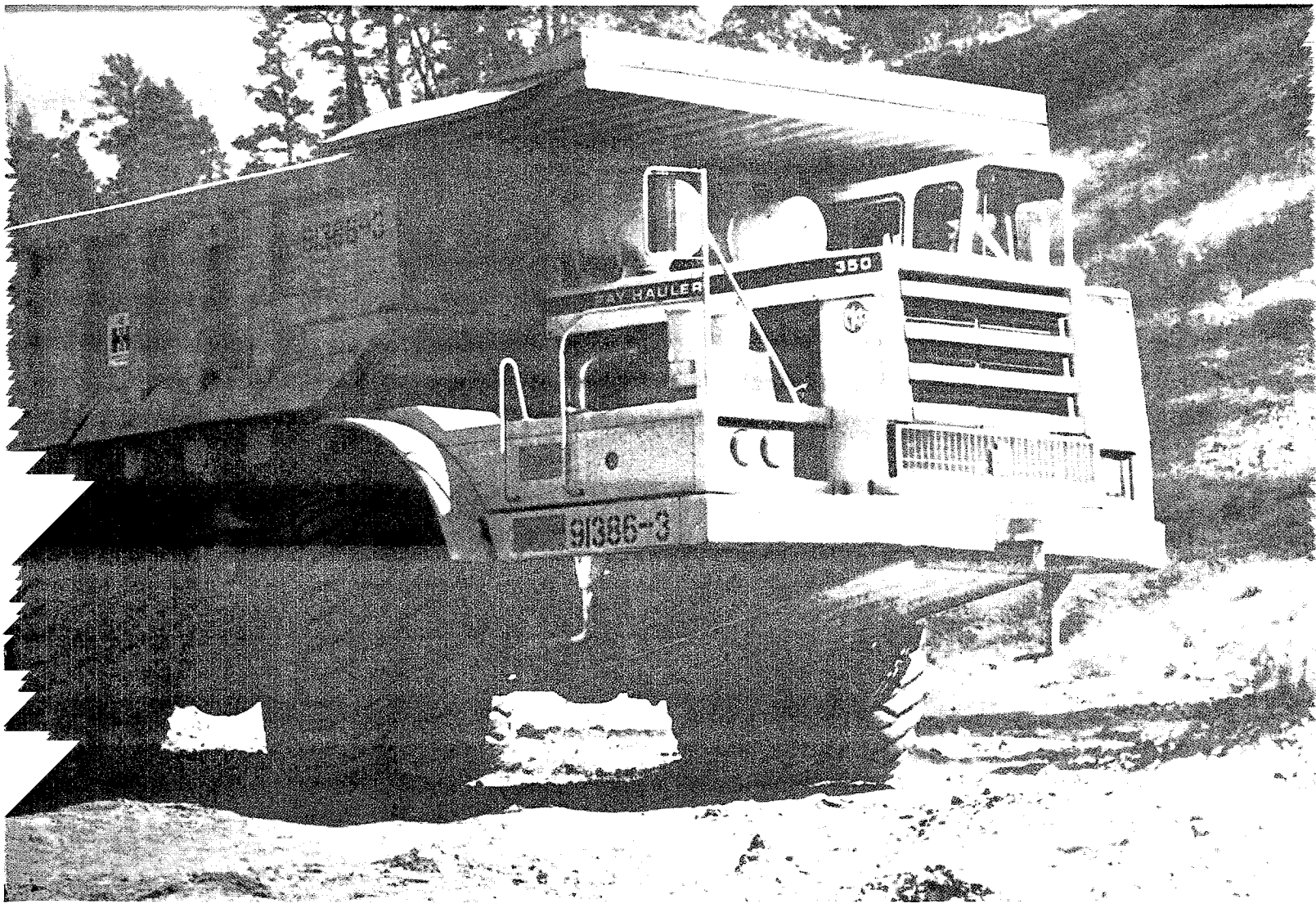
When material is moved from one location to another—load, haul, dump, return—a certain amount of time is consumed. This is called Cycle Time. Total cycle time is the sum of these four operations. Load time includes spotting, loading and maneuvering. Haul time is consumed when the machine is transporting its load. Dump time is the interval used to release the load and maneuver on the fill. Return time is the time it takes the empty machine to traverse the haul road back to the loading site.



Each operation, or interval, is stated in minutes and fractions of minutes.* And each one must be determined separately, according to machine speed, material conditions and the distance to move.

*Always remember to convert seconds into fractions of minutes before entering them in your calculations.

Example: $45 \text{ sec} = \frac{45 \text{ sec}}{60 \text{ sec/min}} = .75 \text{ min}$



CYCLE TIME—LOADING

Loading time depends on the method of earthmoving to be employed. Scrapers alone account for three different methods, based on specific machine design. There are dual powered units that assist each other with PAYmate (push-pull) loading as well as the self-loading elevating scraper.

The most prevalent scraper today is the single engine, open bowl, push-loaded type. The time it takes to load such a scraper is influenced, obviously, by the power of the pusher. *A rule of thumb frequently used to determine adequate push power states that one pound of push is needed for every pound of payload.* The pounds of push a tractor will deliver can be found by multiplying crawler weight by the Coefficient of Traction (see Table VII, Page 25). This figure defines tractive effort available in various materials as a percent of Gross Vehicle Weight (GVW).

In determing how many pushers will be required, it is necessary to know how many scrapers one pusher can handle. This can be obtained by dividing scraper cycle time by pusher cycle time . . .

For example:

Scraper cycle time : 4 min
Pusher cycle time : 1.3 min

$$\frac{4 \text{ min}}{1.3 \text{ min}} = 3 \text{ scrapers per pusher}$$

Obviously, if the push power is inadequate, or if you have too many scrapers for the number of pushers available, you will have to add extra time for spotting, or wait-time.

The most efficient method of push-loading can be determined by noting conditions in the cut. Here are three common arrangements for pusher/scraper operations, each one applicable to a specific site. Pusher cycle time can be found in Table III.

Table IV provides a guideline to usable load-time figures for different types of scrapers under different conditions. It is assumed that adequate push power is available.

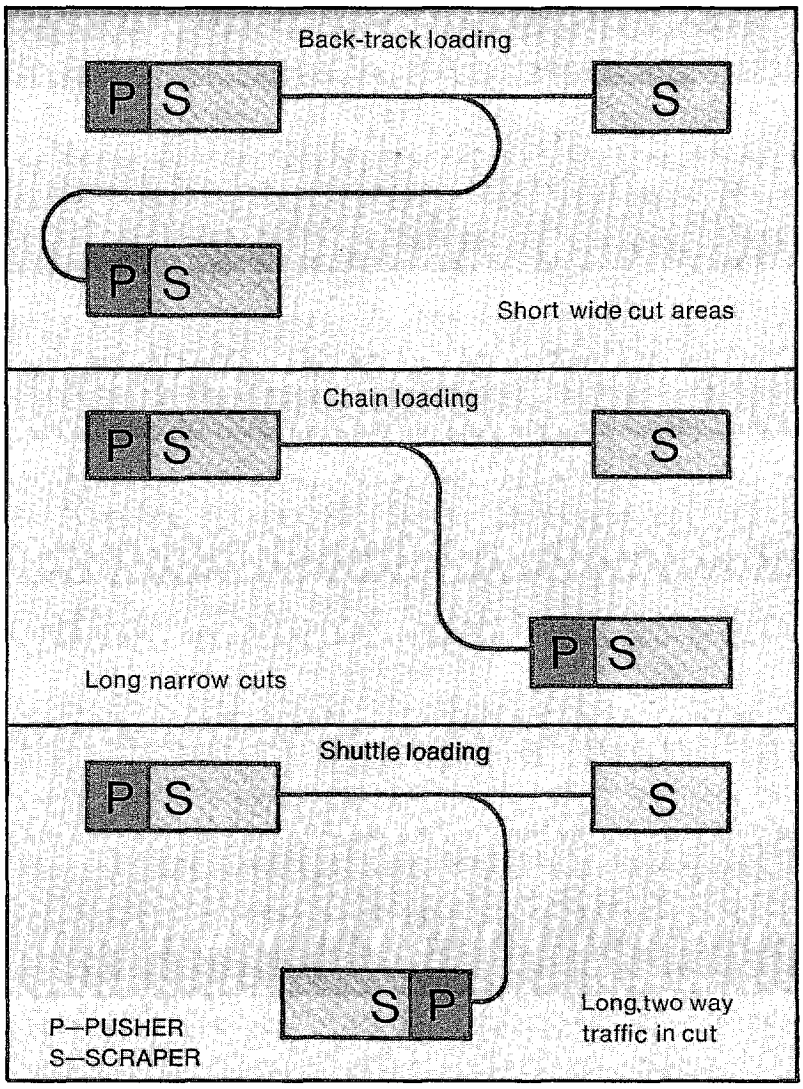


TABLE III

Pusher Cycle Times (min)

	Favorable	Average	Unfavorable
Back-track loading	0.9	1.3	1.7
Chain loading	0.7	0.9	1.2
Shuttle loading	0.7	0.9	1.2

TABLE IV

Loading Times—Scraper (min)

	Open Bowl			Elevating	
Conditions	Single Engine	Dual Engine	PAY Mate	Single Engine	Dual Engine
Favorable	0.40	0.35	0.90	0.70	0.45
Average	0.60	0.50	1.20	1.00	0.60
Unfavorable	0.80	0.70	1.50	1.30	0.75
	(Assume adequate pusher)				

Note: Elevating scrapers are never push-loaded. Doing so may damage loading mechanisms.

CYCLE TIME—LOADING

As with scrapers and pushers, hauler/loader systems should be matched for maximum efficiency. When the loading unit is inadequate for the number of haulers, additional time (due to waiting) must be added to the cycle time of every truck. Conversely, too few haulers will idle the loader, decreasing its efficiency. *A general rule of thumb states that the loader should be able to top off the hauler in three to five passes.* The tables shown here give approximate cycle times for different operating conditions and bucket capacities for both front-end loaders and power shovels.

To find total load time for a hauler, multiply loader cycle time by the number of passes required to load the truck. The number of passes can be determined by simply dividing capacity of the hauler by capacity of the loader.

EXAMPLE:
A loader with a 6-cu. yd. bucket loading 24-yd. haulers on 0.5 minute cycles will load the body in four passes . . .

$$\frac{24 \text{ cu yd}}{6 \text{ cu yd/pass}} = 4 \text{ passes}$$

And total load time will be . . .
0.5 min./pass x 4 passes = 2.0 min

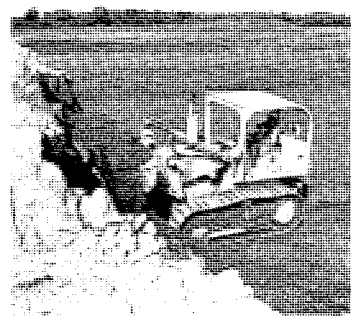


TABLE V

Front-End Loader Cycle Times

	Rubber-Tired		Crawler
Conditions	**0 - 5 cu yd**	**5 cu yd & Above**	**All**
Favorable	0.30	0.42	0.42
Average	0.33	0.50	0.50
Unfavorable	0.42	0.66	0.58

(Fractions of minutes)

TABLE VI

Shovel Output	Approximate Production in BCY/MIN (60-Minute Hour, 90-Degree Swing)										
	DIESEL					ELECTRIC					
Bucket Capacity (Cu Yds)	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Moist Loam, light sandy clay	5.93	7.75	9.67	11.4	13.3	14.7	16.8	18.9	20.2	22.2	24.2
Sand & gravel	5.56	7.50	9.25	10.8	12.3	14.2	16.3	18.5	19.6	21.4	23.3
Common ground	5.00	6.75	8.50	10.1	11.4	13.8	15.7	17.7	18.9	20.6	22.3
Hard clay	4.42	6.00	7.50	8.83	10.1	13.3	15.2	17.0	18.3	19.8	21.4
Rock, well blasted	3.83	5.33	6.83	8.33	9.58	12.8	14.6	16.4	17.6	19.0	20.4
Common excavation with rocks roots, etc.	3.33	4.83	6.33	7.67	9.00	11.8	13.7	15.5	16.5	17.8	19.1
Wet Sticky clay	3.08	4.50	5.75	7.00	8.17	10.6	12.2	13.7	14.9	16.0	16.7
Rock Poorly Blasted	2.67	3.92	5.08	6.25	7.33	9.5	11.0	12.6	13.6	14.6	15.3

Courtesy Bucyrus-Erie Co.

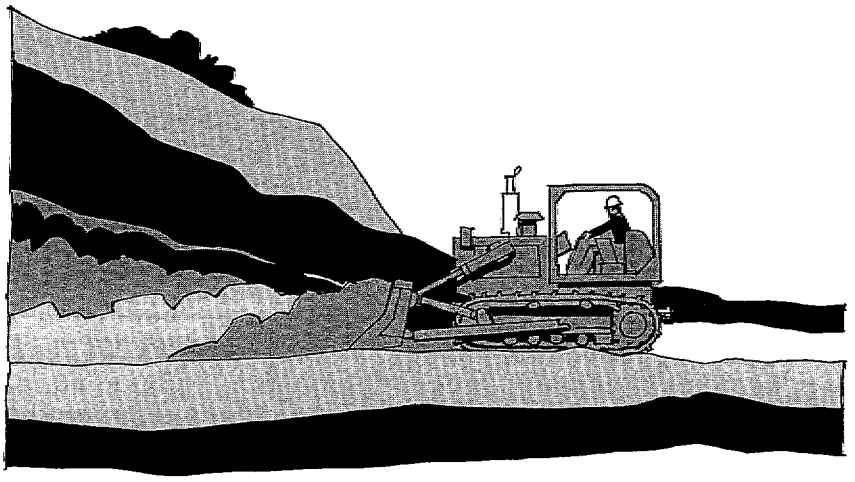
CYCLE TIME—LOADING

Loading time for a crawler dozer also can be established as a part of total cycle time. In most materials a dozer will load its blade in about 25 feet. Time consumed in picking up the load is between 0.15 and 0.20 minutes, depending on material conditions.

In figuring the production of a crawler dozer—as well as with all earthmoving estimates—common sense is essential. Study the soil. Evaluate job conditions. Understand why the time it takes to load a dozer blade pioneering in rocky soil will not equal the loading time of the same machine in light clay.

Remember . . .

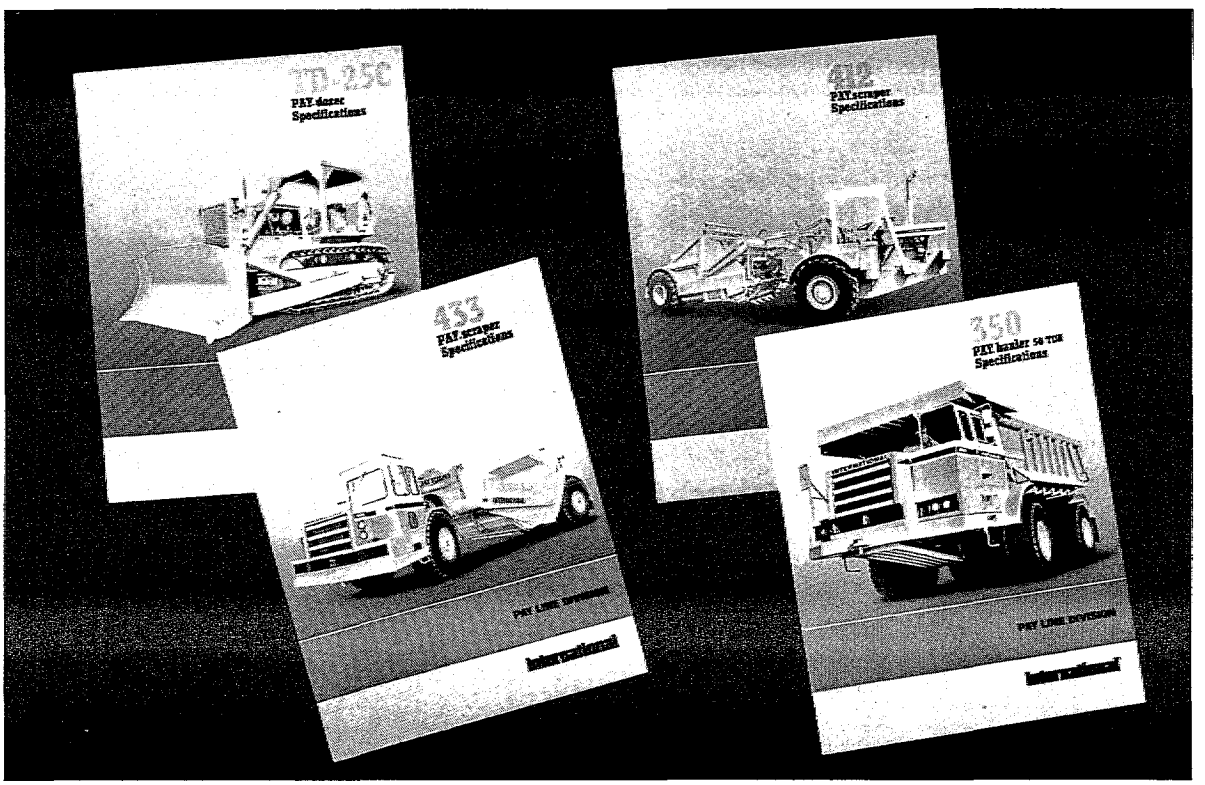
The blade should load in 25 feet.
The time should not be more than 0.20 minutes.

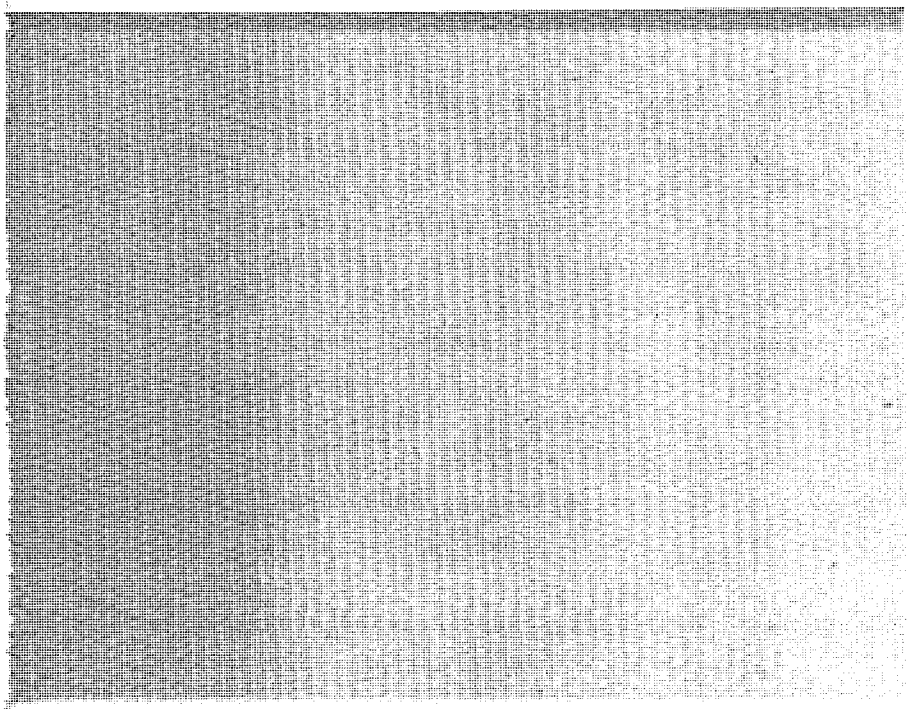


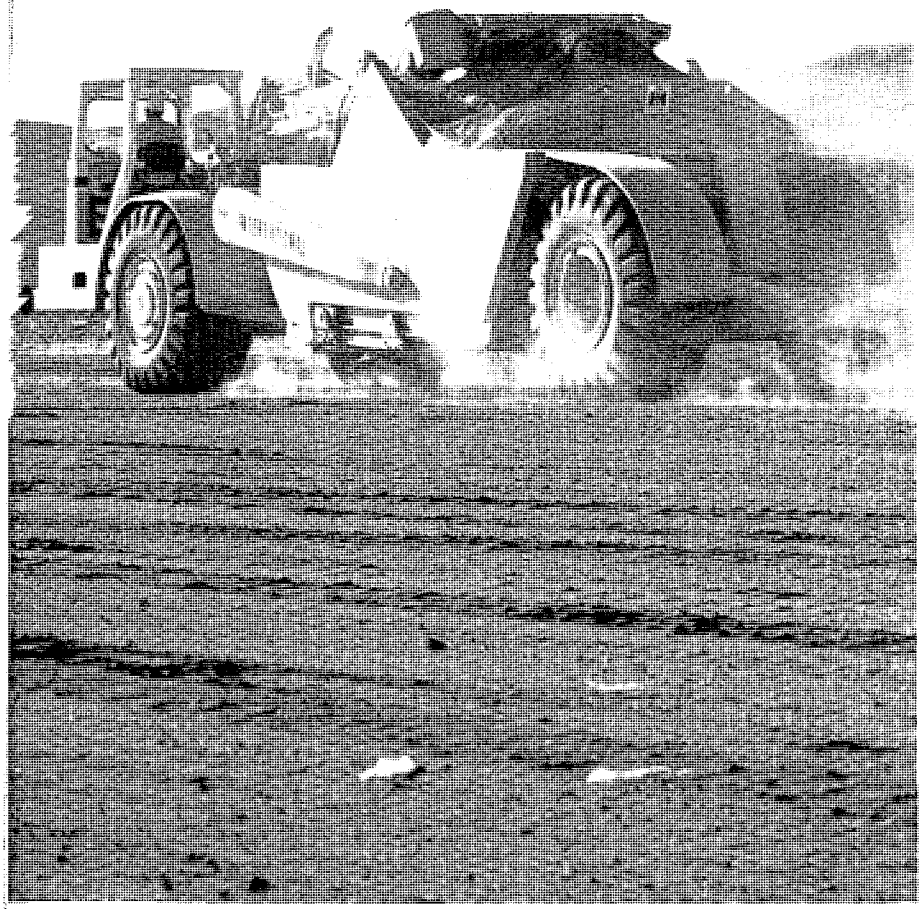
CYCLE TIME—HAULING

It's easy to figure haul and return time if you know how far and how fast you're traveling. Simply divide the distance in feet by the speed in feet per minute. First, of course, we must find the average speed, and that calls for a determination of weight, total resistance, and usable pull.

Both the empty and loaded weight of a machine must be determined to arrive at an accurate speed figure. Gross vehicle weight (GVW) is the empty vehicle weight (EVW) of the machine, plus the weight of its payload. Empty vehicle weights and the maximum payload weights are shown on specification sheets.







CYCLE TIME—HAULING

Rimpull (RP) is the force needed to move rubber-tired equipment along the road. Drawbar Pull (DBP) is the force required to move a crawler tractor. Performance curves for both RP and DBP are given in the specification sheets.

The amount of usable pull* for any machine depends on total weight bearing on the drive tires or tracks, and how the tires or tracks interact with the ground surface.

Traction is a common term that is not difficult to understand. With perfect conditions, 100 percent of a vehicle's weight on the drive tires or tracks could be applied to this effort (coefficient of traction = 1.0). But we rarely work with perfect conditions, so an adjustment must be made. Traction differs according to ground conditions and the coefficient of traction merely represents the *degree of traction* between the tire or track and the ground surface.

The calculation for finding maximum usable RP or DBP is simple . . .
Weight on Drive Tires or Tracks × Coefficient of Traction

Remember that effective weight is the weight on the drive wheels or tracks. For example, a single engine scraper with a GVW of 107,420 pounds would have an effective driving weight of 56,770 pounds (52.8 percent of total weight) on the front axle. Note that this percentage changes from the loaded to the empty machine.

The same scraper, returning empty, would have a driving weight of 39,573 pounds (66.6 percent of EVW). These figures are found in the appropriate specification sheet, and vary according to machine models.

*Altitude affects engine horsepower. Approximately 3% resistance is added for every 1,000 feet above the rated, maximum altitude. Many turbocharged engines require no power deration up to 10,000 feet. However, turbocharged horsepower ratings (altitude) do vary according to model. Always check specification sheets to verify power rating criteria. Naturally aspirated engines are also rated up to specified elevations. Consult specification sheets for power criteria.

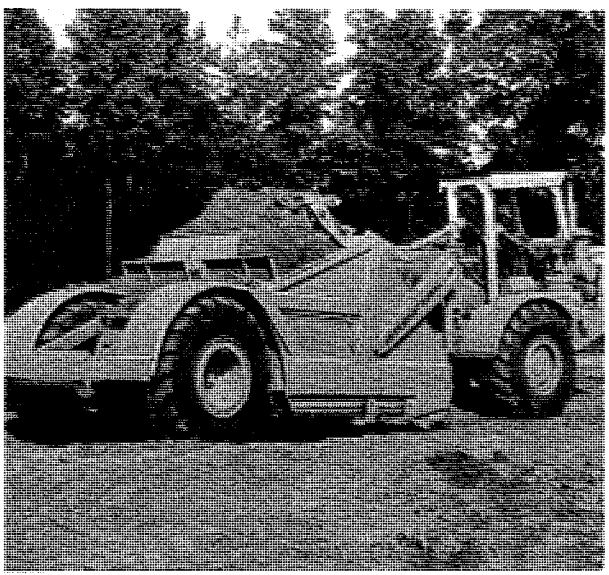
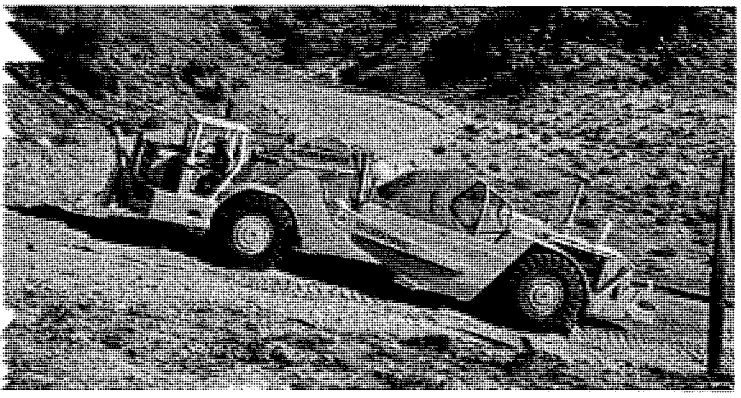


TABLE VII

COEFFICIENT OF TRACTION

	Rubber Tires		Tracks	
Type of Surface	**Dry**	**Wet Surface**	**Dry**	**Wet Surface**
Smooth blacktop	.8 - 1.0	.6 - .9	.....	.....
Rough concrete	.9 - 1.0	.8 - 1.0	.3 - .6	.3 - .6
Hard smooth clay	.6 - 1.0	.1 - .3	.4 - .7	.2 - .4
Hard clay loam	.5 - .8	.15 - .4	.6 - .9	.4 - .9
Firm sandy loam	.4 - .8	.25 - .8	.6 - 1.0	.6 - 1.0
Spongy clay loam	.4 - .6	.15 - .3	.7 - 1.0	.6 - .9
Rutted clay loam	.3 - .5	.15 - .3	.7 - 1.0	.6 - .9
Rutted sandy loam	.3 - .4	.2 - .5	.7 - 1.0	.7 - 1.0
Gravel road, firm	.5 - .8	.3 - .9	.7 - .9	.7 - .9
Gravel, not compacted	.3 - .5	.4 - .6	.5 - .9	.6 - 1.0
Gravel loose	.2 - .4	.3 - .5	.4 - .7	.5 - .8
Sand, loose	.1 - .2	.1 - .4	.3 - .5	.4 - .7
Snow, packed	.1 - .4	.0 - .3	.2 - .6	.2 - .6
Ice, roughened	.1 - .3	.0 - .2	.1 - .4	.0 - .3
Ice, smooth	.0 - .1	.0 - .1	.0 - .1	.0 - .1

CYCLE TIME—HAULING



Total Resistance (TR) or Total Assistance (TA) is the sum of the forces that resist or assist the movement of rubber-tired and track type equipment. These forces consist of Rolling Resistance (RR) and Grade Resistance (GR) or Grade Assistance (GA).

Rolling Resistance is the force that resists movement of machines on different types of terrain. It is caused by flexing of the tires and deformation of the supporting ground surface. Table VIII gives RR in percent of total machine weight for various depths of tire penetration.

Grade Resistance (GR) is the force that must be overcome when traveling uphill. It acts against the total weight of a vehicle, both tracked or rubber-tired. However, the major consideration is with wheeled equipment. Grade Assistance (GA) is the opposite of Grade Resistance (GR). It assists on downhill runs.

When moving uphill, the machine must overcome RR plus GR, whereas on level terrain only RR-is encountered. When traveling downhill, a vehicle must deal with RR and GA, or both resistance and assistance. A grade is usually measured in percent. Each percent of grade produces a hindering or helping force of one percent of the total weight of the machine. This must be calculated for both empty and loaded conditions of the hauling unit.*

*Remember to use percent of grade and not degrees in your calculations. Refer to conversion tables on Page 95.

EXAMPLE:
A scraper has a loaded weight (GVW) of 117,000 lbs, and is traveling on a level haul road with a firm, rutted dirt surface that shows 2 inches of penetration. RR from Table VIII is 5%.

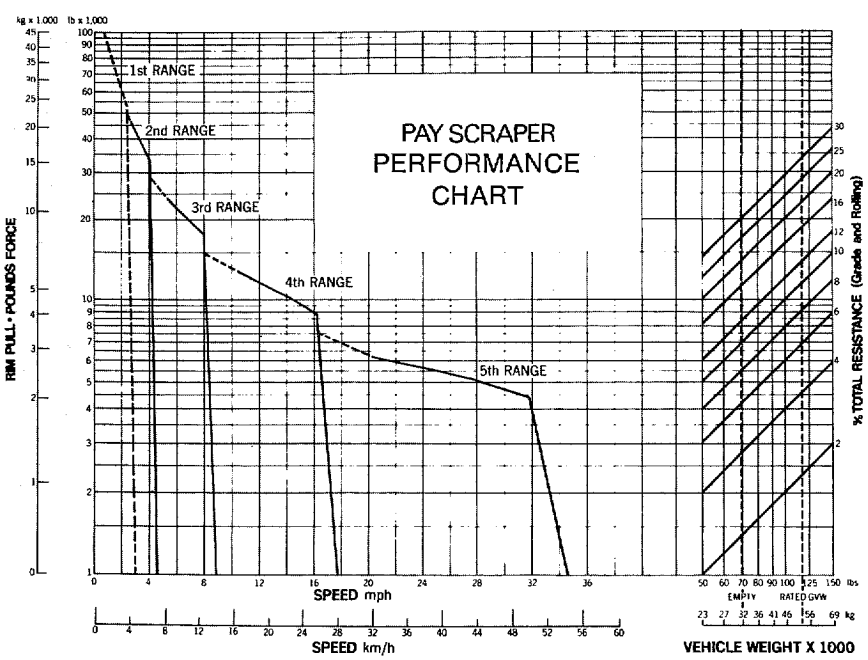
When a 4% grade is encountered a GR of 4% results, so the Total Resistance (TR) becomes 9% (5% + 4% = 9%). The required rimpull to move the vehicle is 9% of 117,000 lbs. or 10,530 lbs.

If the grade is downhill, you obviously have a GA of 4%, and TR is reduced to 1% (5% − 4% = 1%). The required rimpull becomes 1% of 117,000 lbs. or 1,170 lbs.

TABLE VIII

Rolling Resistance Rubber-Tired Equipment

Inches of Tire Penetration	Rolling Resistance
0	2%
1	4%
2	5%
3	6%
Greater than 3	Penetration (in) x 2%



TO DETERMINE VEHICLE PERFORMANCE:

Step 1—Read up on the rated gross vehicle weight line (or empty line) to the intersection of the percent of total resistance.

Step 2—From that point, read horizontally to the speed curve.

Step 3—At the point of intersection with the speed range curve, read down to the maximum speed obtainable.

NOTE: Total resistance equals actual percent grade, plus actual percent of rolling resistance. Usable rimpull depends upon available traction and gross vehicle weight.

A direct reading of maximum attainable speed can be made from the percent of TR by use of the performance chart. These charts, found in your scraper or hauler specification sheets, are easy to use, as noted on the next page.

In the two examples shown here the maximum attainable speeds are 14 mph and 34 mph, respectively.

CYCLE TIME—HAULING

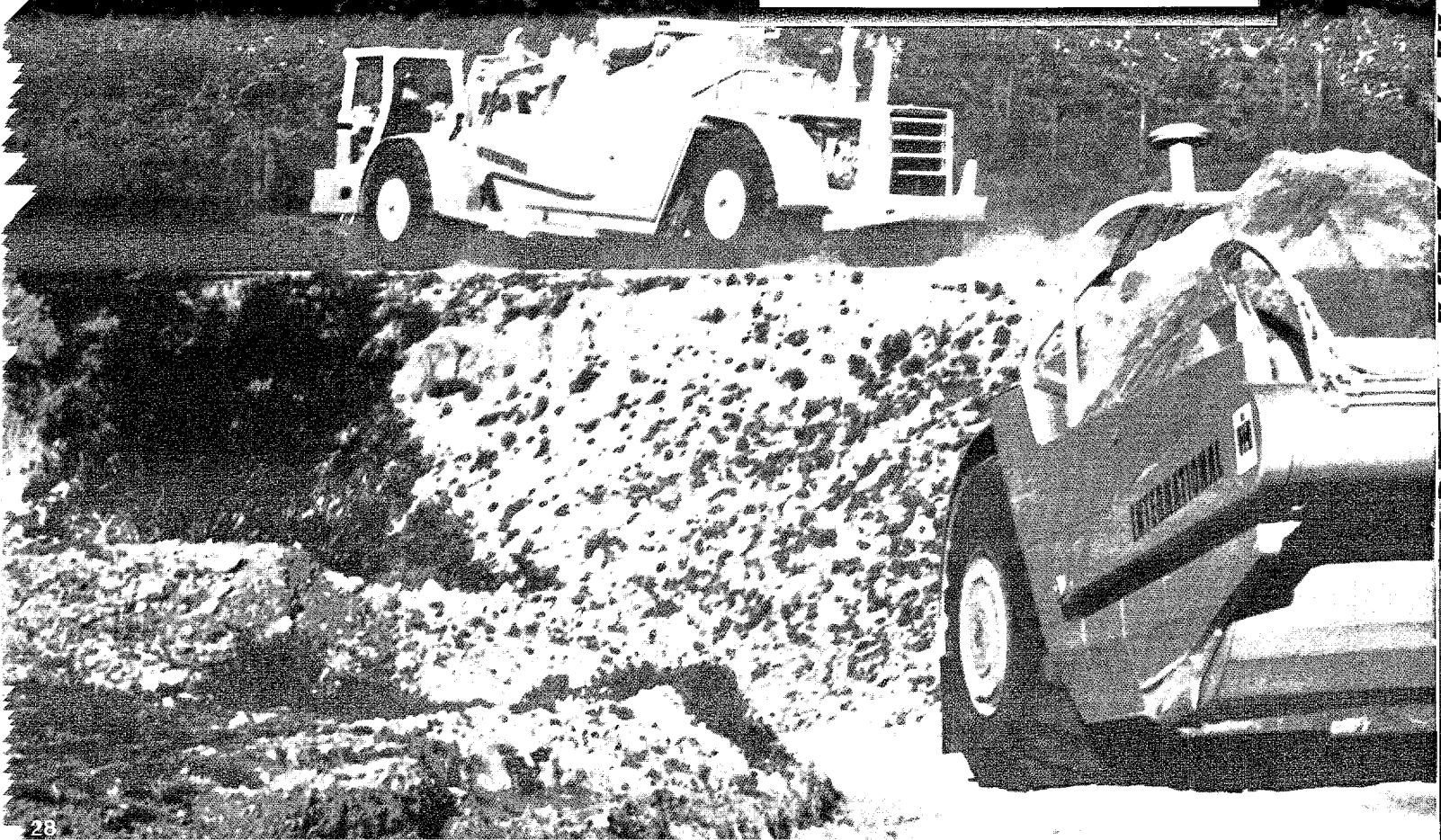
Resistance and Rimpull are taken into account in the performance charts, which are published by the manufacturer to assist you in figuring vehicle speed. These charts, found in the specification sheets for each machine, are easy to use if you follow these simple steps . . .

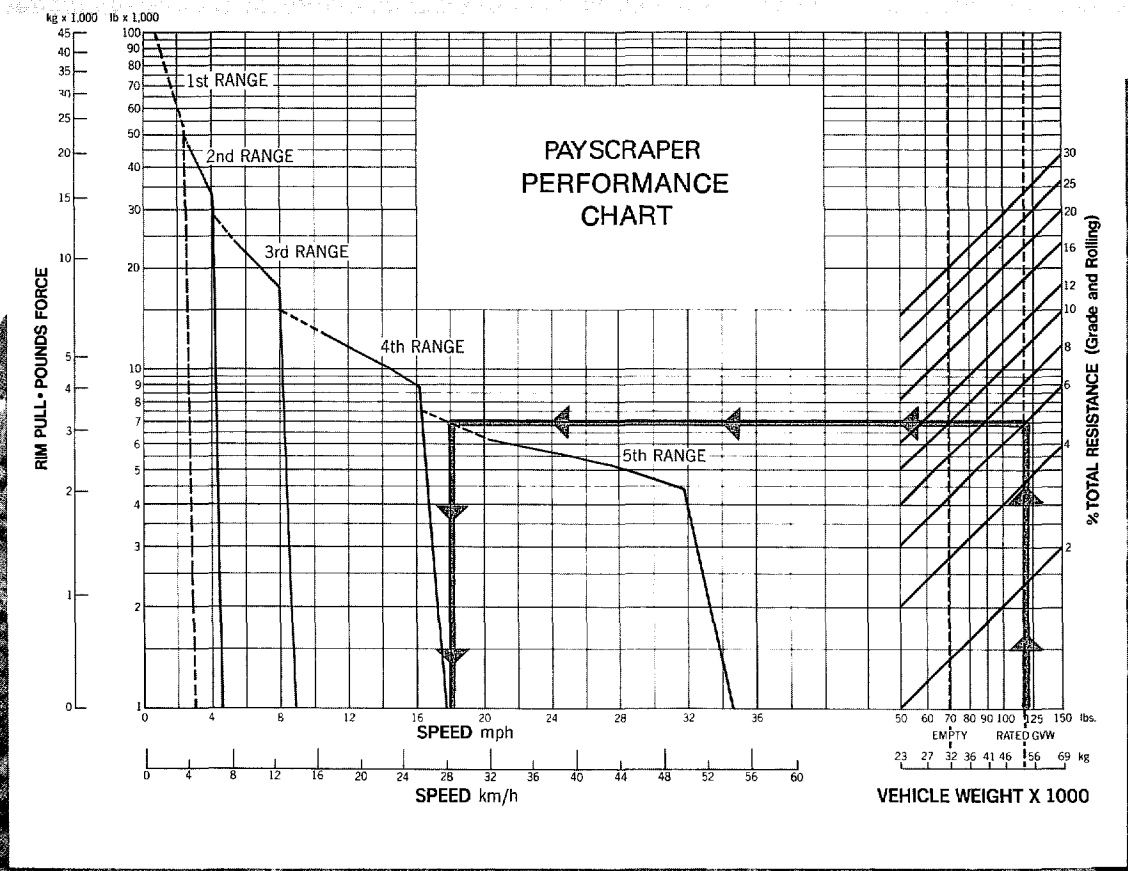
1. Read up from the appropriate GVW line (EVW plus payload) to the intersection of the percent of TR (slanting lines).
2. From that point, read horizontally to the speed curve.
3. From the point of intersection with the speed range curve, read down to find the maximum attainable speed.

Note: When TA is encountered, consider TR to be zero percent.

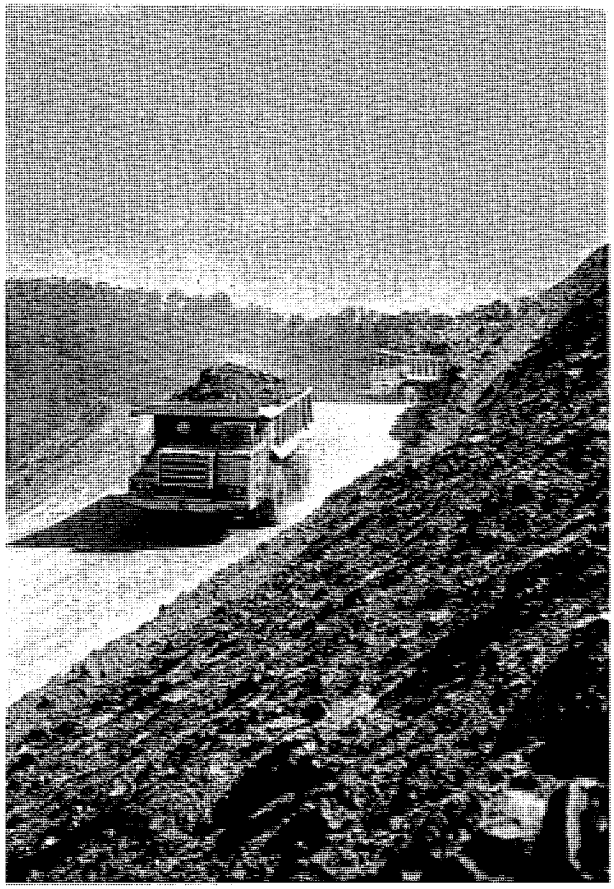
EXAMPLE:

Rated gross vehicle weight (GVW) according to the scraper performance chart shown here is 117,000 lbs. (dotted line). Assuming we have a resistance of 6%, read up to the slanting line (TR) then left to the speed curve. We intersect the 5th range curve, so our maximum attainable speed is approximately 18 mph.




PAYSCRAPER
PERFORMANCE
CHART
kg x 1,000
lb x 1,000
RIM PULL • POUNDS FORCE
1st RANGE
2nd RANGE
3rd RANGE
4th RANGE
5th RANGE
SPEED mph
SPEED km/h
% TOTAL RESISTANCE (Grade and Rolling)
EMPTY
RATED GVW
VEHICLE WEIGHT X 1000

CYCLE TIME—HAULING

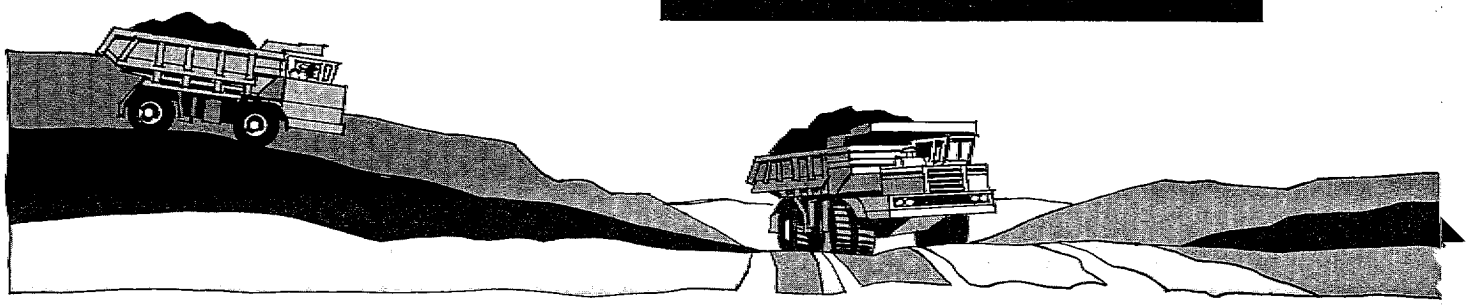


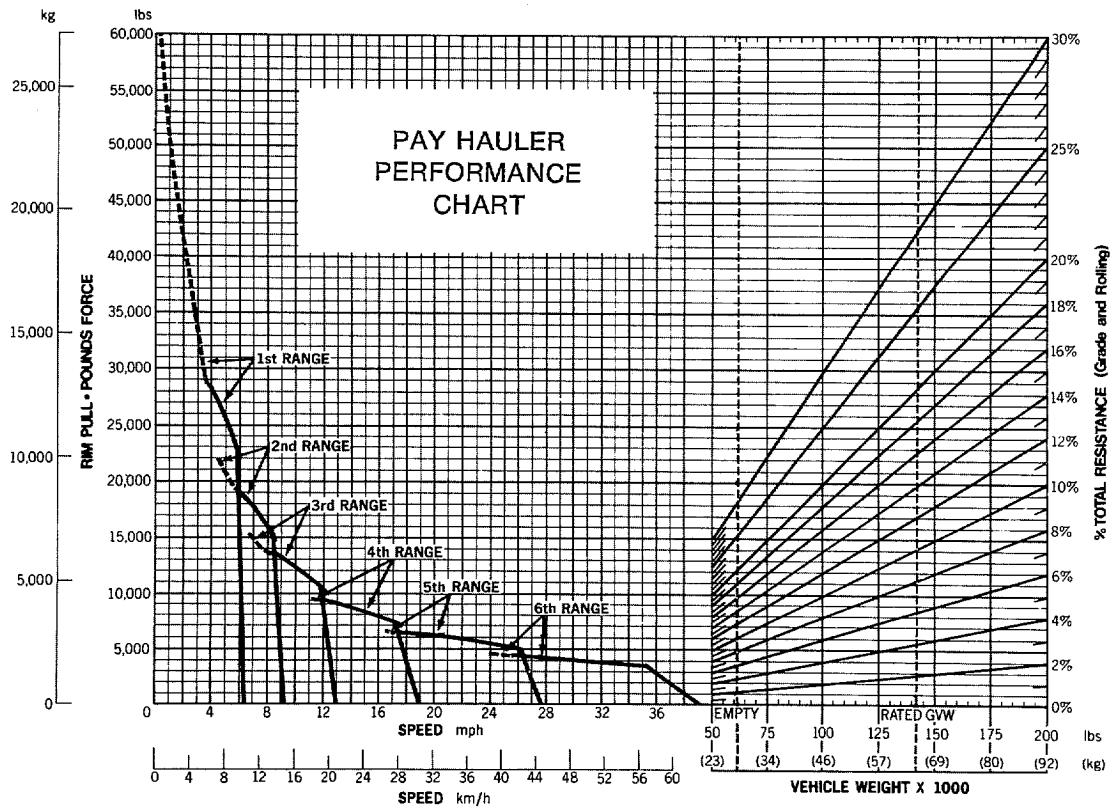
Many of today's off-highway haulers come equipped with a retarder. This is a hydraulic device capable of controlling vehicle speed on downhill runs. It is applied by the operator in a gear range to match haul road conditions, thereby preventing overspeeding of the engine.

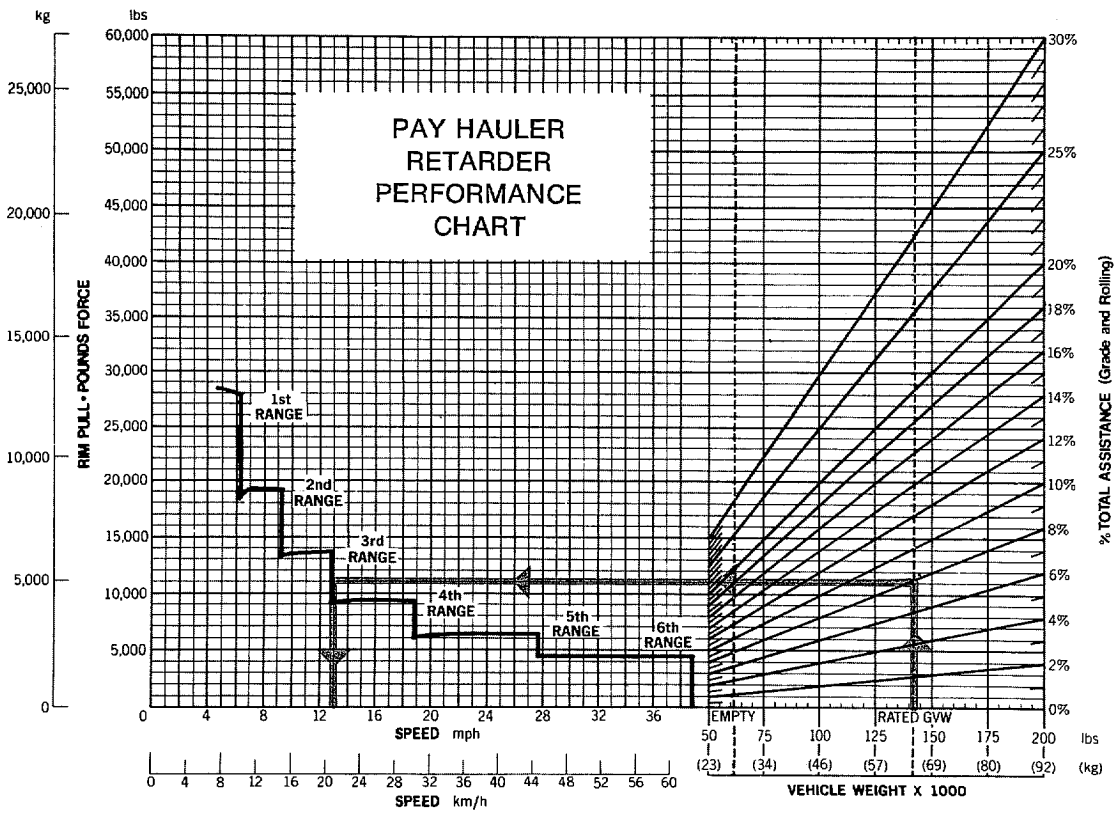
The specification sheet of a vehicle equipped with a retarder displays two performance charts—one for figuring MPH in the conventional manner (when TR is encountered) and one for figuring speeds when the retarder is applied (when TA is found).

To determine retarder performance, read up on the GVW line to intersect the TA line, as we did with the TR line on the scraper performance chart. From that intersection read across to the speed range curve, then down to maximum attainable speed.

EXAMPLE:
Assume that Total Assistance (TA) from your RR/GA calculation is 8% and GVW is 142,400 lbs. (broken line). Read up the GVW line, then left from intersection of the slanting 8% line to meet the speed range line. From there move down to maximum attainable speed, which in this case is 13 mph (3rd range). This is the maximum safe speed at which the vehicle should be operated under these conditions.




PAY HAULER
PERFORMANCE
CHART
kg
lbs
RIM PULL • POUNDS FORCE
1st RANGE
2nd RANGE
3rd RANGE
4th RANGE
5th RANGE
6th RANGE
SPEED mph
SPEED km/h
% TOTAL RESISTANCE (Grade and Rolling)
EMPTY
RATED GVW
VEHICLE WEIGHT X 1000


PAY HAULER
RETARDER
PERFORMANCE
CHART
kg
lbs
RIM PULL • POUNDS FORCE
1st RANGE
2nd RANGE
3rd RANGE
4th RANGE
5th RANGE
6th RANGE
SPEED mph
SPEED km/h
% TOTAL ASSISTANCE (Grade and Rolling)
EMPTY
RATED GVW
VEHICLE WEIGHT X 1000

CYCLE TIME—HAULING

With crawler dozers, another type of resistance enters the picture, caused by the load itself as it moves over the ground. Friction is created at the point of contact, where one material rides over another. This resistance is calculated by the use of the appropriate Coefficient of Friction, as found in Table IX. Simply multiply weight of the load by the coefficient of friction. This step is necessary to accurately determine required Drawbar Pull (DBP), which in turn, will give us crawler speed.

Blade Capacity x Loose Weight x Coefficient of Friction = DBP

Grades do not affect crawler dozer performance as a general rule, unless they are of an extreme nature. Do not be concerned with GR or GA for a crawler tractor until it exceeds ±5 percent.

EXAMPLE:
A crawler dozer is working on level terrain in dry gravel. The machine is equipped with a semi-U blade with a 10.1 cu yd capacity. What is the TR encountered by the crawler under these conditions?

From Table I, Page 11, the IBCF for this material is found to be 0.89 and the weight is 3,250 lbs /BCY. The payload for the blade would be capacity x loose weight, or . . .

Blade capacity x Loose Weight = Payload
10.1 cu yd x 3250 lbs/BCY x 0.89 = 29,214 lbs

From Table IX the Coefficient of Friction for this material is estimated to be 0.90. Therefore, using the resistance formula,

Payload (lbs) x Coefficient of Friction

the Travel Resistance (TR) to be overcome is calculated to be . . .

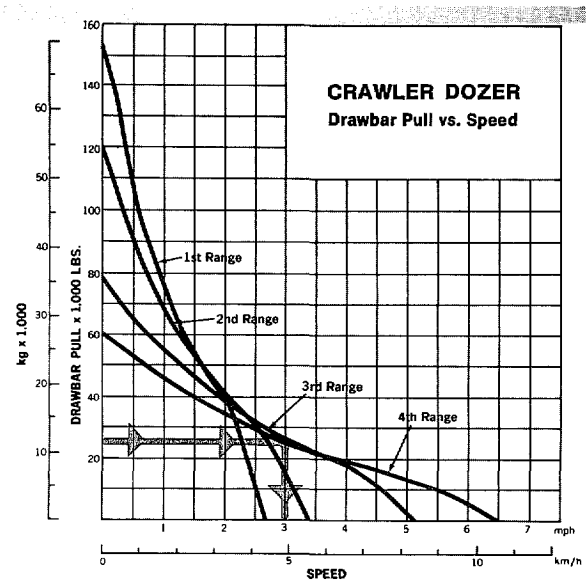
Blade Capacity (29,214 lbs) x Coef. of Friction (0.90)
= 26,293 lbs

As shown on the DBP chart,
26,293 lbs corresponds with 3 mph

TABLE IX

Coefficient of Friction	
Dry sand, clay, mixed earth	0.4 to 0.7
Damp clay	1.0
Wet clay	0.31
Gravel	0.8 to 1.1

(An appropriate figure can be taken from the range given for certain materials. Otherwise, experience and observation are helpful.)



CYCLE TIME

DUMPING

Dump times for hauling equipment can be obtained by using Table X. In actual application, remember to check for unusual conditions that could affect your figures, such as a wet fill area where scrapers may encounter slow going, or sticky material that may delay rear-dump haulers. Any extra time for waiting, spotting, maneuvering, etc. must be added in.

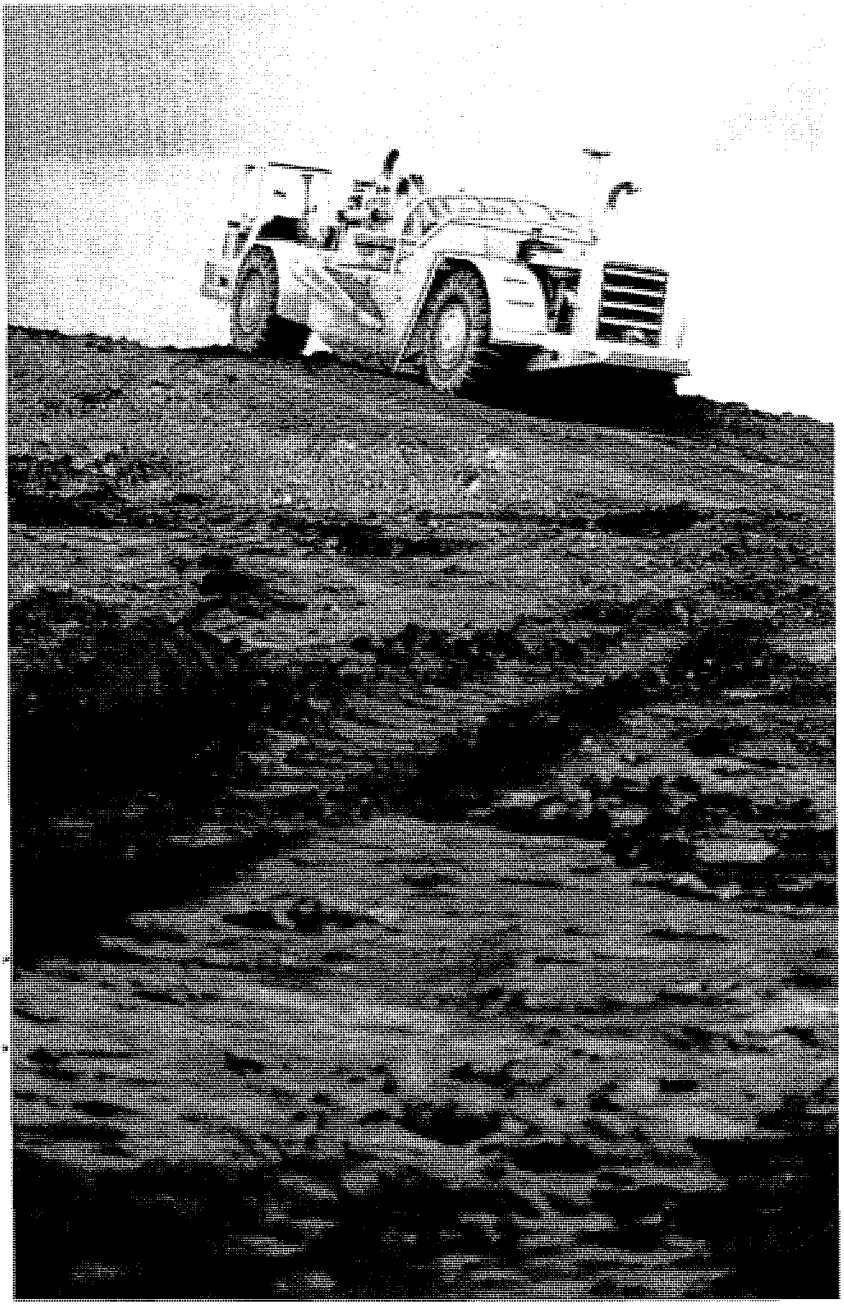
With crawler dozers, most of the dump is included in forward travel (haul) speed, since a dozer normally releases the load without slowing down, and stops only to reverse direction. *A crawler dozer should be able to dump the entire load in 0.1 minutes.*

TABLE X

Turn and Dump Intervals

	Haulers		Scrapers	
Conditions	Bottom Dump	End Dump	Open Bowl	Elevating
Favorable	0.3	0.7	0.3	0.4
Average	0.6	1.0	0.4	0.5
Unfavorable	1.5	1.5	0.6	0.7

(In Minutes)



RETURNING

To figure return time, the same procedures that applied to the hauling leg are used. Each return section is studied and laid out in a similar manner to the haul sections. If you are returning over the same road, there are just two things to remember . . .

1. Weight is reduced by the amount of the load.
2. Grade resistances & grade assistances are reversed.

Five mph is considered an average return time for crawler dozers. However, if return speed is limited to a certain gear range, use maximum speed in that range as a return speed.

CYCLE TIME—MPH CALCULATION

After you have determined the maximum attainable speed under a given set of conditions, you must keep in mind that other factors affect this speed: acceleration, deceleration, turns, tight overpasses, safety considerations, just to name a few. Therefore, your maximum attainable speed must be derated to an average travel speed throughout each haul road section. To adjust the maximum attainable MPH figure and obtain the average MPH for a given section, multiply by the appropriate speed factor in Table XI.

Maximum MPH x Speed Factor = Average MPH

Notice that the table presents a range of figures to choose from within the various haul distances, allowing a precise match of factors and feet; however, the haul road layout will also influence your choice.* For example, a sharp turn may call for a lower factor in a given section.

In addition, note that there are two columns of figures containing the speed factors, one for entering a specific section with the vehicle already underway, and one for starting from, or coming to, a stop.

*Recall that grades and RR have already been accounted for in our maximum MPH calculation.

EXAMPLE:

An off-highway hauler is approaching the second section of a 3-section haul road. The maximum attainable speed in the 2,500-ft second section is 35 mph. No curves or extraordinary conditions exist in the second section. What is the average speed?

The speed factor is taken from the second column of Table XI. The maximum possible factor is 0.95 for these conditions. But, the unit must accelerate in the first part of the second section, therefore, a speed factor of 0.90 is chosen. The average speed for the second section then becomes . . .

35 mph x 0.90 = 31.5 mph

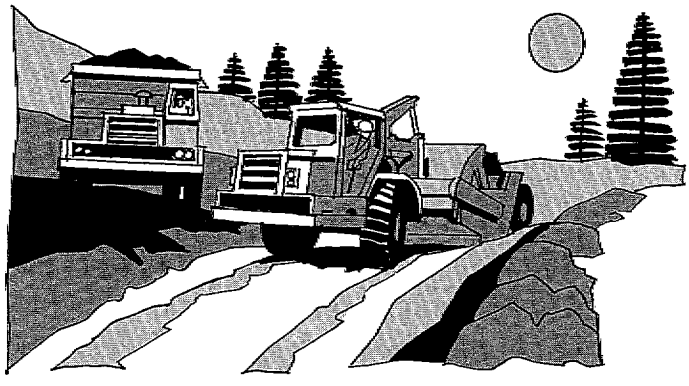


TABLE XI

Speed Factors		
Length of Haul Road in Feet	**Starting from Or Coming To a Stop in Haul Section**	**Moving when Entering Haul Road Section**
200 - 500	0.33 - 0.51	0.56 - 0.80
501 - 1000	0.43 - 0.67	0.65 - 0.83
1001 - 1500	0.53 - 0.75	0.78 - 0.90
1501 - 2000	0.59 - 0.80	0.84 - 0.93
2001 - 2500	0.62 - 0.84	0.88 - 0.95
2501 - 3000	0.65 - 0.85	0.90 - 0.97
3001 - 3500	0.68 - 0.87	0.92 - 1.00
3501 & Above	0.70 - 0.95	0.95 - 1.00

CYCLE TIME–MPH CALCULATION

When we know how to calculate average MPH for a given set of conditions, we are ready to apply the figures to a specific haul road. It is necessary to break the haul road into sections wherever travel conditions change. Then apply the travel time formula to each haul road section. The sum of the times spent on the sections is the total travel time. Always remember: start a new section whenever conditions change.

It is useful in many cases to draw a rough map of the site, indicating the distance of each section, with haul road conditions noted, such as grades, curves, RR, etc.

The Travel Time Formula for each section of the haul road and return is . . .

$$\text{Time} = \frac{\text{Distance in Feet}}{\text{Speed (MPH)} \times 88^*}$$

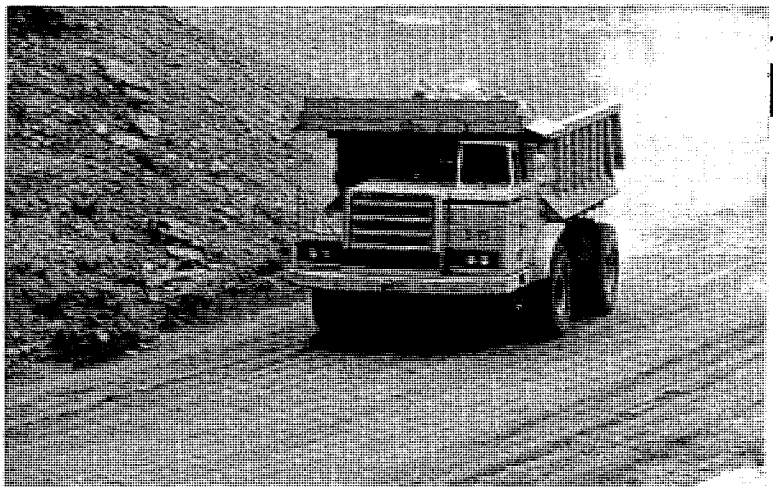
*88 is a constant used to convert MPH into Feet per Min. (FPM).

EXAMPLE:

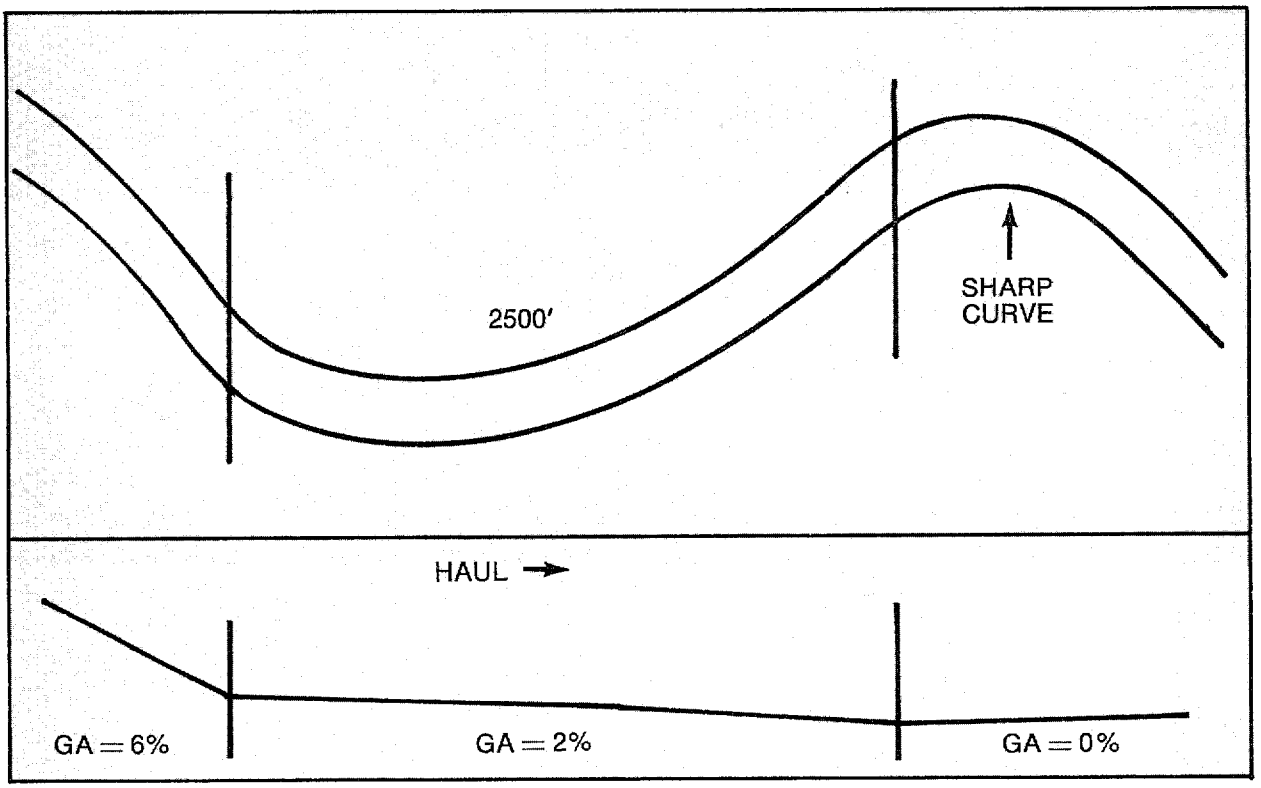
Continuing with the example on Page 36, our hauler is moving at an average speed of 31.5 mph on a 2,500-ft section of the haul road. Apply the travel time formula . . .

$$\frac{\text{Distance (2,500 ft)}}{\text{Speed (31.5 mph)} \times 88} = 0.90 \text{ minutes}$$

It will take 0.90 minutes to travel that section under the given set of conditions.



HAUL ROAD SKETCH



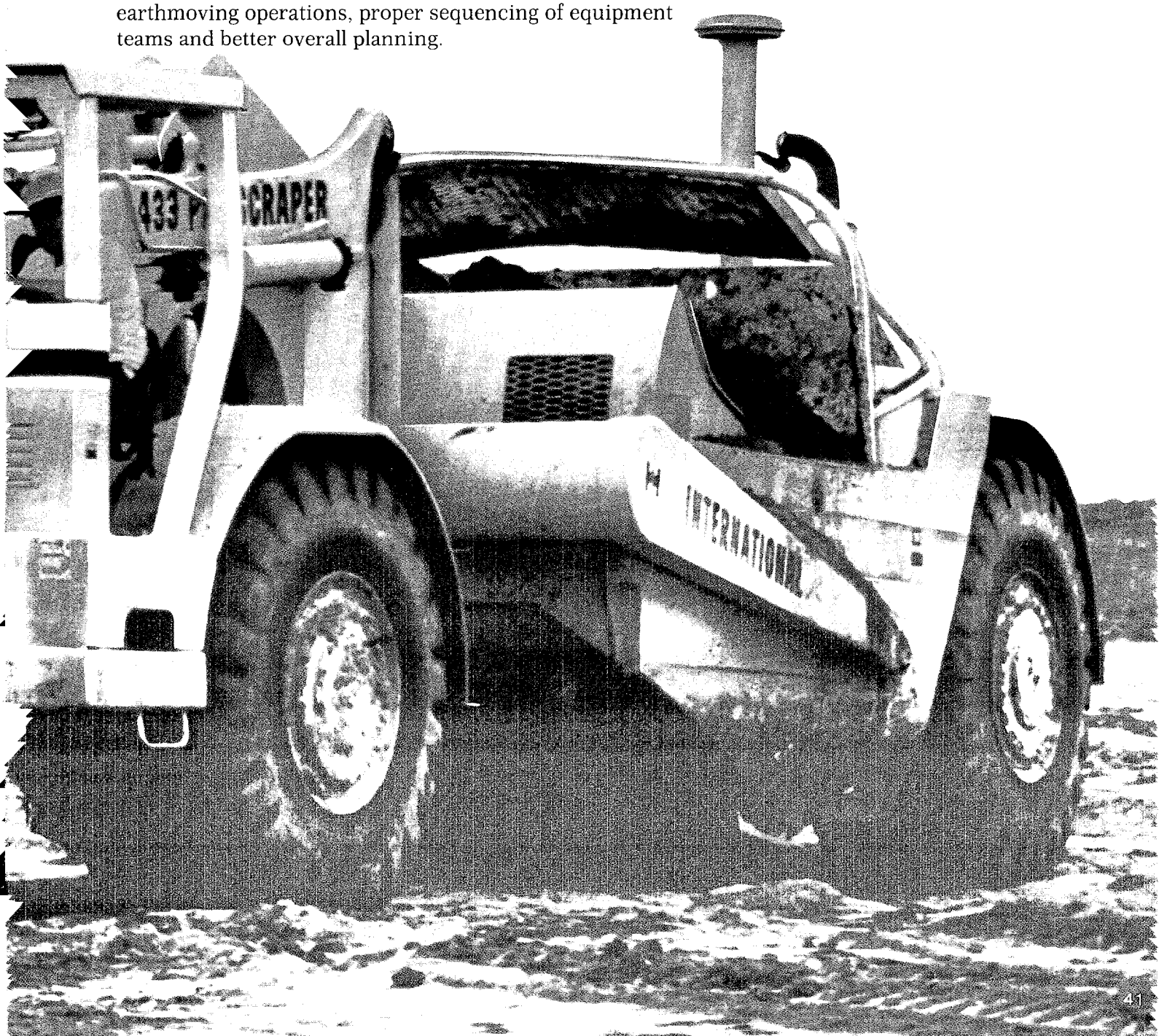
CYCLE TIME—SUMMARY

Cycle Time is the combined time it takes to . . .

Load *Haul* *Dump* *Return*

We have seen how the various time measurements add up to total Cycle Time, the key unknown item in figuring earthmoving production. It's a good idea to fix in your mind the different cycle time factors, since this calculation will be the foundation of your estimate. In summary, the time consumed in operations such as spotting, turning, loading and dumping tend to remain constant. Haul and return times depend on factors that influence MPH, and they, of course, may change.

A thorough knowledge of Cycle Time will suggest further efficiencies to you, such as improved layout of earthmoving operations, proper sequencing of equipment teams and better overall planning.



EFFICIENCY HOUR

There is one final point to consider: it is improbable that construction equipment will operate on a full 60-minute hour at 100 percent efficiency every day. This is due to unavoidable delays in the normal workday, such as equipment adjustment, lubrication or service, and stops by the operators, as well as machine moves, road maintenance, traffic, blasting, etc.

To account for these inevitable time losses, an Efficiency Hour in minutes per clock hour is applied. Table XII gives various figures in minutes of actual worktime per 60-minute hour for different types of equipment.

These figures are only estimates—accurate time keeping will help you obtain more exact figures.

Total cycles per hour is calculated by dividing the available time in one hour by the cycle time.

$$\text{Cycles Per Hour} = \frac{\text{Efficiency Hour (E)}}{\text{Cycle Time (C)}}$$

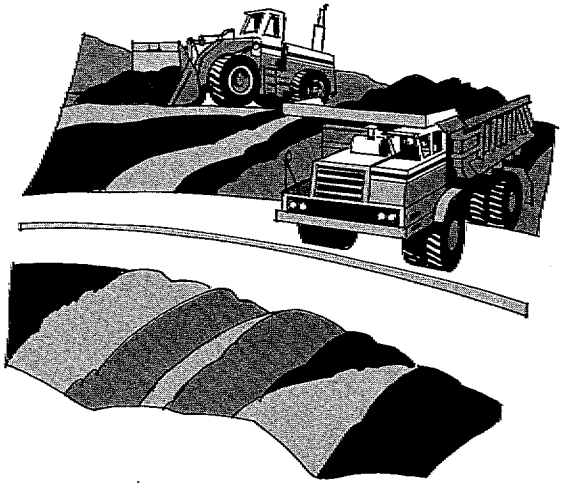
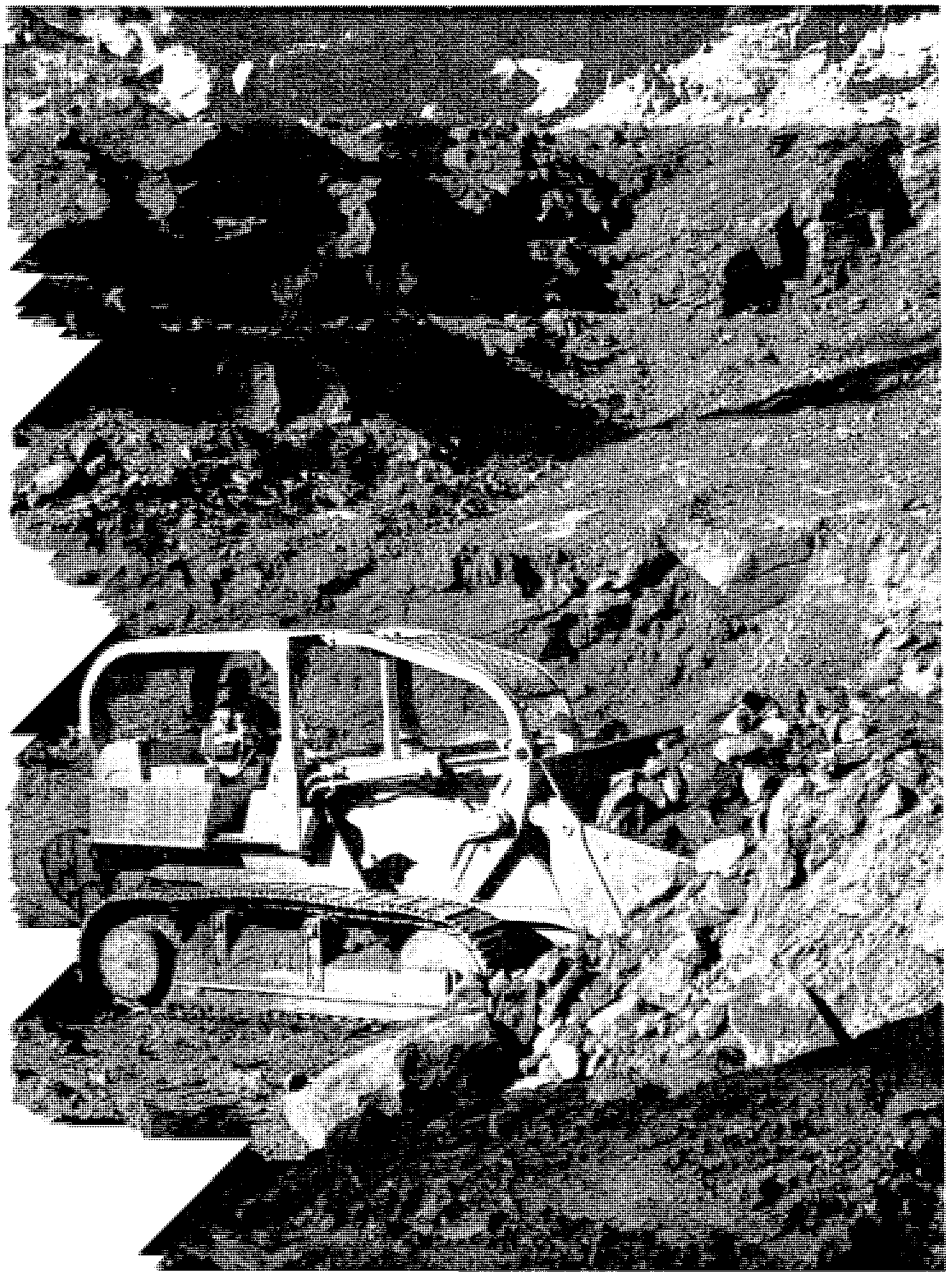


TABLE XII

Efficiency Hour					
Conditions	Crawlers	Front End Loaders	Elevating Scrapers	Haulers & Open Bowl Scrapers	Hydraulic Excavators
Favorable	55	50	57	50	55
Average	50	45	50	45	50
Unfavorable	45	40	45	40	45

(In Minutes)



THE PRODUCTION FORMULA

Remember in the beginning of the book we laid out two job parameters to help in figuring production . . .

Material Carried x Cycles per Hour

Then we explained how the basic items that make up an estimate fit into the overall picture . . .

Production = Material Carried (BCY, LCY, Tons) x Cycles Per Hour

$$= \text{In-Bank Correction Factor (I)} \times \text{Heaped Capacity (H)} \times \frac{\text{Efficiency Hour (E)}}{\text{Cycle Time (C)}}$$

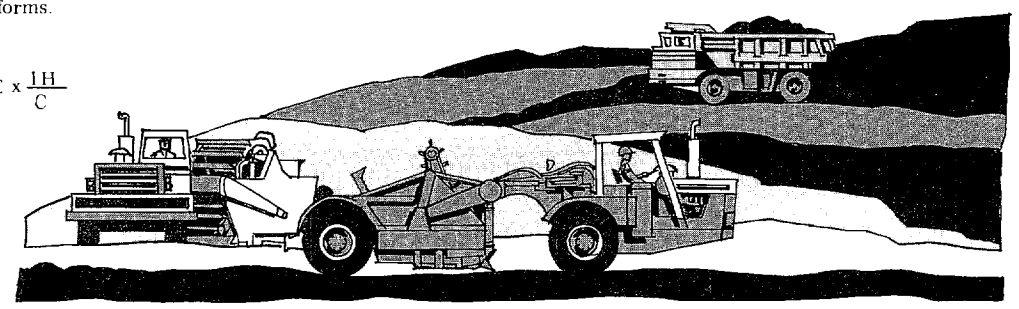
After learning how to calculate the various items that contribute to our estimate, we fit them into the basic production formula like this . . .

$$P = IH \times \frac{E}{C}$$

Following are a few examples, featuring a variety of machines and conditions, to help you gain confidence in your application of the formula. Study these examples so that you thoroughly understand all of the calculations involved. From there it's an easy step to figure out reliable production estimates and cost projections for a real job.

Note that the production formula can be presented in a variety of forms. One form which has previously been used by International is:

$$P = E \times \frac{IH}{C}$$

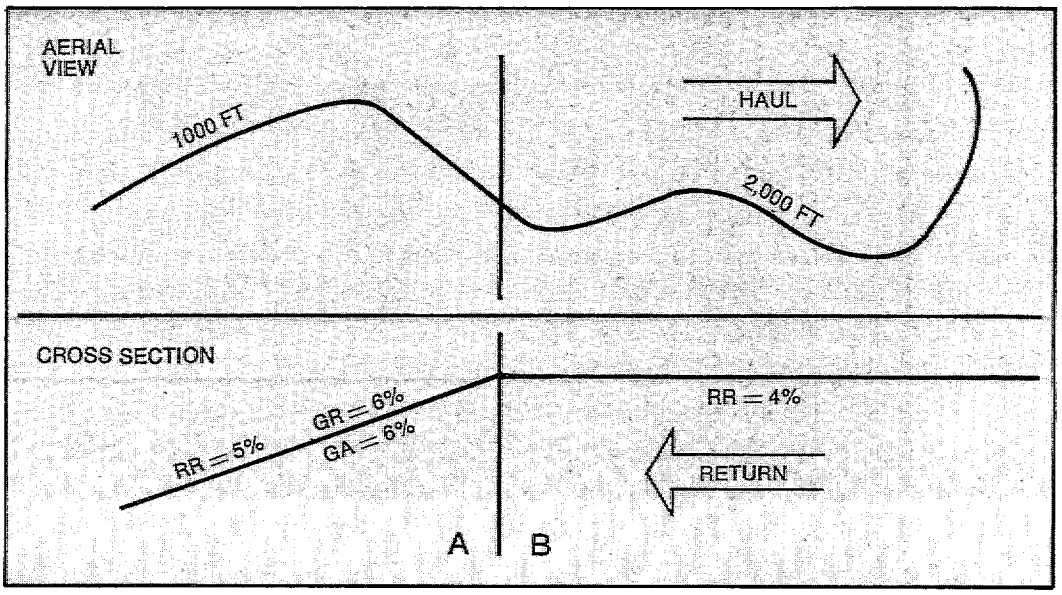


EXAMPLE:

431 PAY SCRAPER
TD-25C PUSHER

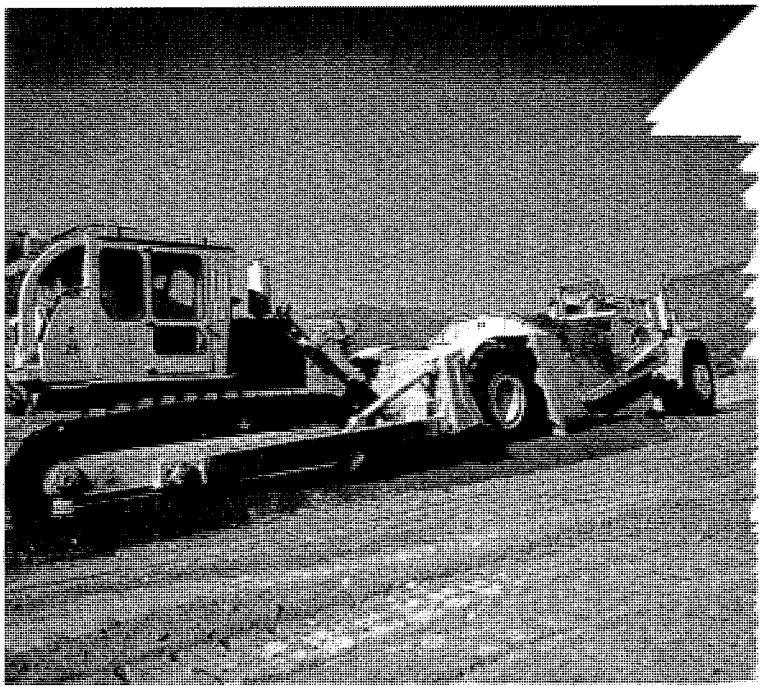
An earthmoving contractor has won a bid to remove 1.5 million bank yards of loam on a highway relocation project. He has one full season to complete the work, in which he figures about 180 work days will be available. He plans to work 10 hours out of every day. Therefore, he has an *hourly* production requirement of 833 BCY. (1,500,000 BCY ÷ [180 days x 10 hrs/day])

The contractor needs to know how many 431 PAY scrapers and TD-25C pushers, under average conditions, will be required. Conditions in the cut area suggest that the back-track method of push-loading will be most efficient. A preliminary map indicates haul road conditions as follows . . .



To determine the required number of scrapers and crawlers, three basic calculations must be made to find . . .

1. Machine Capacity
2. Cycle Time
3. Hourly production of 431 Pay Scraper



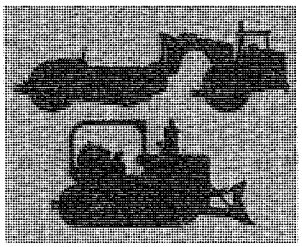
1. MACHINE CAPACITY
   From Table I (page 11) the in-bank weight for a cubic yard of loam is 2,700 lbs/BCY and the in-bank correction factor is 0.83.

   Heaped capacity for the 431 is 21 LCY. Loose weight is simply bank weight times the correction factor, or . . .

   2,700 x 0.83 = 2241 lbs/LCY

   Assuming heaped loads, the 431 will have a payload of

   21 LCY x 2241 lbs/LCY = 47,061 lbs



2. CYCLE TIME
   The four basic cycle segments make up the 431 cycle time . . .

   LOAD TIME
   Under average operating conditions, load time for a single engine push-loaded scraper is 0.60 minutes, as found in Table IV (page 17).

   HAUL TIME
   The first step in finding haul time is to determine the 431's total weight. Recall that GVW is EVW, plus payload. The 431 specification sheet shows an EVW of 59,420 lbs, which when combined with payload, gives the GVW . . .

   59,420 + 47,061 = 106,481 lbs

431 PAYSCRAPER AND TD-25C PUSHER (continued)
HAUL

HAUL SECTION A—

In this section the 431 must overcome RR and GR. Tire penetration is 2 inches, which results in a RR of 5% (Table VIII page 27). The layout shows a 6% adverse grade, so the TR is . . .

5% RR + 6% GR = 11% TR

The maximum attainable speed for this section is found on the performance chart in the specification sheet. Following the procedures outlined on page 28, maximum attainable speed is 8.0 mph.

To find average speed, the maximum attainable speed must be derated by use of the speed factor (Table XI on page 37). For a moving vehicle entering a 1,000 ft section of road, the speed factor is 0.83, but a more realistic figure is 0.75 because the scraper is moving at a relatively slow speed and acceleration must be considered. The average speed is the maximum attainable mph x the speed factor, or . . .

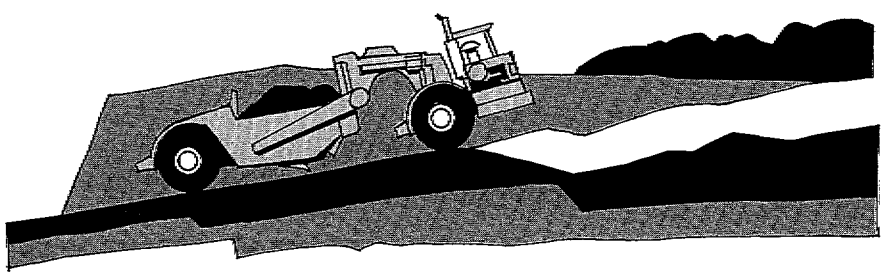
8 mph x 0.75 = 6 mph

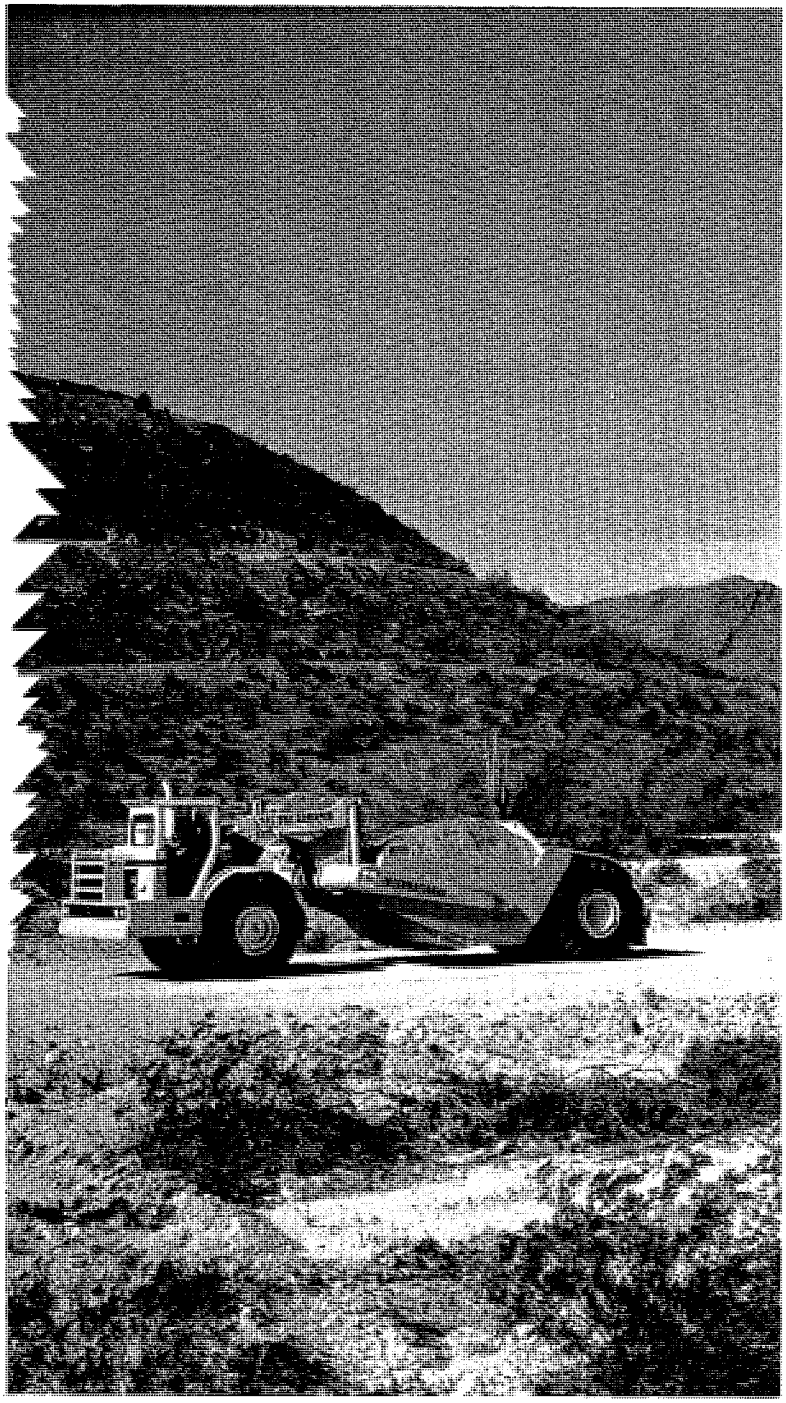
Haul time for Section A, therefore, is found by:

Dividing the distance by the average speed in feet per minute.

$$\text{Time} = \frac{\text{Distance}}{\text{mph x 88}}$$

$$= \frac{1000 \text{ ft}}{6 \text{ mph x 88}} = 1.89 \text{ minutes}$$





HAUL SECTION B –

Tire penetration on this section is estimated to be one inch, which results in a RR of 4% (Table VIII, page 27). There is level grade on this section, so GR is 0%.

$$4\% \text{ RR} + 0\% \text{ GR} = 4\% \text{ TR}$$

With a TR of 4%, the performance chart for the loaded scraper shows a maximum attainable speed of 19 mph. The speed factor for a 2,000 ft section is 0.93 for a moving vehicle entering the section, according to Table XI, page 37. So the average speed is . . .

$$19 \text{ mph} \times 0.93 = 17.7 \text{ mph}$$

Again, applying this to the travel time formula . . .

$$\frac{2000 \text{ ft}}{17.7 \text{ mph} \times 88} = 1.28 \text{ minutes}$$

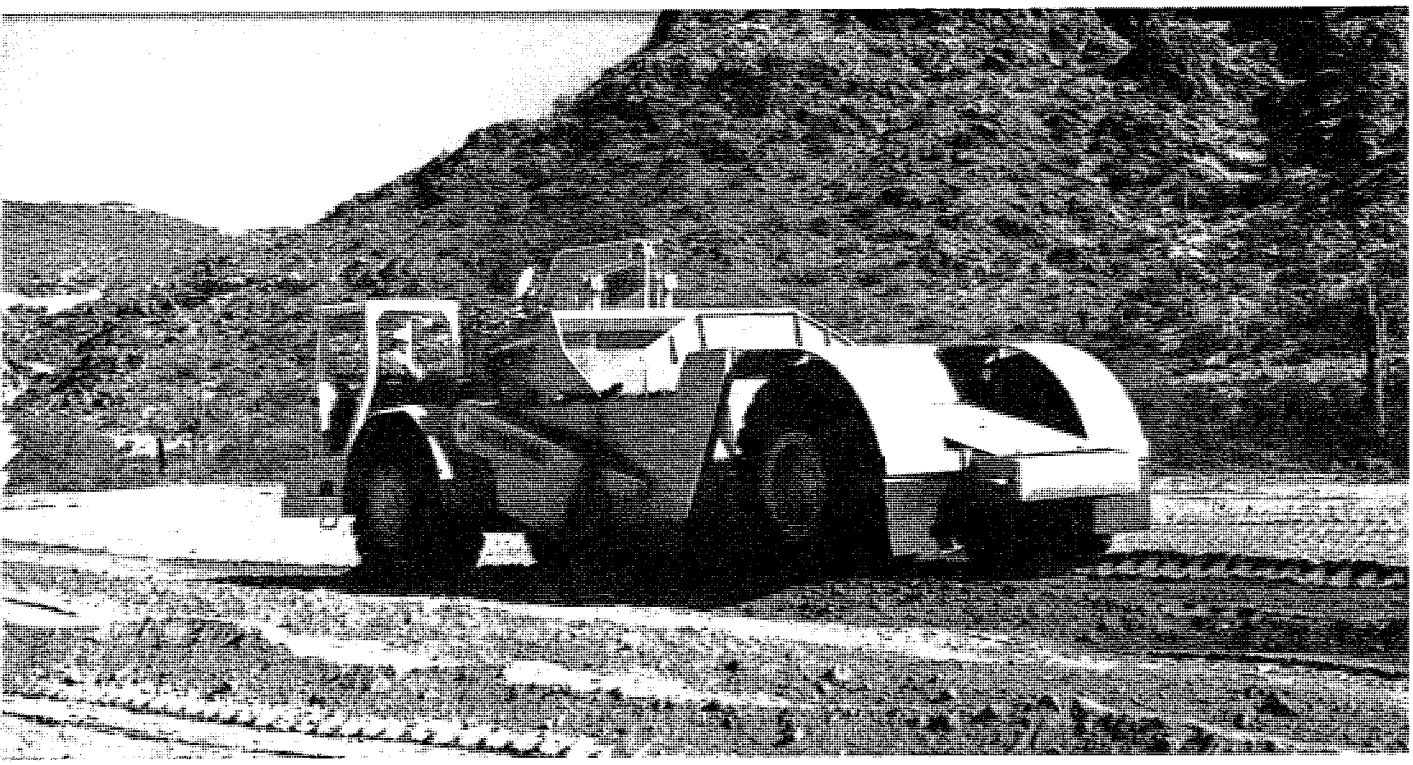
Total haul time is the sum of Section A and Section B, or . . .

$$1.89 + 1.28 = 3.17 \text{ minutes}$$

431 PAYSCRAPER AND TD-25C PUSHER (continued)
DUMP & RETURN

DUMP TIME

According to Table X on page 34, dump time for an open bowl scraper under average conditions is 0.4 minutes. (Dump time includes turning, maneuvering, etc.)



RETURN TIME
RETURN SECTION B

There are no grades on this section, but the scraper encounters a RR of 4%. The machine is empty, with an EVW of 59,420 lbs. The performance chart shows a maximum attainable speed of 32 mph under these conditions.

The speed factor for this 2,000 ft section of road the vehicle already underway is 0.93 (p. 37). Therefore, average speed is . . .

$$32 \text{ mph} \times 0.93 = 29.8 \text{ mph}$$

The travel time formula as applied to Return Section B . . .

$$\frac{2{,}000 \text{ ft}}{29.8 \text{ mph} \times 88} = 0.76 \text{ minutes}$$

RETURN SECTION A

When returning over Section A the 431 moves down a 6% grade. RR is still 5%, so TR becomes . . .

$$5\% \text{ RR} - 6\% \text{ GA} = 1\% \text{ TA}$$

With no retarder, the scraper's maximum speed of 35 mph is assumed to be attainable. Considering safety, the speed factor on a 1,000 ft. stretch for a vehicle underway is 0.75 (p. 37) so average speed is . . .

$$35 \text{ mph} \times 0.75 = 26.3 \text{ mph}$$

Apply the formula and return time for Section A becomes . . .

$$\frac{1{,}000 \text{ ft}}{26.3 \text{ MPH} \times 88} = 0.43 \text{ minutes}$$

Total return time is the sum of Section B and Section A . . .

$$0.76 + 0.43 = 1.19 \text{ minutes}$$

431 PAYSCRAPER AND TD-25C PUSHER (continued)
CONCLUSION

TOTAL CYCLE TIME

Total cycle time is found by adding the cycle segments . . .

Load	0.60
Haul	3.17
Dump	0.40
Return	1.19
Total Cycle Time	5.36 min

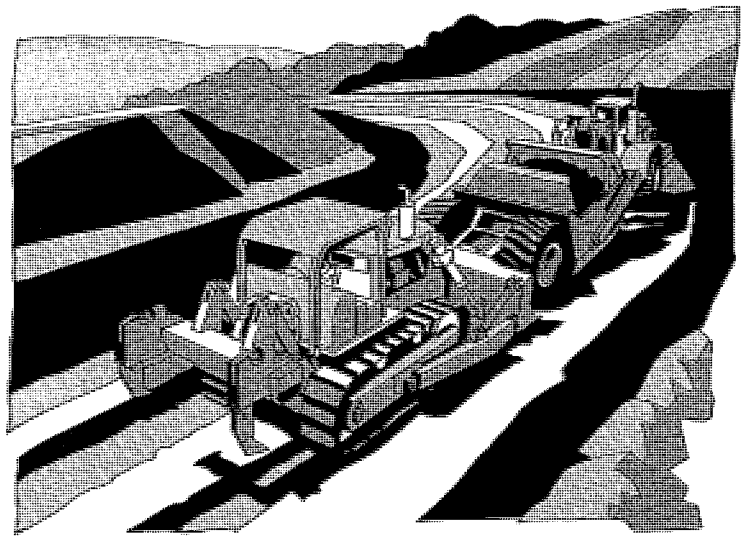
HOURLY PRODUCTION

Assuming a 45 minute hour (page 43), hourly production of a 431, in BCY, is obtained by application of the basic formula . . .

$$P = I\,H \times \frac{E}{C}$$

$$P = 0.83 \times 21\ \text{LCY} \times \frac{45\ \text{min/hr}}{5.36\ \text{min}}$$

$$P = 146\ \text{BCY/hr}$$



EQUIPMENT REQUIREMENTS

The number of scrapers needed to complete the job in the allotted time is found by dividing the required hourly yardage of the project by one scraper's hourly production.

$$\frac{\text{Hourly Required Production}}{\text{Production Per Scraper}} = \text{No. of Scrapers Required}$$

$$\frac{833\ \text{BCY}}{146\ \text{BCY}} = 5.7 \text{ or six PAY scrapers*}$$

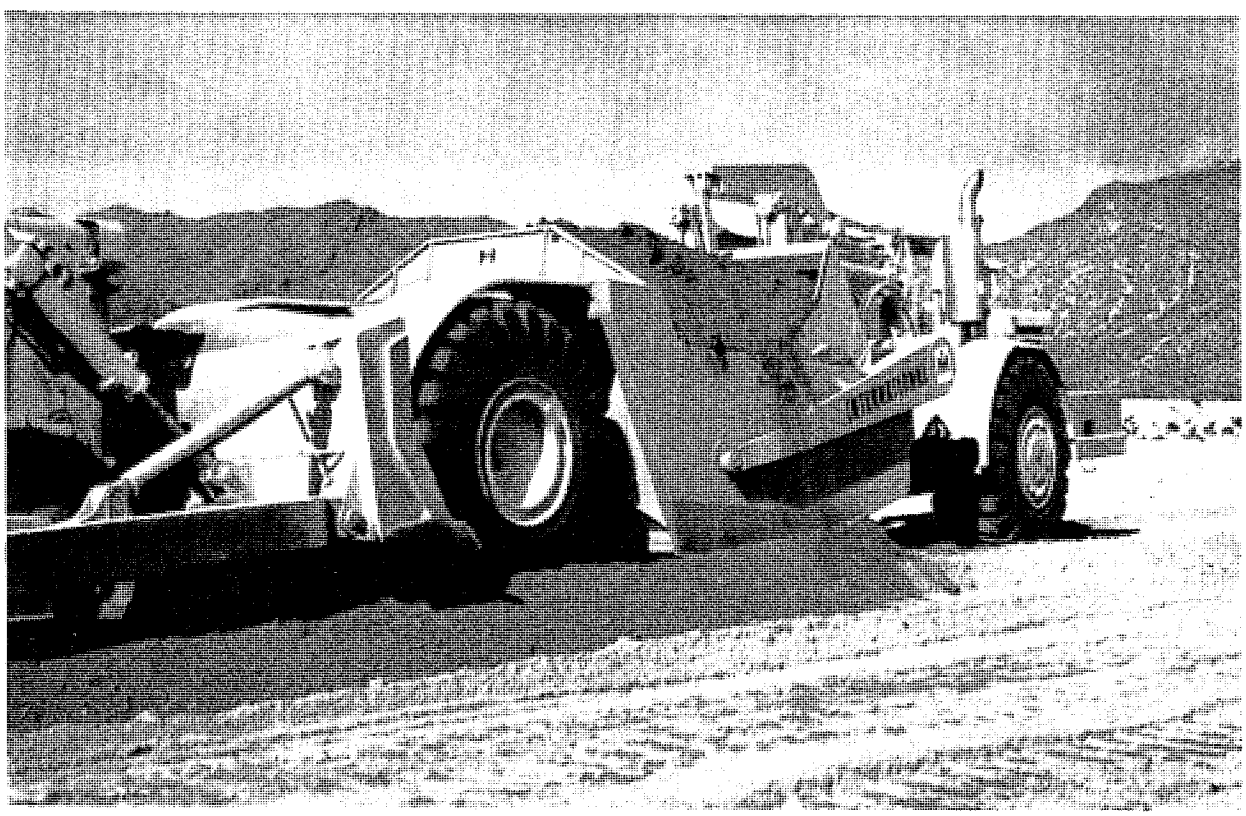
Total scraper requirement would be filled by six 431 PAY scrapers.

The required number of pushers is determined by use of Table III (page 17) where cycle time for the back-track loading method is 1.3 min under average conditions.

$$\frac{\text{Scraper Cycle Time}}{\text{Pusher Cycle Time}} = \text{No. of Scrapers Per Pusher}$$

$$\frac{5.36\ \text{min}}{1.30\ \text{min}} = 4$$

In this example, one TD-25C can efficiently handle four scrapers. Therefore, two TD-25C pushers will be required.



*In actual production estimates, you will find that equipment requirements rarely work out to an even number of machines. Normally regard each fraction of a machine as one unit.

EXAMPLE:

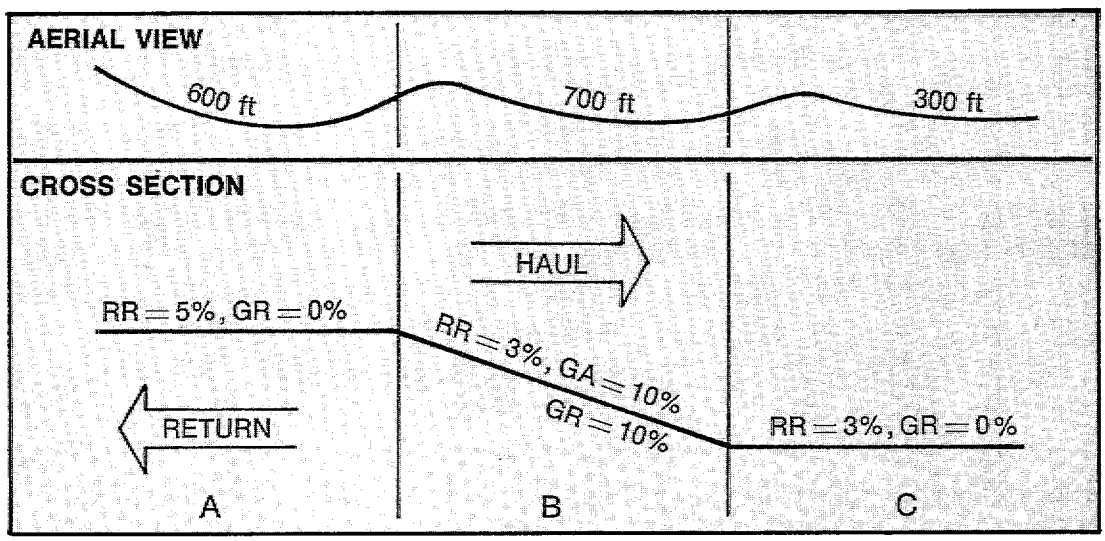
350 PAY HAULER AND H-400C PAY LOADER

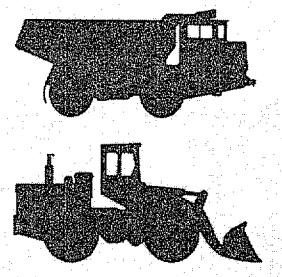
A contractor is considering the purchase of an H-400C and a number of 50 ton 350 PAY haulers to remove shot granite. The granite will be well blasted. The trucks and loader will be working under average conditions. The contractor expects an efficiency hour of 50 minutes.

With the haul road laid out as shown, how many 350s will be required to remove 1000 tons per hour?

In order to find the number of 350s required, we must first estimate . . .

1. Machine Capacity
2. Cycle Time
3. Hourly Production of 350s





1. MACHINE CAPACITY

From Table II on page 13 we see that the capacity factor for a front-end loader bucket loading well blasted rock is 0.85. The capacity of the H-400C is therefore...

Rated Capacity x Capacity Factor
11 cu yd x 0.85 = 9.4 cu yd

If we assume 4 passes of the H-400C will be utilized to load the 350, the capacity of the 350 will be . . .

No. of passes x Loader capacity
4 x 9.4 cu yd = 37.6 cu yd

Granite has a bank weight of 4,600 lbs/BCY and an IBCF of 0.56. Therefore, the Loose weight is . . .

4,600 lbs/BCY x IBCF (0.56)
= 2,576 lbs/LCY.

Carrying 37.6 cu yds per each cycle, the payload for the 350 is . . .

Capacity (37.6 cu yd) x Loose wt. (2576 lbs/LCY)
= 96,858 lbs
= 48.4 tons

Since the 5th pass would overload the 350, our assumption of 4 passes was correct.

2. CYCLE TIME

Once again the cycle time is equal to Load Time + Haul Time + Dump Time + Return Time.

LOAD TIME

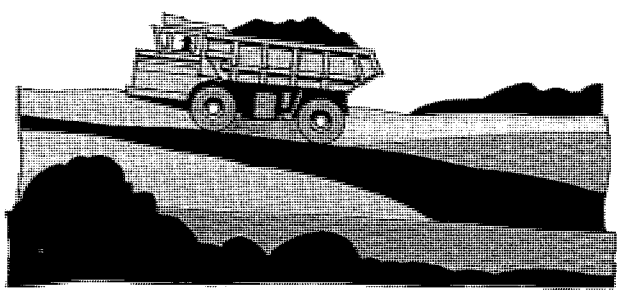
Working in average conditions an H-400C, loading trucks, will cycle in 0.50 min (Table V, page 19). Therefore, the loading time is . . .

Loader Cycle Time x No. of Passes
0.50 x 4 = 2.00 min

350 PAY HAULER AND H-400C PAY LOADER (continued)
HAUL

HAUL TIME

Total Weight must be considered when determining haul time. The machine's GVW which is EVW (72,800 lbs) + payload (96,858 lbs) = 169,658 lbs



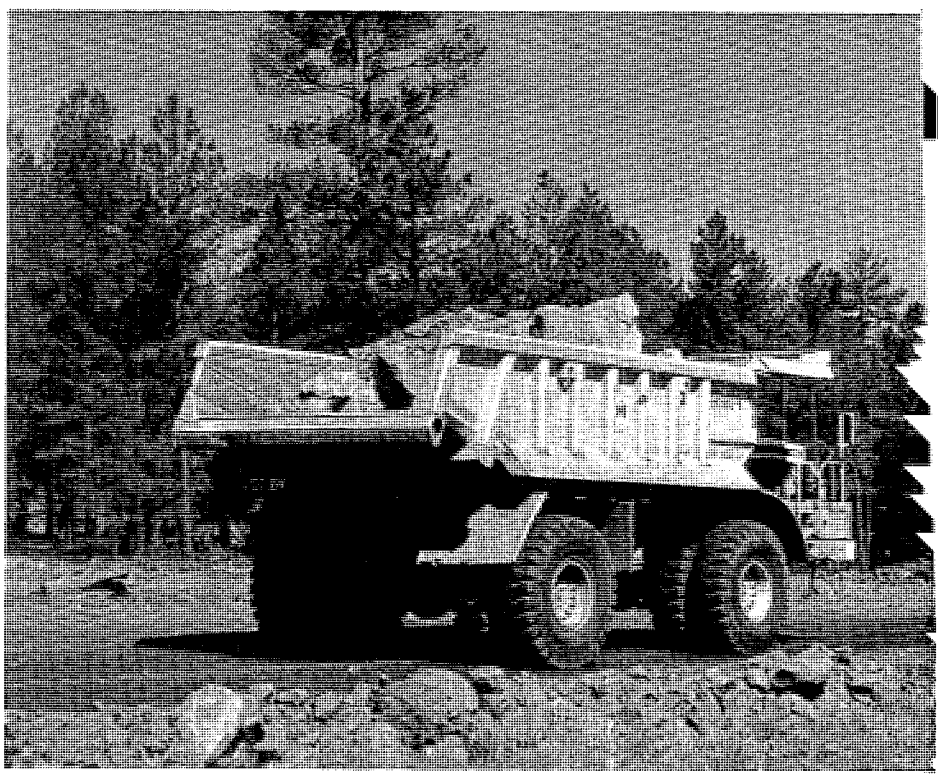
SECTION A

Examining the haul road layout for Section I, we see that the TR is RR (5%) + GR (0%) or 5%.

The maximum attainable speed is read from the performance chart (following procedure on page 28) to be 19.5 mph.

The speed factor for a 600 ft section, vehicle starting from a stop, is 0.48 (p. 37). The average speed for Section A is maximum attainable speed (19.5 mph) x speed factor (0.48) = 9.4 mph.

$$\text{Haul Time Section A} = \frac{\text{Distance (600 ft)}}{\text{Speed (9.4 mph)} \times 88} = 0.73 \text{ min}$$



SECTION B

Examining the haul road layout, we see that the TR for Section B is . . .

RR (3%) − GA (10%) or a TA of 7%

The maximum safe speed under these conditions is read from the retarder performance chart to be 16.0 mph.

The appropriate speed factor for a 700 ft section, vehicle moving when entering, is 0.72 (p. 37). The average speed is maximum attainable speed (16.0 mph) x speed factor (0.72) = 11.5 mph.

Haul time Section B is . . .

$$\frac{\text{Distance (700 ft.)}}{\text{Speed (11.5 mph) x 88}} = 0.69 \text{ min}$$

SECTION C

Examining the haul road layout we see that Section C has a RR of 3% and GR of 0% so the TR = RR (3%) + GR (0%) or a TR of 3%.

Using the performance chart shown on the 350 specification sheet and our parameters of TR = 3%, and GVW of 169,658 lbs, the maximum attainable speed is found to be 32.5 mph.

The speed factor for a 300 ft section, vehicle coming to a stop, is 0.39 (p. 37).

Average speed = Max. Attainable Speed (32.5 mph) x Speed Factor (0.39) = 12.7 mph.

$$\text{Haul Time Section C} = \frac{\text{Distance (300 ft)}}{\text{Speed (12.7 mph) x 88}} = .27 \text{ min}$$

Total Haul Time = Summation of Sections A, B & C

Haul Time = 0.73 min + 0.69 min + 0.27 min = 1.69 min

350 PAYHAULER AND 400C PAYLOADER (continued)
DUMP & RETURN

DUMP TIME

Dump time for an end-dump truck working under average conditions is found from Table X (page 34) to be . . . 1.00 min

RETURN TIME

SECTION C

Returning over Section C the 350 must overcome a TR of RR (3%) + GR (0%) or 3%. The machine is empty so the EVW is used along with the TR of 3% to read the max. attainable speed of 34.0 mph off the performance chart.

An appropriate speed factor for a 300 ft section, vehicle starting from a stop, is 0.39 (p. 37). The average speed is max. attainable speed (34 mph) x speed factor (0.39) or 13.3 mph.

$$\text{Return Time Section C} = \frac{\text{Distance (300 ft)}}{\text{Speed (13.3 mph)} \times 88} = 0.26 \text{ min}$$

SECTION B

Retracing Section B we see that TR = RR (3%) + GR (10%) = 13%.

The maximum attainable speed is found from the performance chart, using TR = 13% and EVW line, to be 16 mph.

The speed factor for a 700 ft section, vehicle moving when entering, is 0.72 (p. 37).

Average Speed = Max. Attainable Speed (16 mph) x Speed Factor (0.72) = 11.5 mph

$$\text{Return Time Section B} = \frac{\text{Distance (700 ft)}}{\text{Speed (11.5 mph)} \times 88} = 0.69 \text{ min}$$

SECTION A

The haul road layout shows a GR of 0% and a RR of 5%.

The maximum attainable speed read from the performance chart is 34 mph.

For a 600 ft section, vehicle coming to a stop, the speed factor is 0.48 (p. 37).

Average Speed = Max. Attainable Speed (34 mph) x Speed Factor (0.48) = 16.3 mph

$$\text{Return Time Section A} = \frac{\text{Distance (600 ft)}}{\text{Speed (16.3 mph)} \times 88} = 0.42 \text{ min}$$

Total Return Time is equal to the summation of Sections C, B and A.

Return Time = 0.26 min + 0.69 min + 0.42 min = 1.37 min

CYCLE TIME

Cycle time for the 350 is . . .

Load		2.00
Haul		1.69
Dump		1.00
Return		1.37
Total Cycle Time	=	6.06 min

CONCLUSIONS:

Applying the production formula . . .

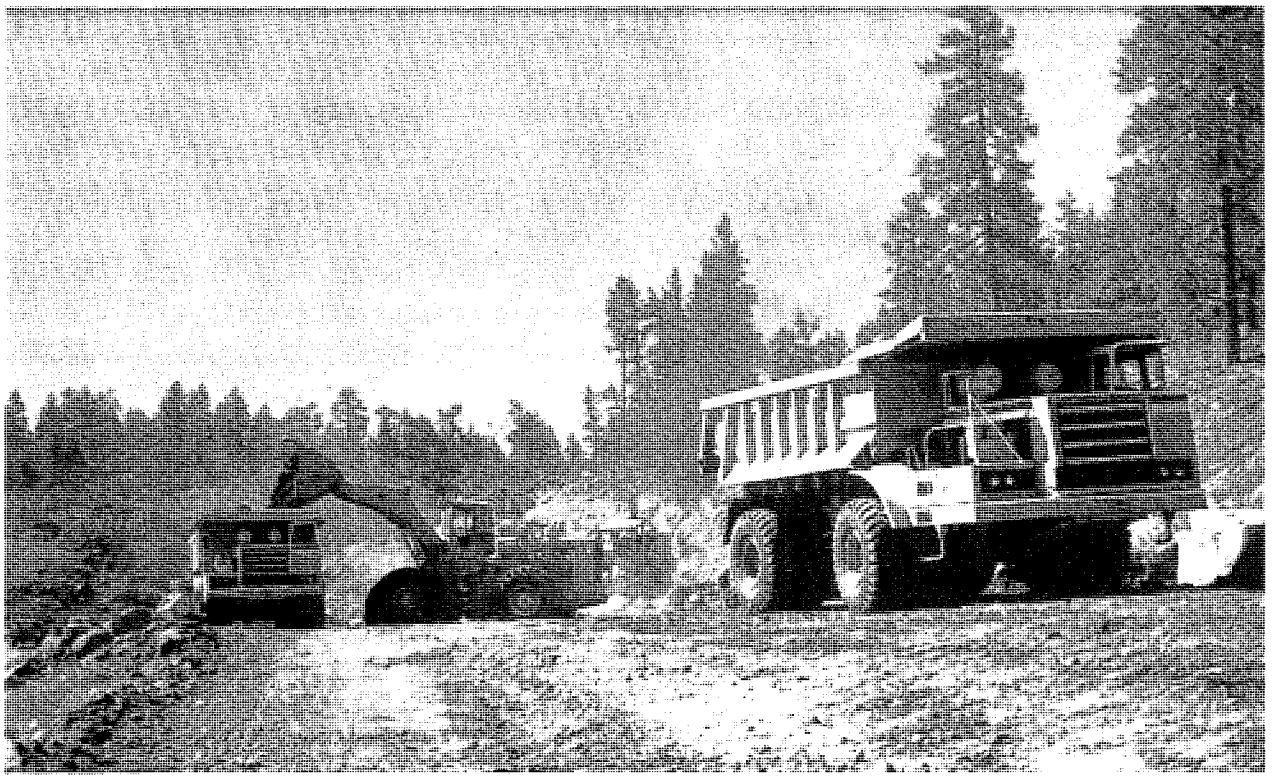
$$P = 48.4 \text{ tons } \times \frac{50 \text{ min/hr}}{6.06 \text{ min}}$$

$$P = 399 \text{ TPH}$$

NOTE: The IBCF is not used here because we are dealing with tons and not BCY.

The project has a required volume of 1000 TPH, therefore, the number of 350's required . . .

$$\frac{\text{Required Production (1000 TPH)}}{\text{Production per Machine (399 TPH)}} = 2.5 \text{ or three 350 PAY haulers}$$

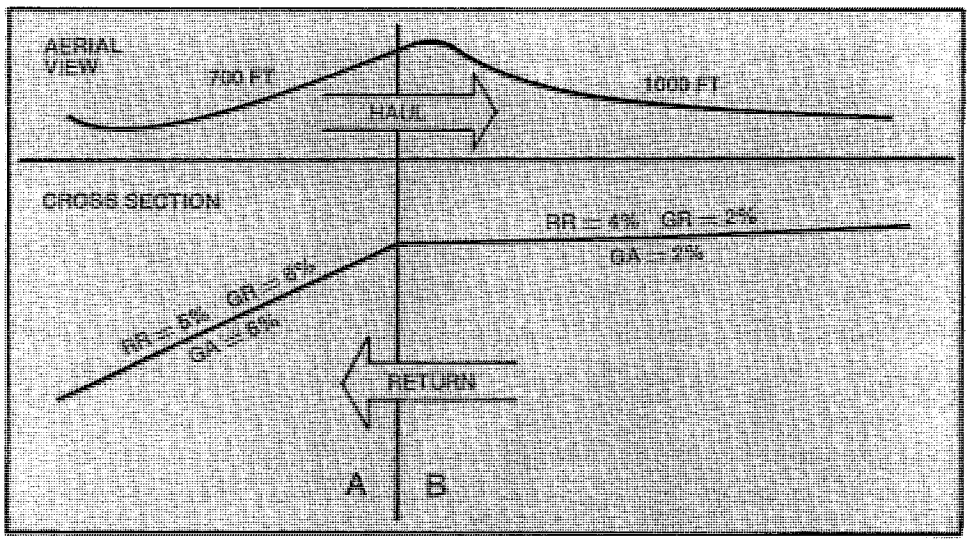


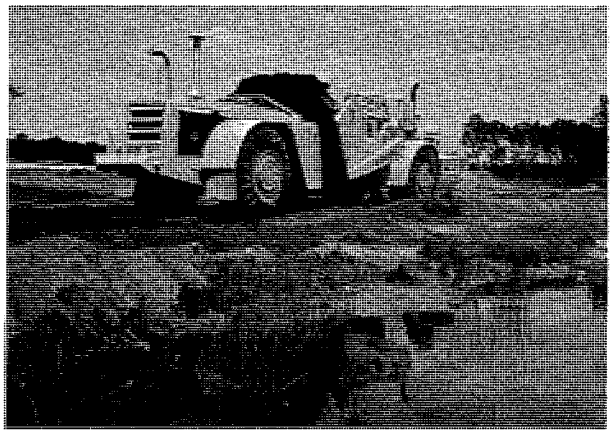
EXAMPLE: 444 PAY SCRAPER

A site preparation contractor, moving 500,000 bank cubic yards of dry clay over a 2-section haul road, has 140 ten hour work days to complete the job. He plans to use the 444 elevating PAY scraper for the earthmoving operation, and needs to know how many machines will be required.

The three basics again must be calculated . . .

1. Machine capacity
2. Cycle Time
3. Production





1. MACHINE CAPACITY
   Dry clay weighs 2,300 lbs/BCY and has an IBCF of 0.85 according to Table I. So the loose weight is 2,300 lbs x 0.85 or 1,955 lbs/LCY. With a 22-yd heaped capacity, the 444 will carry a payload of (22 cu yd x 1,955 lbs) 43,010 lbs.
2. CYCLE TIME
   LOAD TIME—According to Table IV, a dual engine elevating scraper will load in about 0.60 minutes under average conditions.

HAUL TIME

On Section A the 444 must overcome a TR of 11% (5% RR + 6% GR). EVW from the specification sheet plus payload (80,510 + 43,010) results in a GVW of 123, 520 lbs.

Following the 123,520 lb line on the performance chart to the 11% TR line, a maximum attainable speed of 11.0 mph is obtained. Because the unit is moving into this section, an appropriate speed factor from Table XI is 0.72, which provides an average speed of 7.9 mph (0.72 x 11.0 mph = 7.9 mph average speed)

The traveling time for this section would be:

$$\frac{\text{Distance (700 ft)}}{\text{7.9 mph x 88}} = 1.01 \text{ min}$$

HAUL TIME

Section B presents a 4% RR and 2% GR, for a TR of 6%. Tracing the 123,520 lb GVW line to 6% total resistance on the performance chart, the maximum attainable speed is 17 mph

An appropriate speed factor from Table XI is 0.79, so the average speed is (17 x 0.79) 13.4 mph .

Apply the formula to Haul Section B . . .

$$\frac{\text{Distance (1,000 ft)}}{\text{13.4 mph x 88}} = 0.85 \text{ min}$$

Total haul time . . .

Section A	1.01
Section B	0.85
	1.86 min

444 PAYSCRAPER (continued)
DUMP & RETURN

DUMP TIME

The turn and dump interval for elevating scrapers under average conditions, according to Table X is 0.50 min.

RETURN TIME

SECTION B

Returning empty with a 4% RR, and a 2% GA (TR = 2%) the scraper obtains a maximum speed of 33.5 mph, as shown in the performance chart. The speed factor is 0.83 (p. 37), so the average speed is 0.83 x 33.5 = 27.8 mph.

Application of the formula gives the travel time . . .

$$\frac{\text{Distance (1,000 ft)}}{\text{27.8 mph x 88}} = 0.41 \text{ min}$$

SECTION A

Returning down the 6% grade the scraper has the benefit of a 1% TA (5% RR − 6% GA). With no retarder, a maximum speed of 35.0 mph is applied. With deceleration and safety considerations taken into account, a realistic speed factor is 0.65 from Table XI. That reduces maximum speed to an average speed of (35.0 x 0.65) 22.8 mph.

With the travel time formula, the return time for Section A becomes . . .

$$\frac{\text{Distance (700 ft)}}{\text{22.8 mph x 88}} = 0.35 \text{ min}$$

TOTAL RETURN TIME IS . . .

Return Section B	0.41
Return Section A	0.35
Total return time	0.76 min

TOTAL CYCLE TIME
For the 444 under these conditions is . . .

Load	0.60
Haul	1.86
Dump	0.50
Return	0.76
Total CT	3.72 min

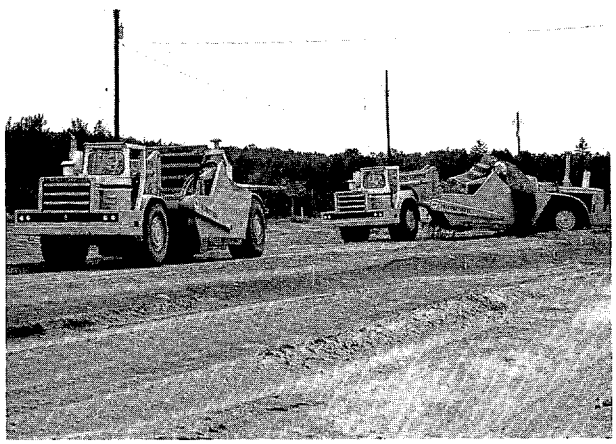
CONCLUSIONS:

With an Efficiency Hour of 50 minutes, the basic formula is now applied.

$$P = IH \times \frac{E}{C}$$

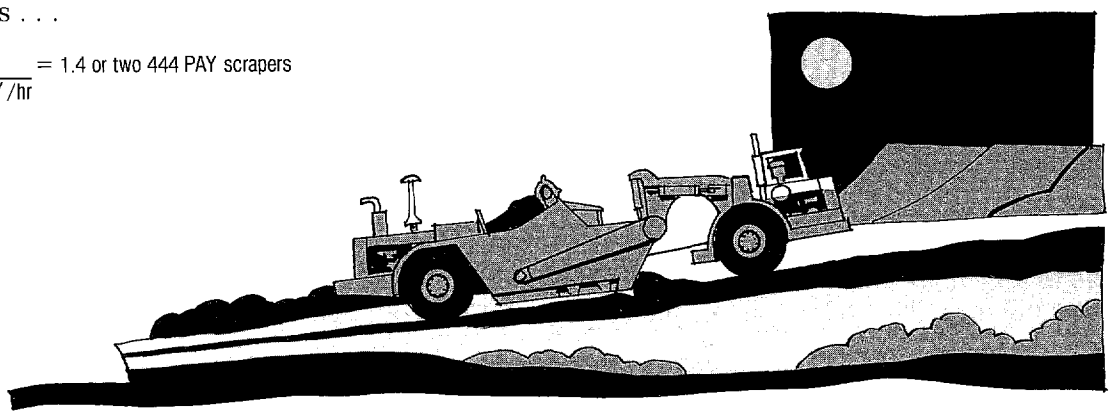
$$P = 0.85 \times 22 \text{ LCY} \times \frac{50 \text{ min/hr}}{3.72 \text{ min}}$$

$$P = 251 \text{ BCY/hr}$$



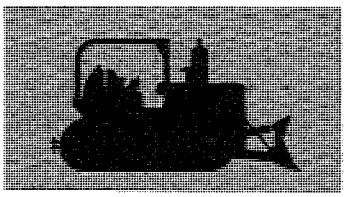
EQUIPMENT REQUIREMENTS
With 140 10-hour days, and 500,000 BCY to move, the contractor requires two 444 PAY scrapers . . .

$$\frac{500{,}000 \text{ BCY}}{1400 \text{ hrs} \times 251 \text{ BCY/hr}} = 1.4 \text{ or two 444 PAY scrapers}$$



EXAMPLE: TD-25C CRAWLER DOZER

A mining company is scheduling a number of reclamation projects wherein several old pits are to be filled with borrow material consisting of earth, sand and gravel. A TD-25C with semi-U blade is available for the work, and the company must determine approximately how long it will take to complete the job.



The first pit requires about 70,000 bank cubic yards of fill, to be dozed a distance of 200 feet. Forward motion of the machine is limited to third range, and reverse speed is 5 mph. What is the hourly production, and how many 10-hour days will be required?

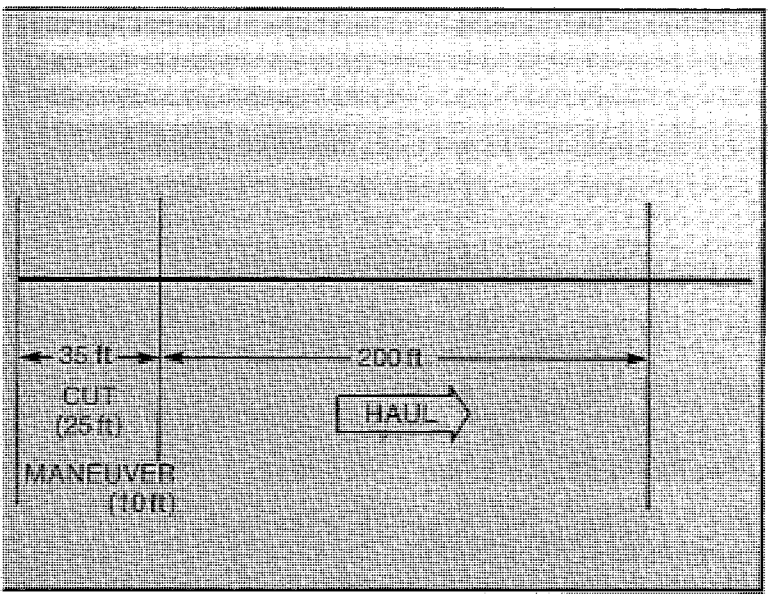


Table I on page 11 shows an IBCF of 0.90 for this material, along with a bank weight of 3,100 lbs/yd. To estimate hourly production we must determine . . .

1. Machine Capacity
2. Cycle Time
3. Production

1. MACHINE CAPACITY

Use of the blade capacity formula on page 13 shows that the TD-25C semi-U blade will handle 10.1 cubic yards . . .

$$\text{Capacity} = \frac{H^2 \times W}{52{,}500}$$

$$= \frac{57.7^2 \times 158.5}{52{,}500} = 10.1 \text{ cu yd}$$

With a loose material weight of 2,790 lbs (3,100 x 0.9) the payload per pass becomes . . .

$$10.1 \times 2{,}790 = 28{,}179 \text{ lbs}$$

2. CYCLE TIME

LOAD TIME

A crawler dozer normally loads in 0.15 to 0.20 minutes (p. 20). Earth, mixed with sand and gravel, is a fairly difficult material to handle, so a conservative 0.18 minutes will be used for load time.

HAUL TIME

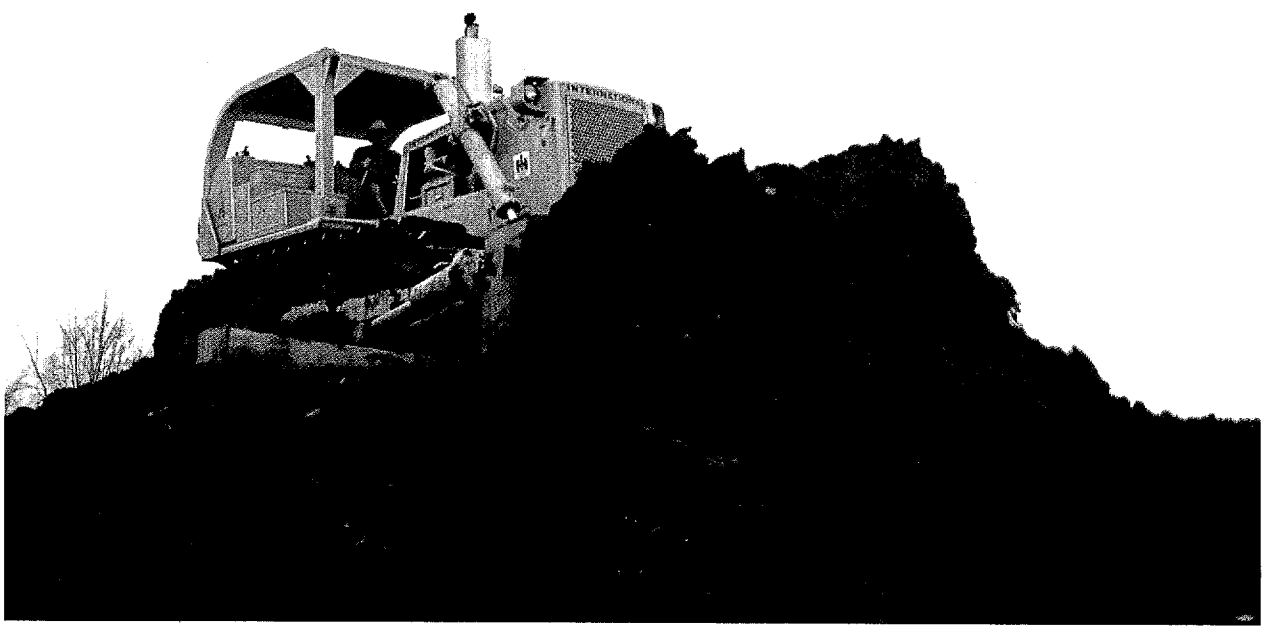
The only resistance for the crawler to overcome is that produced by the friction of the material in front of the blade. The coefficient of friction for this material according to Table IX on page 33 is approximately 0.60, so, the amount of drawbar pull required to move this load is:

Load Weight x Coefficient of Friction
28,179 x 0.60 = 16,907 lbs DBP

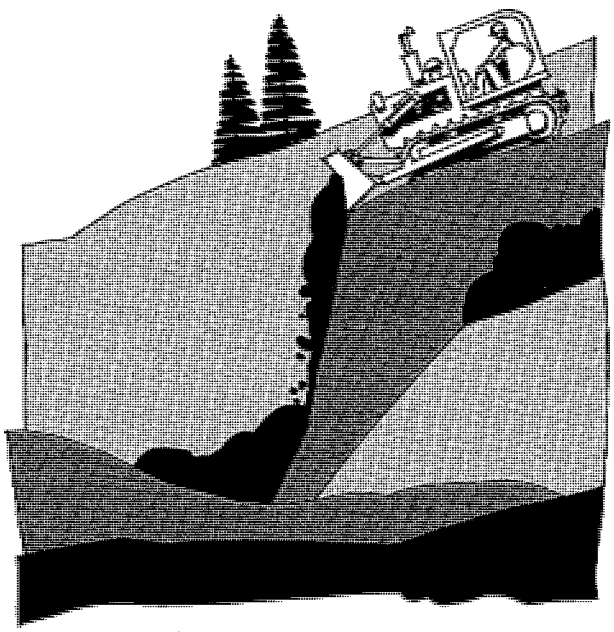
According to the TD-25C performance chart, the speed corresponding to 16,907 lbs DBP is 4.3 mph (in the third range). Thus, the time it takes the TD-25C to move its load 200 ft is derived by use of the travel time formula . . .

$$\frac{\text{Distance (200 ft)}}{4.3 \text{ mph} \times 88} = 0.53 \text{ min}$$

Note: Speed Factors do not apply to crawler hauling speeds



TD-25C CRAWLER DOZER (continued)



DUMP TIME
A standard dump time of 0.1 can be used on this project (page 34).

RETURN TIME
With a 5 mph reverse speed, the time formula is applied again . . .

$$\frac{\text{Distance (235 ft)}}{\text{5 mph x 88}} = 0.53 \text{ min}$$

(NOTE that an extra 35 feet has been added to compensate for positioning and maneuvering (10 ft)—loading (25 ft).

Total cycle time is the sum of:

Load	0.18
Haul	0.53
Dump	0.10
Return	0.53
Total Cycle Time	1.34 min

3. PRODUCTION
An efficiency hour of 50 minutes can be used under these conditions, so the basic formula looks like this . . .

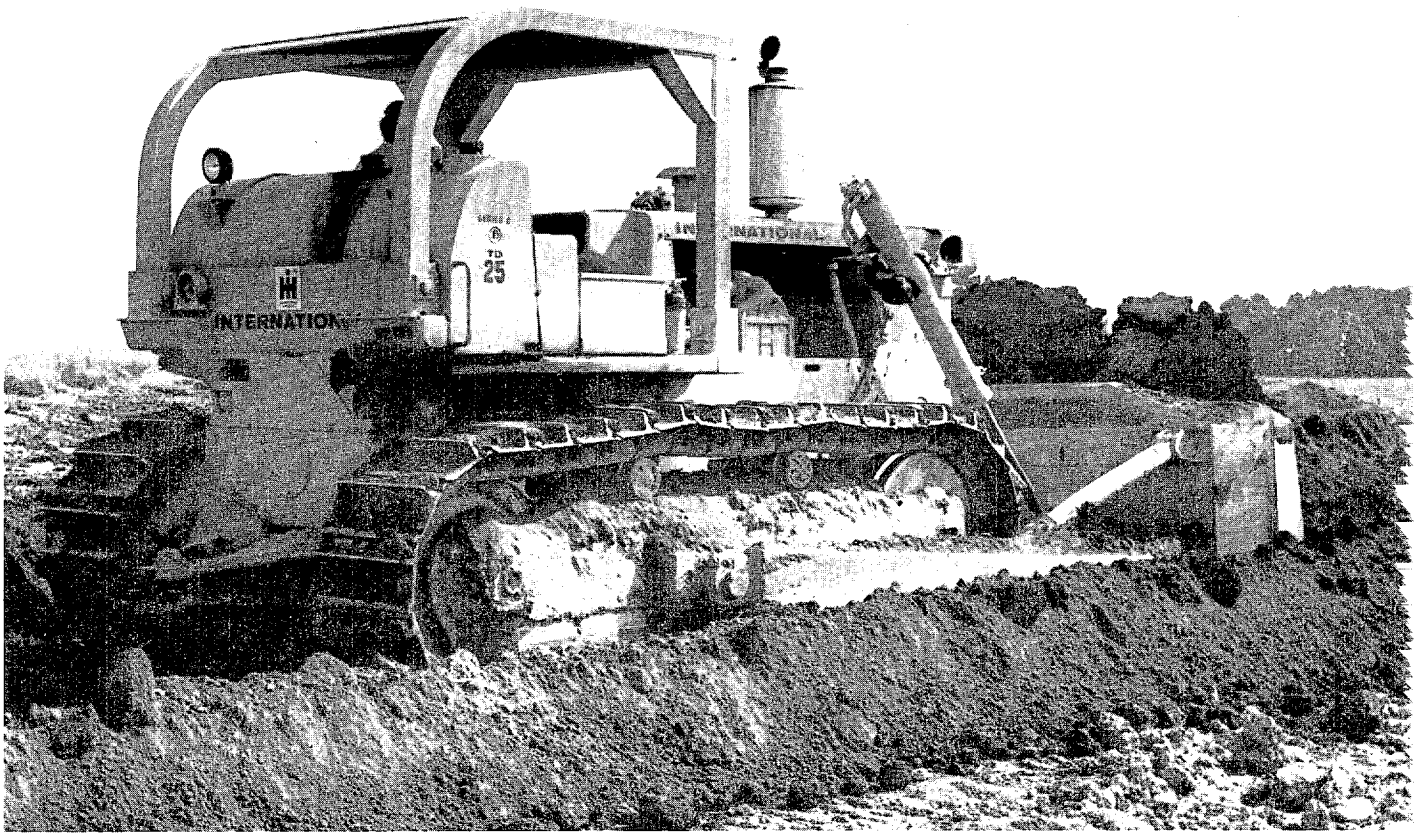
$$P = IH \times \frac{E}{C}$$

$$P = 0.90 \times 10.1 \text{ LCY} \times \frac{50 \text{ min/hr}}{1.34 \text{ min}}$$

$$P = 339 \text{ BCY/hr}$$

CONCLUSION

With 70,000 yards to move, the TD-25C will complete the first pit in 210 hours, or twenty-one 10-hour days.


INTERNATION
25

EXAMPLE: 3984 HYDRAULIC EXCAVATOR

An industrial development contractor on a site preparation job has encountered a layer of wet clay. The material is not suitable for fill, so it must be hauled several miles over public roads to a disposal site. The contractor owns an International 3984 hydraulic excavator with a ⅞ cu yd bucket, that would be ideal for removing this material. Digging at a depth of 15 ft, and loading at a 90 degree swing, he needs to know if the excavator can produce the 50 BCY/hr required to handle his fleet of trucks.

DEPTH FACTOR	
Depth in Feet	Factor
5	1.00
10	0.95
15	0.87
20	0.78

SWING ANGLE	
Angle (In Degrees)	Factor
45	1.00
60	.95
75	.90
90	.86
120	.81
180	.71

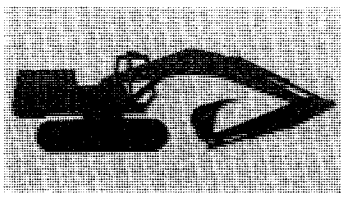
Excavator production calls for a slightly different estimating method, based on a standard figure of 155 cycles per 60 min hour.* As material loadability, swing angle and digging depth change, the number of cycles per hour will be adjusted by the appropriate factors, as given in the tables shown below.**

These factors have been calculated to provide for the extra time required in performing any operation beyond the standards noted above. Digging depth, for example, has been factored for trenches deeper than five feet. The swing angle factor accounts for any distance the bucket must swing beyond the standard 45 degrees. And the loadability factor takes into consideration the extra time consumed in excavating difficult material.

MATERIAL LOADABILITY		
Conditions	Type of Material	Factor
Favorable	Loam, sand, gravel	0.85 - 1.00
Average	General earth, clay	0.65 - 0.85
Unfavorable	Rock, roots, gumbo, etc.	0.50 - 0.65

*The standard figure has been calculated as follows: An excavator rated at 1 cu yd or less, working in easily loaded material, digging to a 5-ft depth, and with a 45 degree swing.

**Spotting time is assumed to be negligible in this example.



In our example, careful consideration of job conditions and the three factors results in the following . . .

	Factors
Material Loadability	0.75
Digging Depth	0.87
Swing Angle	0.86

When these factors are applied to the standard 155 cycles per hour, the number of cycles to expect under these conditions is . . .

$$155 \times 0.75 \times 0.87 \times 0.86 = 87 \text{ cycles/hr}$$

Once the cycles-per-hour rate has been established, BCY production is found by means of the following formula . . .

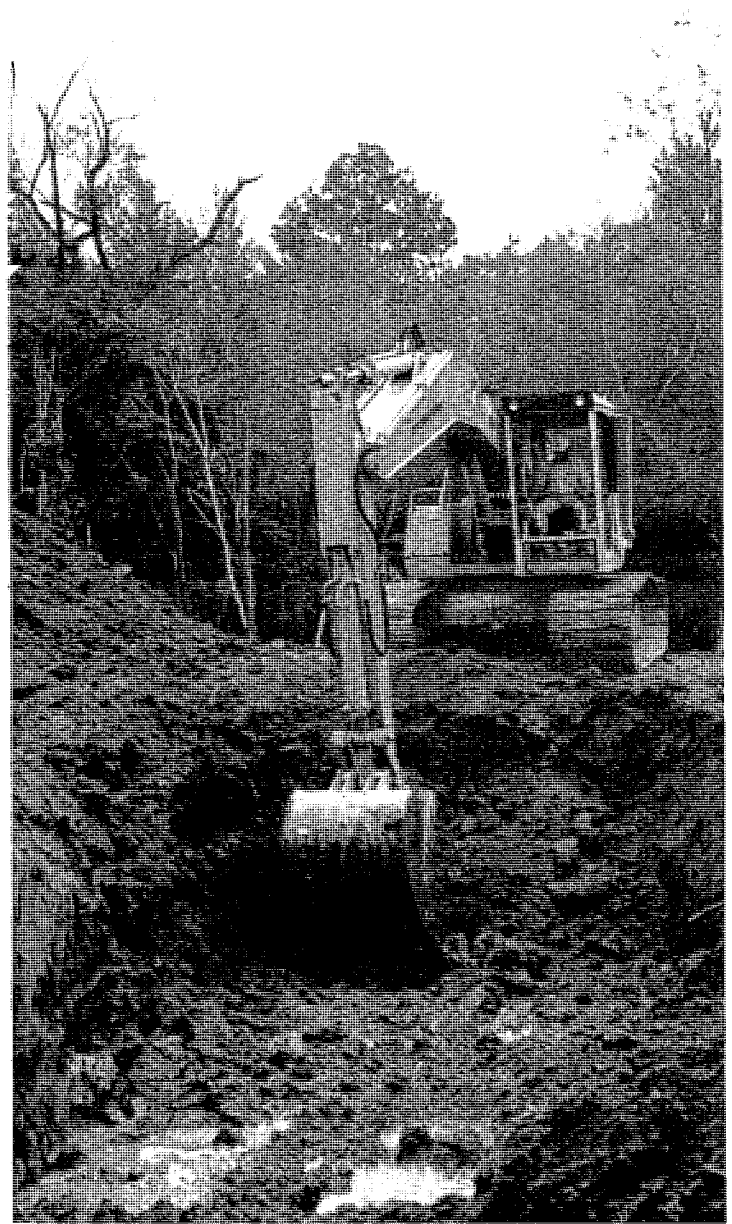
$$\text{Production (BCY)} = \begin{matrix}\text{In-Bank}\\ \text{Correction}\\ \text{Factor}\end{matrix} \times \begin{matrix}\text{Bucket}\\ \text{Capacity}\\ \text{(cu yd)}\end{matrix} \times \frac{\text{Efficiency Hour}}{60} \times \text{Cycles /hr}$$

A 55-minute Efficiency Hour is assumed for the machine on this job, so . . .

$$P = 0.75 \times \tfrac{7}{8} \text{ cu yd} \times \frac{55 \text{ min/hr}}{60 \text{ min/hr}} \times 87 \text{ cycles/hr}$$

$$P = 52 \text{ BCY/Hr}$$

The 3984 will be adequate to meet the contractor's 50 BCY per hour loading requirement.



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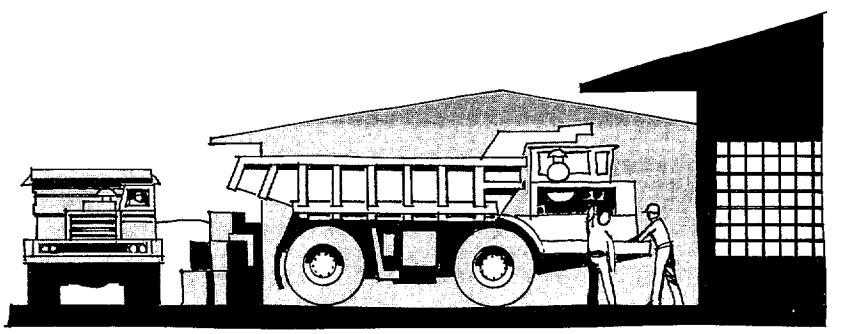
OWNING AND OPERATING COSTS

Profit depends on the margin between cost of moving material and bid price for doing the work. Minimizing cost per yard, therefore, is the key to success in the earthmoving business. Once a reliable production estimate has been developed, the next step is to calculate the cost of that production. Costs per yard are found by dividing the cost of owning and operating the machines by their estimated production, usually on an hourly basis.

Ownership costs are costs incurred by simply having the machines, whether they are working or not.

Operating costs represent the expenses of operating the equipment, such as fuel, lube, service, labor, etc.



HOURLY OWNERSHIP COSTS

Ownership costs are broken down into two categories: Depreciations costs, and costs due to Interest, Insurance and Taxes. They are rarely charged off on any single job. Instead, they are reduced to an hourly figure and prorated over the assumed useful life of the machine. Useful life is determined by wear and obsolescence based on the owner's experience. Table XIII can be used as a guide in determining an estimated useful life (in hours) of machines under various conditions, if no previous figures are available.

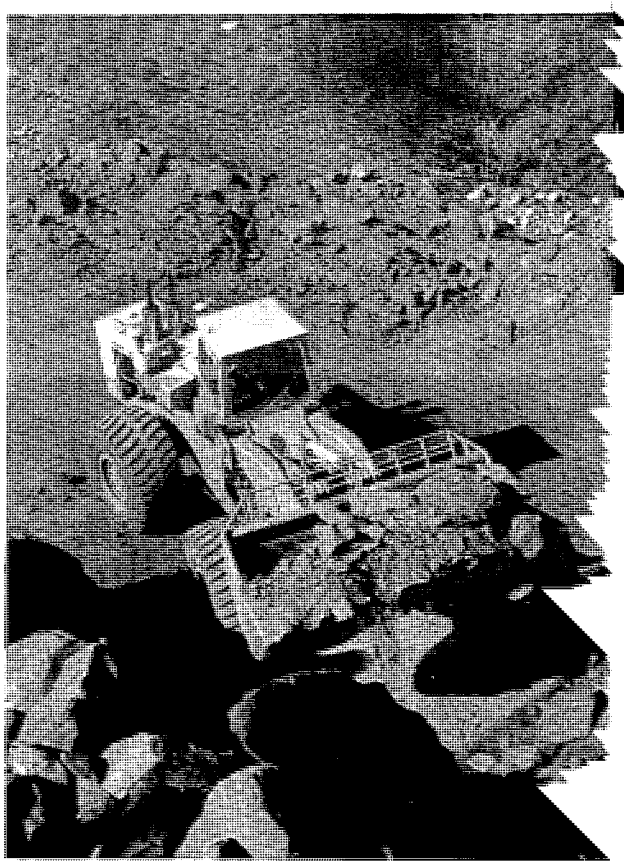
DEPRECIATION

An estimated hourly charge for equipment depreciation can be made by dividing the value to be depreciated by the anticipated hours of useful life. The value to be depreciated should include list price, freight charges and sales taxes, but not the cost of tires since this is an operating cost item.

TABLE XIII

Useful Life of Machines (Hours)

Conditions	Crawler Tractors/ Loaders	Rubber-Tired Loaders Up to 5 cu yd	Rubber-Tired Loaders 5 cu yd & Over	Scrapers	Off Highway Haulers
Unfavorable	8,000	8,000	10,000	8,000	8,000
Average	10,000	10,000	12,000	10,000	10,000
Favorable	12,000	12,000	20,000	15,000	20,000



There are several accepted methods for depreciating heavy equipment, but the Straight-Line Method is generally used by the contractor. With this method, depreciation is charged off at an even rate. It provides an average hourly depreciation figure. With the Straight-Line Method, this example shows how a scraper is depreciated . . .

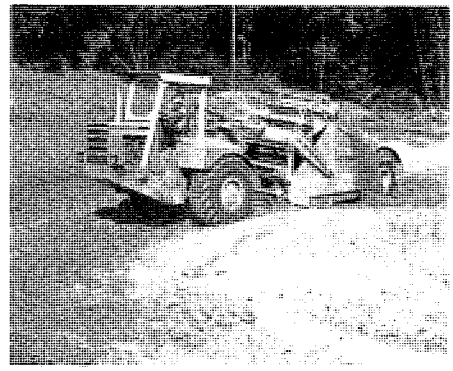
EXAMPLE:

F.O.B. Factory Price	$74,755
Freight & Taxes	1,500
Total Purchase Price	$76,255
Less Tires	12,450
Amount to be Depreciated	$63,805

Under average operating conditions and with an estimated useful life of 5 years or 10,000 hours, the machine will be depreciated at a rate of . . .

$$\frac{\text{Amount to be Depreciated (\$63,805)}}{\text{5 years}} = \$12{,}761/\text{yr}$$

$$\frac{\text{Amount to be Depreciated (\$63,805)}}{\text{5 years x 2000 hrs per year}} = \$6.38/\text{hr}$$



NOTE: When resale or salvage value is considered it must be subtracted from the adjusted purchase price. The resulting figure is the amount to be depreciated.

INTEREST, INSURANCE & TAXES

Another part of ownership costs to be considered is the expense of Interest, Insurance and Taxes.

INTEREST should be figured at the local rate in defining the cost or price for the use of money.

INSURANCE charges should include all of the comprehensive and liability policy premiums that apply to the machine. If a blanket type policy covers all machines, the premium expense could be prorated against each machine, based on the market value of all the assets covered by the policy.

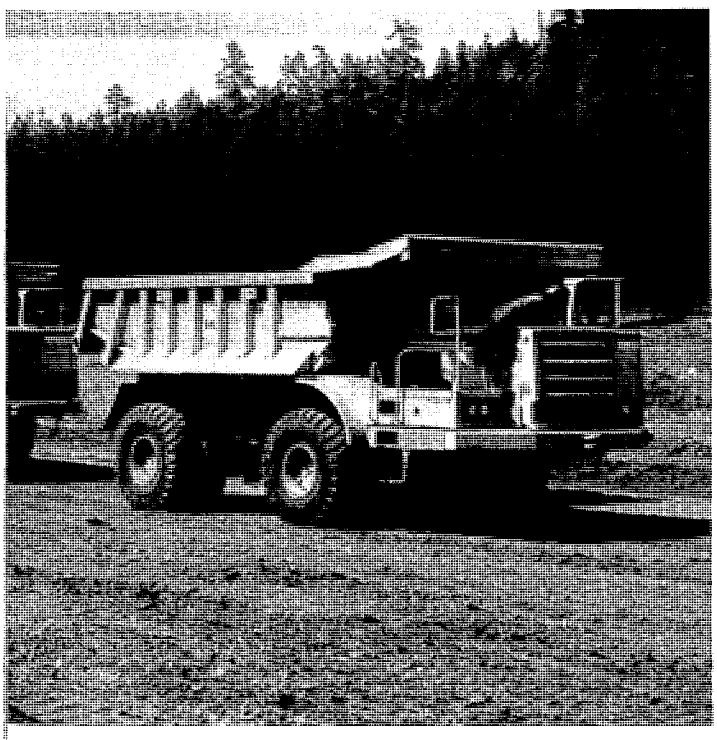
TAXES may vary according to local and state requirements. Don't hesitate to seek the assistance of the local tax assessor.

As a part of ownership cost these expenses can be lumped together as a single item. In examples used in this book, it is assumed that the following rates are applicable . . .

Interest	9%
Insurance & Taxes	5%
Total Interest, Insurance & Taxes	14%(0.14)

To find the hourly cost of Interest, Insurance, and Taxes, it is necessary to establish an average yearly value for the machine. The average yearly value is found by multiplying the Purchase Price times the appropriate factor from Table XIV. In the example on page 73, the average yearly value is Purchase Price ($74,755) x 0.6 or $44,853.

Once the average yearly value is determined, the hourly cost of Interest, Insurance, and Taxes is found through the following formula . . .



$$\frac{\text{Average Yearly Value} \times \text{Total Interest, Insurance \& Taxes}}{\text{Hours Worked per Year}}$$

In our example . . .

$$\frac{\text{Average Yearly Value (\$44,853)} \times \text{Interest, Insurance, \& Taxes (0.14)}}{\text{2,000 Hrs/Year}}$$

$$= \$3.14/\text{hr}$$

NOTE: When resale or salvage value is used, the average yearly value is calculated as follows . . .

$$\text{Average yearly value} = \frac{P(N+1) + S(N-1)}{2N}$$

P = Purchase price
S = Salvage value
N = Useful life (in years)

TABLE XIV

Average Value Factor	
Years	**Factor**
1	1.0
2	0.75
3	0.67
4	0.63
5	0.60
6	0.58
7	0.57
8	0.56
9	0.56
10	0.55

HOURLY OPERATING COSTS

Operating costs represent items consumed as the machine is operated. The rate of consumption varies according to the type of work. Since the cost of fuel, oil, lube and other consumable items may vary by type and geographical area,

Model	Fuel (GPH)			Engine Oil (GPH)	Transmission Oil (GPH)	Final Drive Oil (GPH)	Steering Hydraulic Oil (GPH)	Chassis Lubricant lbs / hr	Filter Costs $
	Light	Average	Heavy						
Crawler Tractors									
500E	1.4	1.7	1.9	.0200	.0155	.0005	.0055	.02	.09
TD-7E	1.9	2.4	2.8	.0275	.0175	.0050	.0100	.02	.06
TD-8E	2.3	3.0	3.4	.0275	.0185	.0080	.0100	.02	.08
TD-15C	4.1	5.2	6.0	.0225	.0350	.0220	.0240	.04	.16
TD-20E	6.0	7.6	8.7	.0325	.0340	.0400	.0330	.04	.15
TD-25C	8.9	11.2	12.9	.0438	.0650	.0205	.0580	.04	.21
Crawler Loaders									
500E	1.4	1.7	1.9	.0200	.0155	.0005	.0055	.02	.10
100E	2.1	2.6	3.0	.0275	.0175	.0050	.0100	.02	.06
125E	2.4	3.0	3.5	.0275	.0185	.0080	.0100	.02	.08
175C	3.8	4.8	5.5	.0288	.0350	.0220	.0240	.04	.15
250C	5.7	7.1	8.2	.0325	.0400	.0280	.0280	.04	.13
Rubber-Tired Loaders									
H-25B-Gas	1.8	2.5	2.8	.0175	.0035	.0009	.0058	.09	.07
H-25B-Diesel	1.8	2.0	2.3	.0175	.0035	.0009	.0058	.09	.07
H-30B-Gas	2.5	2.8	3.0	.0100	.0055	.0016	.0120	.09	.05
H-30B-Diesel	1.8	2.0	2.2	.0100	.0055	.0016	.0120	.09	.06
H-50C-Gas	2.8	3.0	3.2	.0250	.0075	.0045	.0120	.09	.08
H-50C-Diesel	2.3	2.5	2.8	.0250	.0075	.0045	.0120	.09	.06
H-60E	2.8	3.0	3.3	.0238	.0075	.0023	.0180	.09	.19
H-65C	4.0	4.3	4.5	.0250	.0045	.0090	.0210	.09	.25
H-80B	5.2	5.4	5.6	.0225	.0075	.0160	.0340	.09	.31
H-90E	6.2	6.9	7.6	.0400	.0075	.0160	.0450	.09	.28
H-100C	7.7	8.6	9.5	.0425	.0114	.0117	.0548	.09	.42
560	9.9	11.0	12.1	.0375	.0180	.0185	.0950	.11	.38
H-400C	17.3	25.9	34.6	.0900	.0340	.0480	.1260	.12	.50
Off-Highway Haulers									
330	10.0	11.0	12.2	.0425	.0300	.0123	.0400	.10	.24
340	10.0	11.0	12.2	.0425	.0300	.0123	.0400	.10	.24
350-Detroit	17.0	19.0	21.8	.0850	.0350	.0138	.0400	.10	.17
350-Cummins	17.0	19.0	21.8	.0720	.0350	.0138	.0400	.10	.20

local prices should be used. The following charts, provide general consumption figures for International Pay Line equipment for normal service intervals and average loads.

Model	Fuel (GPH)			Engine Oil (GPH)	Transmission Oil (GPH)	Final Drive Oil (GPH)	Steering Hydraulic Oil (GPH)	Chassis Lubricant lbs / hr	Filter Costs $
	Light	Average	Heavy						
Open-Bowl Scrapers									
431	8.1	9.3	12.8	.0325	.0260	.0210	.0340	.10	.20
433	13.1	14.9	20.6	.0538	.0510	.0420	.0340	.14	.29
Elevating Scrapers									
412	5.6	5.9	6.1	.0213	.0140	.0133	.0215	.10	.19
442	9.2	10.5	14.0	.0325	.0260	.0290	.0340	.10	.20
444	14.8	16.9	22.5	.0538	.0510	.0540	.0340	.14	.31
Excavators									
3964	1.9	3.8	5.8	.0246	.0260	w/Trans	w/Trans	.02	.19
3984	3.8	4.3	5.8	.0246	.0260	w/Trans	w/Trans	.02	.13
Loggers									
3966	1.9	3.8	5.8	.0246	.0260	w/Trans	w/Trans	.02	.13
S-8	2.0	3.0	4.0	.0400	.0010	.0037	.0080	.02	.34
Wheel Tractors									
140	0.8	0.9	1.0	.0116	.0006	.0003	——	.02	.02
2400B-Gas	2.0	2.2	2.4	.0158	.0140	w/Trans	w/Trans	.04	.10
2400B-Diesel	1.4	1.6	1.7	.0158	.0140	w/Trans	w/Trans	.04	.10
2500B-Gas	2.2	2.5	2.7	.0158	.0140	w/Trans	w/Trans	.04	.10
2500B-Diesel	1.9	2.2	2.4	.0231	.0140	w/Trans	w/Trans	.04	.10
3400A-Gas	2.0	2.2	2.4	.0158	.0140	w/Trans	w/Trans	.04	.10
3400A-Diesel	1.4	1.6	1.7	.0158	.0140	w/Trans	w/Trans	.04	.10
3500A	1.9	2.2	2.4	.0231	.0135	w/Trans	w/Trans	.07	.07
3600A	2.7	3.0	3.3	.0207	.0250	w/Trans	w/Trans	.07	.11
3820	2.3	2.6	2.9	.0268	.0080	.0020	.0040	.07	.09
3850	2.3	2.5	2.8	.0207	.0080	.0030	.0130	.04	.07
4500-Gas	1.6	1.8	1.9	.0158	.0140	w/Trans	w/Trans	.04	.10
4500-Diesel	1.3	1.4	1.5	.0158	.0140	w/Trans	w/Trans	.04	.10
3200B	1.1	2.2	3.3	.0200	.0003	.0055	.0290	.013	.13
3300B	1.5	3.1	4.6	.0250	.0003	.0055	.0290	.013	.13

HOURLY OPERATING COSTS

TIRES

Tire costs can vary considerably with differences in haul road conditions, inflation, overload, speeds, material, and location on the machine. Table XV indicates the major factors and how they affect tire life of hauling equipment. They are based on an optimum life of 5,000 hours when average vehicle speed is 10 mph. Keep in mind the expense of overloading, and the adverse effects of speed, surface conditions, curves, abrasive material, severe weather and operator abuse.

Material conditions are critical in estimating life of loader tires, particularly front-mounted tires working in rock. Remember that counter-weights, chains and other accessories may influence the life of loader tires.

The formula to follow in estimating tire life is . . .

5,000 Hours Average Life x Tire Life Expectancy Factors

The necessary factors are shown in Table XV.

EXAMPLE:

An all-wheel drive hauler operating at rated capacity where . . .

Speeds are not over 20 mph.
Grades are under 15%
Curves are medium
Haul road maintenance is average

5,000 x 0.8 x 0.7 x 0.9 x 0.9 = 2,268 hours

The price of tires divided by estimated hours of life equals the hourly cost.

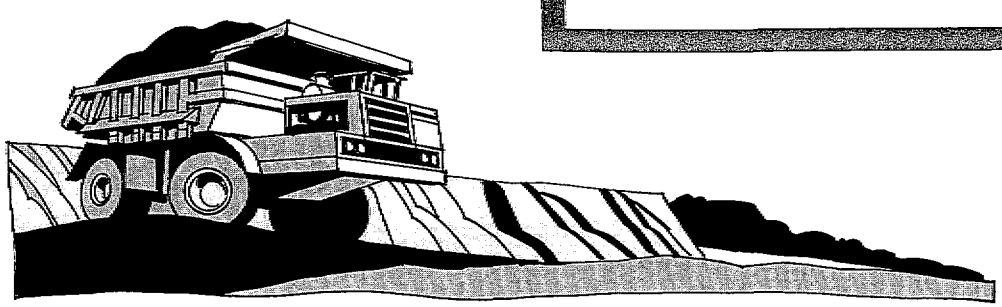


TABLE XV

Tire Life Expectancy Factors

Maintenance

Excellent	1.0
Average	0.9
Poor	0.7

Curves

None	1.0
Medium	0.9
Severe	0.8

Grades (Drive Tires Only)

Level	1.0
6% Medium	0.9
15% Maximum	0.7

Loads

No overloads	1.0
20% overload	0.8
40% overload	0.5

Speeds (Maximum)

10 mph	1.0
20 mph	0.8
30 mph	0.6

Wheel Positions

Trailing	1.0
Front	0.9
Driving:	
Rear dump	0.8
Bottom dump	0.7
Scraper	0.6
Loader	0.5
Dozer	0.6

Surface Conditions

Soft earth, no rock	1.0
Soft earth, some rock	0.9
Well maintained gravel road	0.9
Poorly maintained gravel road	0.7
Blasted sharp rock	0.6

REPAIRS AND LABOR

Repair costs are impossible to forecast with accuracy, but such items as engine overhaul, transmission rebuilds, new clutch and brake linings, etc. tend to occur at predictable intervals. Experience is helpful in estimating the frequency of repair.

In Table XVI the hourly cost of repairs and related labor is expressed as a percentage of hourly depreciation, since depreciation directly reflects useful life, which is based on severity of the operation. Calculate the depreciation following the method outlined previously, then apply the appropriate percentage to that figure. In determining the operator's wage, always include fringe benefits, such as retirement, taxes, etc.

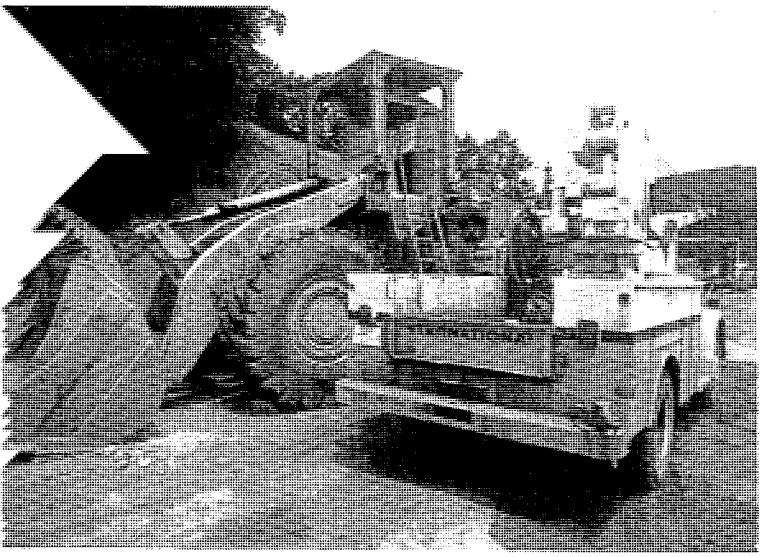


TABLE XVI

Repairs and Labor Costs

Machine	% of Depreciation
Crawler Tractors	80-100
Crawler Loaders	80-100
Haulers (less tires)	50-100
Scrapers (less tires)	80-100
Loaders (less tires)	60-80
Hydraulic Excavators	70-100

Leading manufacturers of production earthmoving equipment publish owning and operating cost sheets designed to help you in estimating hourly costs.

International®

PAY LINE DIVISION

September 1975

HOURLY OWNING & OPERATING COSTS

TD-25C

Semi "U" Hydraulic Tilt

HOURLY OWNERSHIP COSTS

Depreciation:

Purchase Price (Including options/shipping/taxes/etc.)	$ 136,340	
Tire Replacement Costs	(-) —	
Amount to be Depreciated	$ 136,340	
Hourly Depreciation = Amount to be Depreciated (136,340) / 5 x Hours/Year (2,000) =	$ 13.63	

Interest/Insurance/Taxes (IIT)

Hourly Cost of IIT = Purchase Price ($ 136,340) x IIT (0.14) x 0.6 / Hours/Year (2000) = $ 5.73

TOTAL OWNERSHIP COSTS $ 19.36

HOURLY OPERATING COSTS

Fuel:	11.2 gph	$ 0.34	per gallon	$ 3.81
Engine Oil:	.0438 gph	1.38	per gallon	0.06
Transmission Oil:	.0650 gph	1.45	per gallon	0.09
Final Drive Oil:	.0205 gph	1.66	per gallon	0.03
Steering and/or Hyd. Oil:	.0580 gph	1.45	per gallon	0.08
Chassis Lubricant:	0.04 lbs/hr	0.28	per lb.	0.01
Filter Costs for Average Conditions: (all filters)				0.21
Hourly Tire Costs: Tire Replacement Costs ($ --) / Hours of Service (-- Hrs.)				—
Estimated Repair Costs: 90 % x Hourly Depreciation ($13.63)				12.28
Operator's Wage (including fringe benefits, insurance, etc.)				8.00

TOTAL OPERATING COSTS $ 24.57

TOTAL ESTIMATED HOURLY OWNERSHIP & OPERATING COSTS $ 43.93

Formulas based on 5 years of actual useful life. For alternative number of years, refer to Earthmoving Principles.

NOTE: This is an estimate only and no guarantee is made, nor implied, that actual job costs will not be higher or lower than those shown.

OWNING AND OPERATING COSTS

International PAY LINE DIVISION

September 1975

HOURLY OWNING & OPERATING COSTS

431 PAY SCRAPER

Standard

HOURLY OWNERSHIP COSTS

Depreciation:

Purchase Price (Including options/shipping/taxes/etc.)		$ 124,212
Tire Replacement Costs		(-) 17,532
Amount to be Depreciated		$ 106,680
Hourly Depreciation = Amount to be Depreciated (106,680) / 5 x Hours/Year (2000)	=	$ 10.67

Interest/Insurance/Taxes (IIT)

Hourly Cost of IIT = Purchase Price ($ 124,212) x IIT (0.14) x 0.6 / Hours/Year (2000) = $ 5.22

TOTAL OWNERSHIP COSTS $ 15.89

HOURLY OPERATING COSTS

Fuel:	9.3 gph	$ 0.34 per gallon	$ 3.16
Engine Oil:	.0325 gph	1.38 per gallon	0.04
Transmission Oil:	.0260 gph	1.45 per gallon	0.04
Final Drive Oil:	.0210 gph	1.66 per gallon	0.03
Steering and/or Hyd. Oil:	.0340 gph	1.45 per gallon	0.05
Chassis Lubricant:	0.10 lbs/hr	0.28 per lb.	0.03
Filter Costs for Average Conditions: (all filters)			0.20
Hourly Tire Costs: Tire Replacement Costs ($26,298)* / Hours of Service (6000 Hrs.)			4.38
Estimated Repair Costs: 90 % x Hourly Depreciation ($10.67)			9.60
Operator's Wage (including fringe benefits, insurance, etc.)			8.00

TOTAL OPERATING COSTS $ 25.53

TOTAL ESTIMATED HOURLY OWNERSHIP & OPERATING COSTS $ 41.42

Formulas based on 5 years of actual useful life. For alternative number of years, refer to Earthmoving Principles.

NOTE: This is an estimate only and no guarantee is made, nor implied, that actual job costs will not be higher or lower than those shown.

* Recapped at 3000 hours for 1/2 replacement cost.

International PAY LINE DIVISION

September 1975

HOURLY OWNING & OPERATING COSTS

350 PAY HAULER

Cummins Engine

HOURLY OWNERSHIP COSTS

Depreciation:

Purchase Price (Including options/shipping/taxes/etc.)		$ 202,637
Tire Replacement Costs		(-) 22,197
Amount to be Depreciated		$ 180,440
Hourly Depreciation = Amount to be Depreciated (180,440) / 5 x Hours/Year (2000)	=	$ 18.04

Interest/Insurance/Taxes (IIT)

Hourly Cost of IIT = Purchase Price ($ 202,637) x IIT (0.14) x 0.6 / Hours/Year (2000) = $ 8.51

TOTAL OWNERSHIP COSTS $ 26.55

HOURLY OPERATING COSTS

Fuel:	19.0 gph	$ 0.34 per gallon	$ 6.46
Engine Oil:	.0720 gph	1.38 per gallon	0.10
Transmission Oil:	.0350 gph	1.45 per gallon	0.05
Final Drive Oil:	.0138 gph	1.66 per gallon	0.02
Steering and/or Hyd. Oil:	.0400 gph	1.45 per gallon	0.06
Chassis Lubricant:	0.10 lbs/hr	0.28 per lb.	0.03
Filter Costs for Average Conditions: (all filters)			0.20
Hourly Tire Costs: Tire Replacement Costs ($ 33,296)* / Hours of Service (6000 Hrs.)			5.55
Estimated Repair Costs: 75 % x Hourly Depreciation ($18.04)			13.53
Operator's Wage (including fringe benefits, insurance, etc.)			8.00

TOTAL OPERATING COSTS $ 34.00

TOTAL ESTIMATED HOURLY OWNERSHIP & OPERATING COSTS $ 60.55

Formulas based on 5 years of actual useful life. For alternative number of years, refer to Earthmoving Principles.

NOTE: This is an estimate only and no guarantee is made, nor implied, that actual job costs will not be higher or lower than those shown.

* Recapped at 3000 hours for 1/2 replacement cost.

Notice that International's owning and operating cost sheets follow a consistent pattern. Once you have learned the procedure, you can apply the appropriate figures to a cost estimate for any given machine.

International

PAY LINE DIVISION

September 1975

HOURLY OWNING & OPERATING COSTS

H-400C PAY LOADER

11 Cu Yd Spade Nose Rock Bucket

HOURLY OWNERSHIP COSTS

Depreciation:

Purchase Price (Including options/shipping/taxes/etc.)	$ 267,751
Tire Replacement Costs	(-) 45,448
Amount to be Depreciated	$ 222,303
Hourly Depreciation = Amount to be Depreciated (222,303) / 5 x Hours/Year (2000) =	$ 22.23

Interest/Insurance/Taxes (IIT)

Hourly Cost of IIT = Purchase Price ($267,751) x IIT (0.14) x 0.6 / Hours/Year (2000) = $ 11.25

TOTAL OWNERSHIP COSTS $ 33.48

HOURLY OPERATING COSTS

Fuel:	25.9 gph	$ 0.34 per gallon	$ 8.81
Engine Oil:	.0900 gph	1.38 per gallon	0.12
Transmission Oil:	.0340 gph	1.45 per gallon	0.05
Final Drive Oil:	.0480 gph	1.66 per gallon	0.08
Steering and/or Hyd. Oil:	.1260 gph	1.45 per gallon	0.18
Chassis Lubricant:	0.12 lbs/hr	0.28 per lb.	0.03
Filter Costs for Average Conditions: (all filters)			0.50
Hourly Tire Costs: Tire Replacement Costs ($68,172) * / Hours of Service (6000 Hrs.)			11.36
Estimated Repair Costs: 70 % x Hourly Depreciation ($22.23)			15.56
Operator's Wage (including fringe benefits, insurance, etc.)			8.00

TOTAL OPERATING COSTS $ 44.69

TOTAL ESTIMATED HOURLY OWNERSHIP & OPERATING COSTS $ 78.17

Formulas based on 5 years of actual useful life. For alternative number of years, refer to Earthmoving Principles.

NOTE: This is an estimate only and no guarantee is made, nor implied, that actual job costs will not be higher or lower than those shown.

* Recapped at 3000 hours for 1/2 replacement cost.

International

PAY LINE DIVISION

September 1975

HOURLY OWNING & OPERATING COSTS

3984 EXCAVATOR

7/8 Cu Yd Bucket

HOURLY OWNERSHIP COSTS

Depreciation:

Purchase Price (Including options/shipping/taxes/etc.)	$ 73,389
Tire Replacement Costs	(-) ——
Amount to be Depreciated	$ 73,389
Hourly Depreciation = Amount to be Depreciated (73,389) / 5 x Hours/Year (2000) =	$ 7.34

Interest/Insurance/Taxes (IIT)

Hourly Cost of IIT = Purchase Price ($ 73,389) x IIT (0.14) x 0.6 / Hours/Year (2000) = $ 3.08

TOTAL OWNERSHIP COSTS $ 10.42

HOURLY OPERATING COSTS

Fuel:	4.3 gph	$ 0.34 per gallon	$ 1.46
Engine Oil:	.0246 gph	1.38 per gallon	0.03
Transmission Oil:	.0260 gph	1.45 per gallon	0.04
Final Drive Oil:	w/trans gph	1.66 per gallon	
Steering and/or Hyd. Oil:	w/trans gph	1.45 per gallon	
Chassis Lubricant:	0.02 lbs/hr	0.28 per lb.	0.01
Filter Costs for Average Conditions: (all filters)			0.13
Hourly Tire Costs: Tire Replacement Costs ($ --) / Hours of Service (-- Hrs.)			——
Estimated Repair Costs: 85 % x Hourly Depreciation ($ 7.34)			6.24
Operator's Wage (including fringe benefits, insurance, etc.)			8.00

TOTAL OPERATING COSTS $ 15.91

TOTAL ESTIMATED HOURLY OWNERSHIP & OPERATING COSTS $ 26.33

Formulas based on 5 years of actual useful life. For alternative number of years, refer to Earthmoving Principles.

NOTE: This is an estimate only and no guarantee is made, nor implied, that actual job costs will not be higher or lower than those shown.

International

PAY LINE DIVISION

September 1975

HOURLY OWNING & OPERATING COST

444 PAY SCRAPER

STANDARD

HOURLY OWNERSHIP COSTS

Depreciation:

Purchase Price (Including options/shipping/taxes/etc.)	$ 172,610
Tire Replacement Costs	(-) 19,685
Amount to be Depreciated	$ 152,925
Hourly Depreciation = Amount to be Depreciated (152,925) / 5 x Hours/Year (2000) =	$ 15.29

Interest/Insurance/Taxes (IIT)

Hourly Cost of IIT = Purchase Price ($ 172,610) x IIT (0.14) x 0.6 / Hours/Year (2000) = $ 7.25

TOTAL OWNERSHIP COSTS $ 22.54

HOURLY OPERATING COSTS

Fuel:	16.9 gph	$ 0.34 per gallon	$ 5.75
Engine Oil:	.0538 gph	1.38 per gallon	0.07
Transmission Oil:	.0510 gph	1.45 per gallon	0.07
Final Drive Oil:	.0540 gph	1.66 per gallon	0.09
Steering and/or Hyd. Oil:	.0340 gph	1.45 per gallon	0.05
Chassis Lubricant:	0.14 lbs/hr	0.28 per lb.	0.04
Filter Costs for Average Conditions: (all filters)			0.31
Hourly Tire Costs: Tire Replacement Costs ($ 29,528) * / Hours of Service (6000 Hrs.)			4.92
Estimated Repair Costs: 90 % x Hourly Depreciation ($15.29)			13.76
Operator's Wage (including fringe benefits, insurance, etc.)			8.00

TOTAL OPERATING COSTS $ 33.06

TOTAL ESTIMATED HOURLY OWNERSHIP & OPERATING COSTS $ 55.60

Formulas based on 5 years of actual useful life. For alternative number of years, refer to Earthmoving Principles.

NOTE: This is an estimate only and no guarantee is made, nor implied, that actual job costs will not be higher or lower than those shown.

* Recapped at 3000 hours for 1/2 replacement cost.

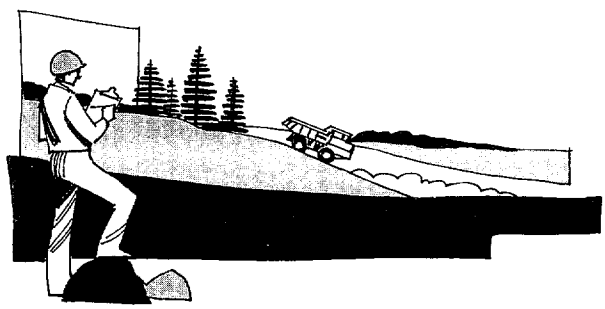
INTERNATIONAL

SUMMARY—COST PER PRODUCTION UNIT

Now that we have learned how to estimate production, and how to figure equipment costs, one final step is necessary to complete the picture. We must combine estimated production with owning and operating costs in a manner that will yield a reliable cost-per-yard or cost-per-ton figure. The approach is very simple . . .

$$\frac{\text{Total Cost-Per-Hour of Equipment}}{\text{Total BCY or Ton Production/hr}} = \text{Cost per BCY or Ton}$$

Let's follow through with the examples given previously, and see how the final cost estimates work out . . .



SUMMARY—COST PER PRODUCTION UNIT

431 PAY SCRAPER
TD-25C PUSHER
EXAMPLE PAGE 46

IBCF	0.83
Heaped Capacity	21 LCY
Cycle Time	5.36 min
Efficiency Hour	45 min

$$P = IH \times \frac{E}{C}$$

$$0.83 \times 21 \text{ LCY} \times \frac{45 \text{ min/hr}}{5.36 \text{ min}} = 146 \text{ BCY/hr}$$

PRODUCTION

Equipment requirements on the 1.5 million yard highway job call for six scrapers and two pushers to meet the completion date. So the total production figure is (6 x 146) 876 BCY/hr.

COST

The cost of owning and operating a 431 PAY scraper as stated on the preceding cost sheet is $41.42 per hour, or $248.52 for six machines. The TD-25C cost sheet shows an hourly owning and operating cost of $43.93, or $87.86 for the two pushers. Total equipment cost, therefore, is $336.38 per hour. The cost-per-yard formula is . . .

$$\frac{\text{Total cost-per-hour of equipment}}{\text{Total BCY Production/hr}} = \text{Cost per BCY}$$

The cost-per-yard estimate for the earthmoving portion of the highway relocation project . . .

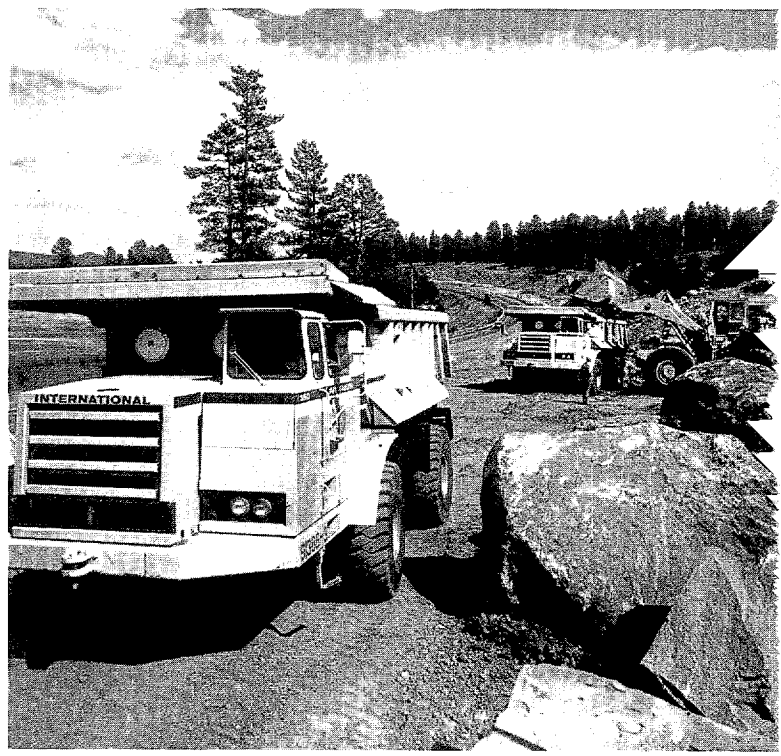
$$\frac{\$336.38}{867 \text{ BCY/hr}} = \$0.38 \text{ per BCY}$$

350 PAY HAULER
H-400C PAY LOADER
EXAMPLE PAGE 54

Heaped Capacity	48.4 Tons
Cycle Time	6.06 min
Efficiency Hour	50 min

$$P = IH \times \frac{E}{C}$$

$$0.60 \times 48.4 \text{ tons} \times \frac{50 \text{ min/hr}}{6.06 \text{ min}} = 399 \text{ tph}$$



PRODUCTION
Our estimate shows that three 350 PAY haulers will be adequate to remove the required rock, with a total production figure of 1197 tph.

COST
Cost sheet for the 350 reveals an hourly owning and operating cost of $60.55 per hauler, or $181.65 for three machines. The H-400C cost sheet shows an owning and operating cost of $78.17 per hour, so the total machine owning and operating cost is $259.82 per hour. Application of the cost-per-ton formula . . .

$$\frac{\text{Total cost-per-hour of equipment}}{\text{Total TPH production/hr}} = \text{Cost per Ton}$$

Cost for the loader/hauler team on the project operation then becomes . . .

$$\frac{\$259.82}{1197 \text{ tph}} = \$0.22 \text{ per ton}$$

SUMMARY—COST PER PRODUCTION UNIT

PRODUCTION

Two 444 PAY scrapers are required to move the 500,000 bank cu. yds. in 140 days.

COST

The cost sheet on page 83 reveals an hourly owning and operating cost of $55.60 for the 444 PAY scraper. Follow the cost-per-yard formula in your calculations . . .

$$\frac{\text{Total cost-per-hour of equipment}}{\text{Total BCY Production/hr}} = \text{Cost per Yard}$$

Remember to include the cost of both machines and their combined production when you apply the figures . . .

$$\frac{\$111.20}{2 \times 251 \text{ BCY/hr}} = \$0.22 \text{ per BCY}$$

444 PAY SCRAPER EXAMPLE PAGE 60

IBCF	0.85
Heaped Capacity	22 cu yds
Cycle Time	3.72 min
Efficiency Hour	50 min

$$P = IH \times \frac{E}{C}$$

$$0.85 \times 22 \text{ LCY} \times \frac{50 \text{ min/hr}}{3.72 \text{ min}} = 251 \text{ BCY/hr}$$

TD-25C CRAWLER
EXAMPLE PAGE 64

IBCF	0.90
Heaped Capacity	10.1 cu yds
Cycle Time	1.34 min
Efficiency Hour	55 min

$$P = IH \times \frac{E}{C}$$

$$0.90 \times 10.1 \text{ LCY} \times \frac{50 \text{ min/hr}}{1.34 \text{ min}} = 339 \text{ BCY/hr}$$

PRODUCTION

The TD-25C crawler dozer in our production estimate will move 70,000 BCY of borrow material in twenty-one, 10-hour days. It is the only earthmoving machine being studied.

COST

The cost of owning and operating a TD-25C, according to the cost sheet on page 81, is $43.93 per hour. When we apply the cost-per-yard formula . . .

$$\frac{\text{Total Cost per Hour of Equipment}}{\text{Total BCY Production /hr}} = \text{Cost per Yard}$$

We find the production cost to be . . .

$$\frac{\$43.93}{339 \text{ BCY/hr}} = \$0.13 \text{ per BCY}$$

SUMMARY—COST PER PRODUCTION UNIT

3984 EXCAVATOR
EXAMPLE PAGE 68

IBCF	0.75
Bucket Capacity	⅞ cu yd
Cycles per hour	87
Efficiency Hour	55 min

$$P = I \times H \times \frac{E}{60} \times \text{Cycles/hr.}$$

$$= 0.75 \times \tfrac{7}{8}\ \text{LCY} \times \frac{55\ \text{min/hr}}{60\ \text{min}} \times 87\ \text{cycles/hr}$$

$$= 52\ \text{BCY/hr}$$

PRODUCTION
The 3984 excavator will be able to handle the 50 BCY loading requirement without assistance.

COST
According to the cost sheet on page 83, the machine's estimated owning and operating cost is $26.33 per hour. Application of the cost-per-yard formula . . .

$$\frac{\text{Total cost-per-hour of equipment}}{\text{Total BCY Production/hr}} = \text{Cost per Yard}$$

$$\frac{\$26.33}{52\ \text{BCY/hr}} = \$0.51\ \text{per BCY}$$

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MEASUREMENT UNITS AND CONVERSIONS

Unit	Multiply By	To Get	Multiply By	To Get
		AREA		
acre	4.046 856 E+03	square metre (m^2)	2.471 054 E−04	acre
acre	4.046 856 E−01	square hectometre (hm^2)	2.471 054 E+00	acre
are	1.000 000*E+02	square metre (m^2)	1.000 000*E−02	(a)
square foot (ft^2)	9.290 304*E−02	square metre (m^2)	1.076 391 E+01	(ft^2)
square inch (in^2)	6.451 600*E−04	square metre (m^2)	1.550 003 E+03	(in^2)
square inch (in^2)	6.451 600*E+00	square centimetre (cm^2)	1.550 003 E−01	(in^2)
square inch (in^2)	6.451 600*E+02	square millimetre (mm^2)	1.550 003 E−03	(in^2)
square mile ($mile^2$)	2.589 988 E+06	square metre (m^2)	3.861 022 E−07	($mile^2$)
square rod (rod^2)	2.529 285 E+01	square metre (m^2)	3.953 686 E−02	(rod^2)
square rod (rod^2)	2.529 285 E−03	square hectometre (hm^2)	3.953 686 E+02	(rod^2)
square yard (yd^2)	8.361 274 E−01	square metre (m^2)	1.195 990 E+00	(yd^2)
		FORCE		
dyne (dyn)	1.000 000*E−05	newton (N)	1.000 000*E+05	(dyn)
kilogram-force (kgf)	9.806 650*E+00	newton (N)	1.019 716 E−01	(kgf)
kilopond (kp)	9.806 650*E+00	newton (N)	1.019 716 E−01	(kp)
ounce-force (ozf)	2.780 139 E−01	newton (N)	3.596 942 E+00	(ozf)
pound-force (lbf)	4.448 222 E+00	newton (N)	2.248 089 E−01	(lbf)
poundal (pdl)	1.382 550 E−01	newton (N)	7.233 011 E+00	(pdl)
		LENGTH		
foot (ft)	3.048 000*E−01	metre (m)	3.280 840 E+00	(ft)
inch (in)	2.540 000*E−02	metre (m)	3.937 008 E+01	(in)
inch (in)	2.540 000*E+01	millimetre (mm)	3.937 008 E−02	(in)
microinch (μin)	2.540 000*E−08	metre (m)	3.937 008 E+07	(μin)
microinch (μin)	2.540 000*E−02	micrometre (μm)	3.937 008 E+01	(μin)
micron (μ)	1.000 000*E−06	metre (m)	1.000 000*E+06	(μ)
micron (μ)	1.000 000*E+00	micrometre (μm)	1.000 000*E+00	(μ)
mil	2.540 000*E−05	metre (m)	3.937 008 E+04	mil
mil	2.540 000*E+01	micrometre (μm)	3.937 008 E−02	mil
international nautical mile (n mile)	1.852 000*E+03	metre (m)	5.399 568 E−04	(n mile)
mile (mile)	1.609 344*E+03	metre (m)	6.213 712 E−04	(mile)
rod	5.029 200*E+00	metre (m)	1.988 388 E−01	rod
yard (yd)	9.144 000*E−01	metre (m)	1.093 613 E+00	(yd)
		MASS		
grain	6.479 891*E−05	kilogram (kg)	1.543 236 E+04	grain
long hundredweight (cwt)	5.080 235 E+01	kilogram (kg)	1.968 413 E−02	(cwt)
short hundredweight (sh cwt)	4.535 924 E+01	kilogram (kg)	2.204 622 E−02	(sh cwt)
kilogram-force second squared per metre ($kgf \cdot s^2/m$)	9.806 650*E+00	kilogram (kg)	1.019 716 E−01	($kgf \cdot s^2/m$)
ounce (oz)	2.834 952 E−02	kilogram (kg)	3.527 397 E+01	(oz)
ounce (oz)	2.834 952 E+01	gram (g)	3.527 397 E−02	(oz)
penneyweight (dwt)	1.555 174 E−03	kilogram (kg)	6.430 149 E+02	(dwt)
pound (lb)	4.535 924 E−01	kilogram (kg)	2.204 622 E+00	(lb)
slug	1.459 390 E+01	kilogram (kg)	6.852 178 E−02	slug
long ton (2240 lb)	1.016 047 E+03	kilogram (kg)	9.842 064 E−04	long ton (2240 lb)
short ton (2000 lb)	9.071 847 E+02	kilogram (kg)	1.102 311 E−03	short ton (2000 lb)
short ton (2000 lb)	9.071 847 E−01	megagram (Mg)	1.102 311 E+00	short ton (2000 lb)
tonne (t)	1.000 000*E+03	kilogram (kg)	1.000 000*E−03	(t)

Unit	Multiply By	To Get	Multiply By	To Get
POWER (Btu is International Table)				
Btu per minute (Btu/min)	1.758 427 E+01	watt (W)	5.686 902 E−02	(Btu/min)
Btu per hour (Btu/h)	2.930 711 E−01	watt (W)	3.412 141 E+00	(Btu/h)
erg per second (erg/s)	1.000 000*E−07	watt (W)	1.000 000*E+07	(erg/s)
foot pound-force per hour (ft•lbf/h)	3.766 161 E−04	watt (W)	2.655 224 E+03	(ft•lbf/h)
foot pound-force per minute (ft•lbf/min)	2.259 697 E−02	watt (W)	4.425 372 E+01	(ft•lbf/min)
foot pound-force per second (ft•lbf/s)	1.355 818 E+00	watt (W)	7.375 621 E−01	(ft•lbf/s)
horsepower, 550 foot pound-force per second (hp)	7.456 999 E+02	watt (W)	1.341 022 E−03	(hp)
horsepower, 550 foot pound-force per second (hp)	7.456 999 E−01	kilowatt (kW)	1.341 022 E+00	(hp)
electric horsepower	7.460 000*E+02	watt (W)	1.340 483 E−03	electric horsepower
metric horsepower	7.354 99 E+02	watt (W)	1.359 62 E−03	metric horsepower
in Germany: Pferdestärke (PS)				
in France: cheval vapeur (CV)				
kilogram-force metre per second (kgf•m/s)	9.806 65 E+00	watt (W)	1.019 72 E−01	(kgf•m/s)
TEMPERATURE				
degree Celsius (°C)	$t_K = t_C + 273.15$	kelvin (K)	$t_C = t_K - 273.15$	(°C)
degree Fahrenheit (°F)	$t_K = (t_F + 459.67)/1.8$	kelvin (K)	$t_F = 1.8t_K - 459.67$	(°F)
degree Rankine (°R)	$t_K = t_R/1.8$	kelvin (K)	$t_R = 1.8t_K$	(°R)
degree Fahrenheit (°F)	$t_C = (t_F - 32)/1.8$	degree Celsius (°C)	$t_F = 1.8t_C + 32$	(°F)
VELOCITY (Includes Speed)				
foot per hour (ft/h)	8.466 667 E−05	metre per second (m/s)	1.181 102 E+04	(ft/h)
foot per hour (ft/h)	3.048 000*E−01	metre per hour (m/h)	3.280 840 E+00	(ft/h)
foot per minute (ft/min)	5.080 000*E−03	metre per second (m/s)	1.968 504 E+02	(ft/min)
foot per minute (ft/min)	3.048 000*E−01	metre per minute (m/min)	3.280 840 E+00	(ft/min)
foot per second (ft/s)	3.048 000*E−01	metre per second (m/s)	3.280 840 E+00	(ft/s)
inch per second (in/s)	2.540 000*E−02	metre per second (m/s)	3.937 008 E+01	(in/s)
kilometre per hour (km/h)	2.777 778 E−01	metre per second (m/s)	3.600 000 E+00	(km/h)
international knot	1.852 000*E+00	kilometre per hour (km/h)	5.399 568 E−01	international knot
mile per hour (mile/h)	4.470 400*E−01	metre per second (m/s)	2.236 936 E+00	(mile/h)
mile per hour (mile/h)	1.609 344*E+00	kilometre per hour (km/h)	6.213 712 E−01	(mile/h)
mile per minute (mile/min)	2.682 240*E+01	metre per minute (m/s)	3.728 227 E−02	(mile/min)
mile per minute (mile/min)	1.609 344*E+03	metre per minute (m/min)	6.213 712 E−04	(mile/min)
mile per second (mile/s)	1.609 344*E+03	metre per second (m/s)	6.213 712 E−04	(mile/s)
VOLUME (Includes Capacity)				
US bushel	3.523 907 E−02	cubic metre (m^3)	2.837 759 E+01	US bushel
cubic foot (ft^3)	2.831 685 E−02	cubic metre (m^3)	3.531 466 E+01	(ft^3)
cubic inch (in^3)	1.638 706 E−05	cubic metre (m^3)	6.102 376 E+04	(in^3)
cubic inch (in^3)	1.638 706 E−02	litre (l)	6.102 376 E+01	(in^3)
cubic inch (in^3)	1.638 706 E+01	cubic centimetre (cm^3)	6.102 376 E−02	(in^3)
cubic yard (yd^3)	7.645 549 E−01	cubic metre (m^3)	1.307 951 E+00	(yd^3)
cup	2.365 882 E−04	cubic metre (m^3)	4.226 753 E+03	cup
US fluid ounce (US fl oz)	2.957 353 E−05	cubic metre (m^3)	3.381 402 E+04	(US fl oz)
US fluid ounce (US fl oz)	2.957 353 E−02	litre (l)	3.381 402 E+01	(US fl oz)
Canadian liquid gallon	4.546 090 E−03	cubic metre (m^3)	2.199 692 E+02	Canadian liquid gallon
Canadian liquid gallon	4.546 090 E+00	litre (l)	2.199 692 E−01	Canadian liquid gallon
UK liquid gallon (UK gal)	4.546 092 E−03	cubic metre (m^3)	2.199 692 E+02	(UK gal)
UK liquid gallon (UK gal)	4.546 092 E+00	litre (l)	2.199 692 E−01	(UK gal)
US dry gallon (US dry gal)	4.404 884 E−03	cubic metre (m^3)	2.270 207 E+02	(US dry gal)
US liquid gallon (US gal)	3.785 412 E−03	cubic metre (m^3)	2.641 720 E+02	(US gal)
US liquid gallon (US gal)	3.755 412 E+00	litre (l)	2.641 720 E−01	(US gal)
UK fluid ounce (UK fl oz)	2.841 307 E−05	cubic metre (m^3)	3.519 507 E+04	(UK fl oz)
UK fluid ounce (UK fl oz)	2 841 307 E−02	litre (l)	3.519 507 E+01	(UK fl oz)
US peck	8.809 768 E−03	cubic metre (m^3)	1.135 104 E+02	US peck
US dry pint	5.506 105 E−04	cubic metre (m^3)	1.816 166 E+03	US dry pint
US liquid pint	4.731 765 E−04	cubic metre (m^3)	2.113 376 E+03	US liquid pint
US liquid pint	4.731 765 E−01	litre (l)	2.113 376 E+00	US liquid pint
US dry quart	1.101 221 E−03	cubic metre (m^3)	9.080 829 E+02	US dry quart
US liquid quart	9.463 529 E−04	cubic metre (m^3)	1.056 688 E+03	US liquid quart
US liquid quart	9.463 529 E−01	litre (l)	1.056 688 E+00	US liquid quart
tablespoon	1.478 676 E−05	cubic metre (m^3)	6.762 807 E+04	tablespoon
teaspoon	4.928 922 E−06	cubic metre (m^3)	2.028 841 E+05	teaspoon

TABLE OF MATERIAL WEIGHTS

MATERIAL	POUNDS PER CU FT
Alumine	60
Aluminum Chips	15
Aluminum Hydrate	18
Aluminum Ore	75-85
Aluminum Oxide	120
Aluminum Silicate	49
Alum	45-60
Ammonium Chloride (Cryst.)	52
Ammonium Sulphate	55-62
Ammonium Superphosphate	55-60
Andesite Stone	181
Asbestos, Shred	20-25
Ashes	40
Asphalt	100
Asphalt, Crushed	45
Asphaltum	87
Bakelite, Powdered	30-40
Barite or Baryte	180
Bark, Wood	10-20
Barley	38
Basalt Rock	181
Bauxite, Crushed	75-85
Beans, Castor	36
Beans, Navy, Dry	48
Bentonite	51
Block, Paving	136
Blood, Dried	30
Bluestone	110
Bonemeal	55-60
Bones, Crushed (½")	35-40
Bones, Gran.	50
Borax, Powdered	53
Bran	16
Brewers Grain, Dry	25-30
Brewers Grain, Wet	55-60
Brick, Hard Clay	125
Brick, Soft Clay	100
Brick, Paving	157
Brick, Pressed	140
Buckwheat	40-42
Caliche	90-95
Cast Iron Borings	130-200
Cement, Natural	56
Cement, Portland	90
Cement, Portland, Set	183
Cement, Portland, Bag	93
Cement, Portland, Barrel	93
Cement, Rosedale, Bag	69
Cement, Rosedale, Barrel	69
Cement, Western, Bag	64.7
Cement, Western, Barrel	64.7
Chalk, Crushed	85-90
Chalk, Pulpy	75
Charcoal	18-25
Cinders, Coal	40
Cinders, Blast Furn.	57
Clay, Fire	130
Clay, Dry	63
Clay, Wet	110
Clay, Out of Water	80
Clay and Gravel, Dry	100
Clay and Gravel, Out of Water	65
Clay and Sand, Out of Water	65
Coal, Anthracite	60
Coal, Bituminous	50
Cocoa Beans	30-40
Coffee, Green	32
Coke	23-42
Concrete, Cinders	110
Concrete, Gravel	152
Concrete, Limestone	150
Concrete, Sandstone	145
Concrete, Trap Rock	155
Copra	22
Copra, Cake	25-30
Copra, Ground	40-45
Copper, Ore	120-150
Corn, Shelled	45
Corn, Meal	38-40
Cottonseed, Dry	18-25
Cottonseed, Cake	40-45
Crushed Stone	100
Cullet	80-120
Diabase, Broken	175
Dolomite, Broken	110
Earth, Dry, Loose	70
Earth, Dry, Rammed	90
Earth, Dry, Shaken	82
Earth, Damp, Loose	78
Earth, Damp, Packed	96
Earth, Damp, Rammed	100
Earth and Gravel, Dry, Loose	100
Earth and Gravel, Dry, Rammed	120
Earth and Gravel, Wet	120
Earth and Sand, Dry, Loose	100
Earth and Sand, Dry, Rammed	120
Earth and Sand, Wet	120
Feldspar (1⅛")	65-70
Fire Brick	145
Fire Clay	130
Flaxseed	45
Flourspar	82
Fuller's Earth	35-40
Garbage	43
Gravel, Dry	110
Gravel, Out of Water	60
Granite	168
Gypsum, Crushed	100
Gypsum, Powdered	60-80
Hematite, Broken	200
Ilmenite, Ore	140
Iron, Ore	145
Lead, Ore, Broken	300
Lime, Quick, Loose	53
Lime, Quick, Shaken	55
Limestone, Solid	168
Limestone, Loose	96
Limonite, Ore, Broken	155
Magnetite, Ore, Broken	200
Marble, Solid	165
Marble, Loose	96
Mica, Broken	100
Mortar, Set	103
Mud, Dry	90
Mud, Packed	115
Mud, River	90
Mud, Wet	108
Mustard Seed	45
Nitrate, Chilean	72-85
Peas, Dried	45-50
Peanuts, Shelled	20-25
Peat, Dry	25
Peat, Wet	70
Phosphate Rock, Broken	110
Phosphate Rock, Granular	90
Phosphate Rock, Sand	90-100
Pitch	69
Plaster of Paris	98
Porphyry, Broken	100
Powder (Blasting)	62
Pumice, Ground (⅛")	42-45
Quartz	162
Quicklime	95
Rice	36-48
Riprap, Limestone	80
Riprap, Sandstone	90
Riprap, Slate	105
Riprap, Rubble	65
Rock Salt, Broken	95
Rubber	95
Rubbish	8
Salt, Dry, Coarse	45-50
Salt Cake, Dry	85
Saltpeter	69
Sand, Dry Loose	97
Sand, Shaken	100
Sand, Wet	118
Sandstone	149
Shale	162
Slag, Bank	70
Slag, Screenings	100
Slag, Machine	96
Slag, Sand	55
Slate	175
Snow, Fresh	5-12
Snow, Wet	15-50
Soda Ash	20-65
Sodium Nitrate	72-85
Soybeans, Whole	45-50
Steel Chips, Crushed	25-85
Stone, Crushed	85-100
Street Sweepings	31
Sugar Beet Pulp, Dry	12-15
Sugar Beet Pulp, Wet	25-45
Sugar, Raw	55-65
Sugar, Granular	100
Sulphate of Potash	80
Sulphur	125
Talc, Broken	110
Tanbark, Ground	55
Tankage	45
Tar	62
Tile	110
Trapstone	187
Wheat	45-48
Wood Chips	12-20
LIQUID	
Water	8.3 lbs./gal.
Water	62.4 lbs./cu. ft. or 7.4805 gal./cu. ft.
Diesel Oil	7.1 lbs./gal.
Oil, Petroleum	6 lbs./gal.
WOOD	
Fir	25-32 lbs./cu. ft.
Maple	33-43 lbs./cu. ft.
Oak	41-70 lbs./cu. ft.
Pine	26-44 lbs./cu. ft.

TRAVEL TIME CONVERSION

TRAVEL TIME CONVERSION TABLE IN MINUTES

Speed in Miles Per Hour	Travel Distance in Feet 100	200	300	400	500	600	700	800	900	1000
3	.379	.757	1.136	1.515	1.893	2.272	2.650	3.030	3.410	3.79
4	.284	.568	.853	1.136	1.420	1.700	2.000	2.270	2.550	2.84
5	.227	.454	.681	.908	1.136	1.363	1.590	1.820	2.040	2.27
6	.189	.378	.568	.757	.946	1.136	1.325	1.510	1.700	1.89
7	.162	.324	.487	.649	.811	.974	1.136	1.300	1.460	1.62
8	.142	.284	.426	.568	.710	.852	.994	1.136	1.280	1.42
9	.126	.252	.378	.505	.631	.757	.883	1.000	1.136	1.26
10	.113	.227	.341	.454	.568	.681	.795	.909	1.020	1.136
12.5	.091	.182	.273	.363	.454	.545	.636	.727	.818	.909
15	.075	.151	.227	.303	.378	.454	.530	.605	.681	.757
17.5	.065	.129	.194	.259	.324	.389	.454	.519	.584	.649
20	.057	.113	.170	.227	.284	.341	.397	.454	.511	.568
22.5	.050	.101	.151	.202	.252	.303	.353	.404	.454	.505
25	.045	.090	.136	.181	.227	.272	.317	.363	.408	.454
27.5	.041	.082	.124	.165	.206	.248	.289	.330	.371	.412
30	.038	.076	.113	.151	.189	.227	.265	.303	.341	.379
32.5	.035	.070	.104	.139	.174	.209	.244	.279	.314	.349
35	.032	.065	.097	.129	.162	.194	.227	.259	.291	.324

Note: After determining practical average speeds for rubber-tired equipment, find Time required in distance column opposite speed in miles per hour.

TRAVEL SPEED CONVERSION TABLE

Miles Per Hour	Feet Per Minute	Feet Per Second
1	88	1.46
2	176	2.94
3	264	4.40
4	352	5.87
5	440	7.33
6	548	8.80
7	616	10.26
8	704	11.73
9	792	13.20
10	880	14.67
11	968	16.13
12	1,056	17.60
13	1,144	19.07
14	1,232	20.52
15	1,320	22.00
16	1,408	23.47
17	1,496	24.93
18	1,584	26.40
19	1,672	27.86
20	1,760	29.33
21	1,848	30.80
22	1,936	32.26
23	2,024	33.72
24	2,112	35.20
25	2,200	36.67
26	2,288	38.14
27	2,376	39.60
28	2,464	41.04
29	2,552	42.50
30	2,640	44.00

CONVERSION OF DEGREES INTO PER CENT GRADE

Degrees	Per Cent
1	1.75
2	3.49
3	5.24
4	6.99
5	8.75
6	10.51
7	12.28
8	14.05
9	15.84
10	17.63
11	19.44
12	21.26
13	23.09
14	24.93
15	26.80
16	28.67
17	30.57
18	32.49
19	34.43
20	36.40

TON-MILES-PER-HOUR (TMPH)

The most critical factor in tire life is heat. To help you figure what the safe load limit is for a given tire, use the TMPH formula. All earthmover tires have a TMPH limit, specified by the manufacturer, which can be calculated as a number (or value) based on load, distance and speed. To determine the TMPH rating for a tire, simply multiply the average load by the average speed. The calculation must be made for each tire or set, since location on the vehicle makes a difference.

To find the averages . . .

$$\text{Average Load} = \frac{\text{Empty Tire Load \& Loaded Tire Load}}{2}$$

$$\text{Average Speed (mph)} = \frac{\text{Round Trip Distance x Number of Trips/day}}{\text{Hours Worked/day}}$$

Average Load x Average Speed should be less than or equal to the TMPH Rating.

IDENTIFICATION OF OFF-HIGHWAY TIRES

Identification	Tread	Use
C-1	Smooth	C = Compactor
C-2	Grooved	
E-1	Rib	E = Earthmover
E-2	Traction	
E-3	Rock	
E-4	Rock Deep Tread	
E-5	Rock Intermediate	
E-6	Rock—Maximum	
E-7	Flotation	
G-1	Rib	G = Grader
G-2	Traction	
G-3	Rock	
L-2	Traction	L = Loader and Dozers
L-3	Rock	
L-3/L-3S	Half design & half smooth	
L-4	Rock deep tread	
L-4/L-4S	Half design & half smooth (deep tread)	
L-5	Rock extra deep tread	
L-3S	Smooth	
L-4S	Smooth deep tread	
L-5S	Smooth extra deep tread	
L-5/L-5S	Half design & half smooth (extra deep tread)	

EXAMPLE:

Empty tire load	10 tons
Loaded tire load	17 tons
Hours worked per day	18.5
Number of loads hauled	30
Distance, round trip	9 miles

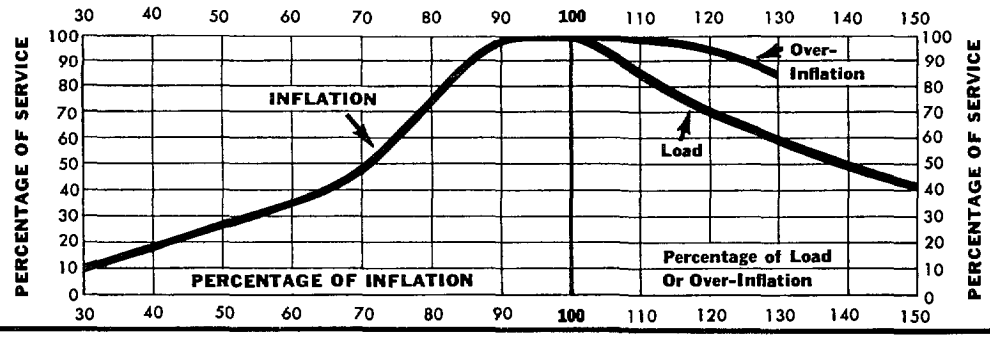
$$\frac{10 \text{ tons} + 17 \text{ tons}}{2} = 13.5 \text{ Average load}$$

$$\frac{9 \text{ miles} \times 30 \text{ trips}}{18.5 \text{ hours}} = 14.6 \text{ Average mph}$$

$$13.5 \times 14.6 = 197 \text{ TMPH Rating}$$

If your tires have a TMPH rating of 197 or higher, there will be no heat problem.

EFFECT OF INFLATION AND LOAD ON TIRE MILEAGE



SCRAPER/HAULER TIRE SELECTION CHART

Material	Haul Road Conditions	Tread
Silt and Clay No Rock High moisture content	Good varying to Poor High Rolling Resistance	Traction Type
Silt and Clay Some Rock Variable moisture content	Good varying to Poor	Rock-type best unless traction is a problem—then use traction tires. Rock-type offers more resistance to cutting.
Silty or Clayey Gravel and Sand Low moisture content	Excellent to Good Firm Surface	Rock type offers better wear characteristics.
Silty or Clayey Gravel and Sand High moisture content	Poor-rutted-pot holes	Rock-type. Extra ply rating may be required to resist bruising.
Blasted Rock	Hard surface-rough	Rock-type. Extra ply rating may be advantageous to resist bruising.
Sand Very low silt or clay content	Good to fair surface	Rock-type with low pressure. Creates minimum soil distrubance resulting in improved flotation.

RULES OF THUMB AND FORMULAE

- Number of PAY scraper units one pusher will handle =

$$\frac{\text{PAY scraper cycle time}}{\text{Pusher cycle time}}$$

- Hourly pusher cost per PAY scraper =

$$\frac{\text{Hourly pusher ownership \& operating costs}}{\text{No. of PAY scrapers served by a single pusher}}$$

- One pound of drawbar effort will load one pound of material into a PAY scraper or tractor drawn scraper in 1/2 minute on level grade.
- Downhill PAY scraper or Tractor Drawn scraper Loading Advantage: Reduced loading time:

$$\text{Seconds Saved} = \frac{(\text{EVW} + \text{P}) \times \%\ \text{grade} \times 60}{\text{P} \times 100\%}$$

Added load in same time:

$$\text{Added load, lbs} = \frac{(\text{EVW} + \text{L}) \times \%\ \text{grade}}{100\% - \%\ \text{grade}}$$

EVW = Empty weight in pounds of tractor, scraper and pusher.
P = Pay load in pounds
L = Load in pounds obtained on level ground in same loading time.

- Travel time in minutes =

$$\frac{\text{Distance (in feet)}}{\text{Speed (mph)} \times 88}$$

- Miles per hour =

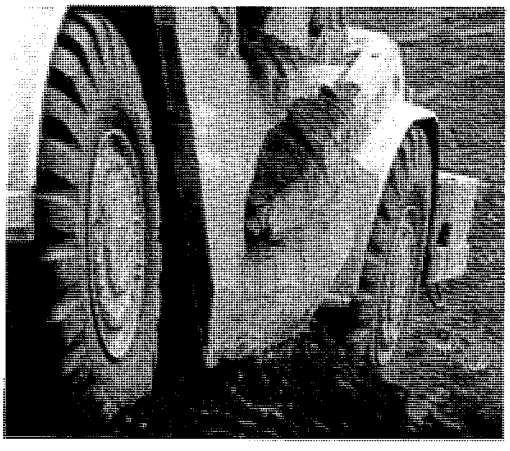
$$\frac{\text{Distance in feet}}{\text{Travel time (minutes)} \times 88}$$

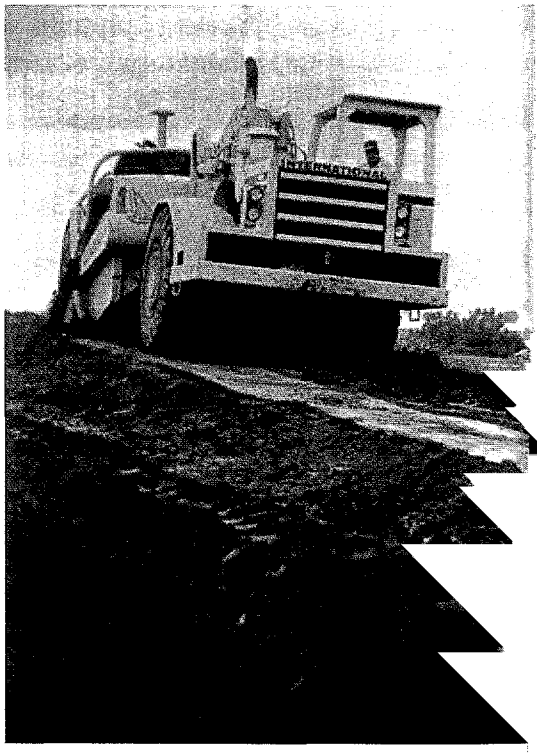
- Power loss from engine flywheel to wheels through the gear train on gear drive machines is 20 percent, on power shift machines it is 30 percent.
- Rolling Resistance (RR), lbs =

$$\frac{\text{Vehicle Wt lbs} \times [(2\% + 1.5\% \times \text{tire penetration, ins})]}{100}$$

- Grade Resistance (GR), lbs =

$$\frac{\text{Vehicle Wt lbs} \times \%\ \text{Grade}}{100}$$





- Approximate ownership and operating costs of power shift crawler tractors $ per hour, less operator =

$$\frac{2.7 \text{ x List Price}}{10{,}000}$$

- Winch line pull in pounds =

$$\frac{\text{HP x 33,000 x \% efficiency of transmission}}{\text{100 x Line speed in feet per minute}}$$

- Drawbar Horsepower =

$$\frac{\text{pounds DB pull x mph}}{375}$$

- Horsepower required to raise water =

$$\frac{\text{gallons per minute x head (feet) x 8.34}}{\text{33,000 ft lb x \% pump efficiency}}$$

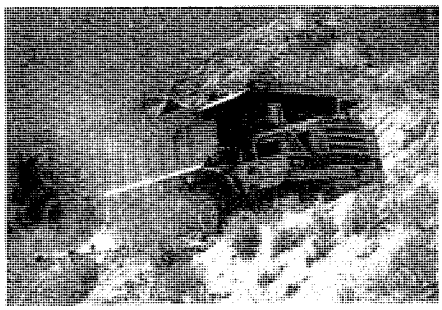
- Torque, lbs-ft =

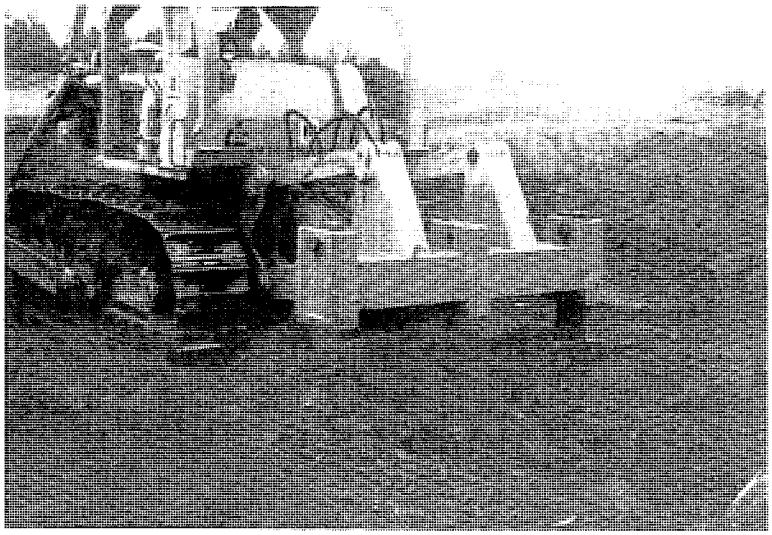
$$\frac{\text{HP x RPM}}{5252}$$

- Piston speed, fpm =

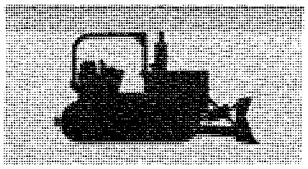
$$\frac{\text{2 x stroke x RPM}}{12}$$

- Shovel production is approximately 100 cubic yards per hour multiplied by the dipper capacity in yards.
- A heavy sheepsfoot roller will consume approximately 25% of gross weight of trailed unit in drawbar pounds pull in loose material.
- One heavy duty ripper will normally keep three PAY scrapers busy when handling 300 cubic yards of material per hour per machine.
- Each one percent of adverse grade will consume one percent of the total gross weight of the machine in rimpull pounds.
- Each one percent of favorable grade will create one percent of the total gross weight of the machine in drawbar pounds pull.





RULES OF THUMB AND FORMULAE



CRAWLER DOZER PRODUCTION

Crawler dozer production in cubic yards per hour depends on power, blade capacity, tractor traveling speeds, and time lost in slippage and gear shifting. The following rule of thumb formula assumes blades of ample capacity for full power of tractor and use of fastest forward and reverse speeds practicable for the dozing distance:

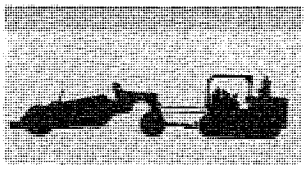
P = Production in *loose* cubic yards per *60-minute hour*

Net Power = Net horsepower at flywheel of power shift crawler tractor engine

D = Distance dozed one-way in feet

For approximate in-bank cubic yards per 50-minute efficiency hour use 220 instead of 330 in the formula.

$$P = \frac{\text{Net Power} \times 330}{D + 50}$$



CRAWLER DRAWN SCRAPER PRODUCTION

Crawler drawn scraper production depends on scraper capacity, drawbar pull for loading, hauling speeds and time lost in loading, turning, gear shifting and dumping. The following rule of thumb applies to scrapers pulled by crawlers with at least 12.5 net engine horsepower at flywheel, and 2700 pounds maximum pull per cubic yard of struck capacity.

P = Production, in-bank cu yd per 60 minute hour

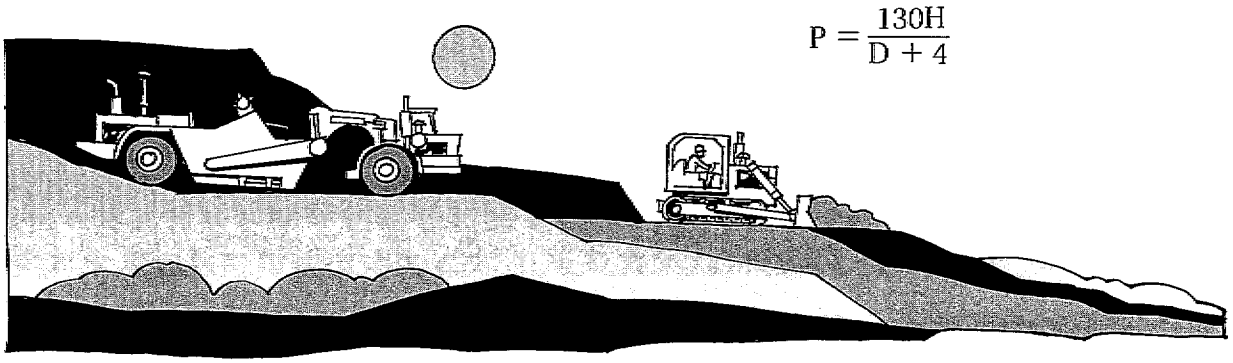
H = Scraper bowl capacity (in-bank corrected heaped capacity)

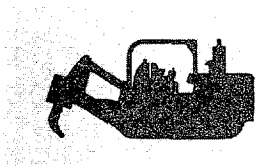
D = Distance hauled one-way in 100 ft. Stations (Distance in feet ÷ 100)

130 = Speed constant equal to 5,280 ft per mile traveling speed x 4.9 mph ÷ 200 feet both ways, per 100-foot haul station. Requires 12.5 net flywheel HP per pay yard of scraper capacity at approximately 200 lbs per ton rolling resistance.

4 = Fixed time constant equal to 1.85 min per cycle at 4.9 mph

$$P = \frac{130H}{D + 4}$$





FORMULA FOR FINDING TRACTOR RIPPER PRODUCTION TIME:

WHERE:

T = Time required to complete ripping, in hours

A = Width of area to be ripped, in feet

W = Effective width of ripper, in feet

P = Depth of penetration per pass, in feet

L = Length of area to be ripped, in feet

MPH = Travel speed, mph (Normally 1.2 to 1.5 MPH)

E = Efficiency Hour in minutes,

$$T = \frac{A}{W} \times P \times \frac{L}{MPH \times 88 \times E}$$

FORMULA FOR FINDING MOTOR GRADER PRODUCTION TIME:

WHERE:

T = Time required to complete grading, in hours

N = Number of passes required

D = Total travel distance, in miles

MPH = Average of forward and reverse travel speeds on all passes

E = Efficiency Hour in minutes,

$$T = \frac{N \times D \times 60}{MPH \times E}$$

FORMULA FOR FINDING AVERAGE TRAVEL SPEEDS:

Average traveling speed in mph in a round trip cycle with no fixed time allowance is:

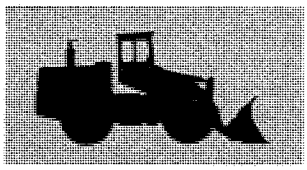
$$S = \frac{2 \times F \times R}{F + R}$$

WHERE:

S = Average mph per cycle (with no fixed time allowance)

F & R = The selected forward & reverse (or haul & return) traveling speeds respectively in mph

EXAMPLE: Forward, 1.5 mph; reverse, 3 mph. Average mph per cycle = 2 x 1.5 x 3 ÷ 4.5 = 2 mph



FORMULA FOR FINDING PAY LOADER PRODUCTION:

WHERE:

P = Production, in tons per hr.

H = Heaped capacity (LCY)

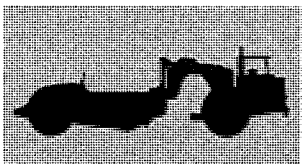
2000 = lbs per ton

E = Efficiency Hour in minutes,

I = In-Bank Correction Factor

C = Cycle Time in minutes

$$P = \frac{\text{Bank Weight} \times I \times H}{2000} \times \frac{E}{C}$$



SELF PROPELLED SCRAPER PRODUCTION

Self-Propelled Scraper production in cubic yards per hour depends on scraper capacity, power for high-speed operation, and time lost in pusher loading, accelerating, dumping and turning. The following rule-of-thumb formula takes these factors into account for quick, rough estimates:

P = Production, in bank cu yds per 60 minute hour on average level haul roads

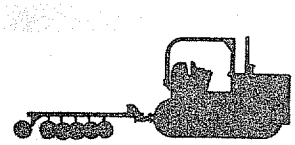
H = Scraper bowl capacity in cubic yards. (Use in-bank corrected heaped capacity)

D = Distance hauled one way in 100-foot stations (Distance in feet ÷ 100)

600 = Speed constant equal to 5,280 feet per mile traveling speed x 22.7 mph ÷ 200 feet both ways per 100 ft. haul station. Requires 15 HP per cu yd of scraper capacity at 65 to 75 lbs per ton GVW rolling resistance.

20 = Fixed time constant for loading, acceleration, turning, and dumping. Equivalent to 2 minutes per cycle at 22.7 mph (2,000 ft per min).

$$P = \frac{600H}{D + 20}$$



FORMULA FOR FINDING PRODUCTION OF TRACTOR DRAWN HARROWS, PLOWS AND CULTIVATORS USED IN CONSTRUCTION WORK:

WHERE:

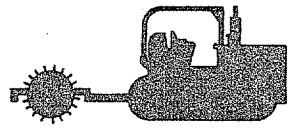
P = Production in square yards per hour

MPH = Speed of towing tractor

W = Effective width of implement, in feet

E = Efficiency Hour in minutes,

$$P = \frac{5280 \times MPH \times W \times E}{9 \times 60}$$



FORMULA FOR FINDING PRODUCTION OF TRACTOR DRAWN SHEEPS-FOOT ROLLERS:

WHERE:

P = Production per sheeps-foot in cu yds per hour

E = Efficiency Hour in minutes

MPH = Ground speed of towing tractor

W = Effective width of roller, in feet (normally 8 or 10 feet with two sections)

D = Depth of lift in inches

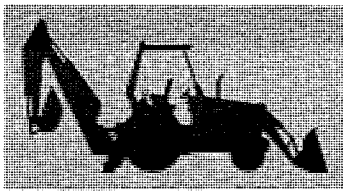
N = Number of passes required (Depends on type and moisture content of soil and weight of roller).

DBP NECESSARY TO PULL SHEEPS-FOOT = TOTAL WEIGHT OF ROLLER x .25

No. of SHEEPS-FOOT UNITS REQUIRED =

$$\frac{\text{cu yds placed on fill per hr}}{P}$$

$$P = \frac{E \times MPH \times W \times D \times 5280}{60 \times N \times 27 \times 12}$$



WHEEL TRACTOR
BACKHOE PRODUCTION

Backhoe production estimates are best determined by timing the machine in question at appropriate digging depths, and then applying the Capacity x Cycles formula. However, a preliminary estimate can be made for backhoe equipped with the standard 24-inch bucket, by application of the following method . . .

Approximately 225 cycles per 60-minute hour can be expected when . . .

Digging depth is	4 feet
Swing angle is	40-60 degrees
Digging conditions are	Favorable

DIGGING DEPTH

Depth in Feet	Factor
4	1.00
6	0.95
8	0.90
10	0.85
12	0.80
14	0.75

SWING ANGLE

Swing in Degrees	Factor
40 - 60	1.00
60 - 70	0.95
Over 70	0.90

MATERIAL LOADABILITY

Conditions	Factor
Favorable	1.00
Average	0.85 - 0.95
Unfavorable	0.50 - 0.80

When conditions are different than those stated, the factors shown in the accompanying charts must be used to adjust your estimate. These charts have been estimated to provide for the extra time required in performing any operation beyond the standard given above. Digging depth, for example, has been factored for trenches deeper than four feet. The swing angle factor accounts for any distance the bucket must swing beyond the standard 40 to 60 degrees. And the loadability factor accounts for difficult digging conditions.

EXAMPLE:
A backhoe has a 6 cubic foot bucket and is digging a 2-ft. wide trench in moist clay at a depth of 6 feet. The swing angle is 75 degrees; digging conditions are considered average. The in-bank correction factor for this material is 0.80, and the efficiency hour is about 55 minutes. Following our formula . . .

$$\frac{225 \text{ cycles/hr} \times 6 \text{ cu ft} \times 55 \text{ min/hr} \times 0.80 \times 0.95 \times 0.90 \times 0.90}{60 \text{ min/hr} \times 27 \text{ cu ft per cu yd}} = 28.2 \text{ BCY/Hr}$$

Backhoe performance is also measured in distance, or linear feet of trench per hour. Once we have established the BCY/hr figure, there is an easy procedure for determining production in feet per hour. The formula for finding the linear foot per hour is . . .

$$\frac{27 \text{ cu ft per cu yd} \times \text{Production (BCY/hr)}}{\text{Trench width} \times \text{depth in feet} \times \text{fall-in factor}} = \text{Linear Feet of Trench Per hour}$$

To continue with our example, remember that the trench is 2 feet wide and 6 feet deep.

$$\frac{27 \text{ cu ft per cu yd} \times 28.2 \text{ BCY/hr}}{2 \times 6 \times 1.03} = 62 \text{ Lin. ft/hr}$$

A fall-in factor must also be used when figuring linear feet per hour because certain materials, when excavated, tend to remain in place, while others tend to cave in. Sand and gravel, for instance, call for constant clean-out of material that falls into the excavation from the trench walls. A firm clay, on the other hand, would require little if any clean-out.

The basic production formula for backhoes is as follows:

$$\text{Production} = \frac{225 \times E \times H \times \text{IBCF} \times \text{Digging Depth Factor} \times \text{Swing Angle Factor} \times \text{Loadability Factor}}{60 \text{ min} \times 27 \text{ cu ft/cu yd}}$$

FALL-IN FACTOR	
Loose material (sand and gravel)	1.67 - 1.43
Average soil	1.05
Firm material (moist clay)	1.03

GLOSSARY

BCY	Bank Cubic Yards
LCY	Loose Cubic Yards
SF	Swell Factor
IBCF or I	In-Bank Correction Factor
TPH	Ton-Per-Hour
GVW	Gross Vehicle Weight
EVW	Empty Vehicle Weight
Cycle	Complete round-trip of any operation
Shuttle	Forward-reverse operation of crawler
Payload	Amount of material handled by the machine, pounds, LCY or BCY
RP	Rimpull
DBP	Drawbar Pull
RR	Rolling Resistance
GR	Grade Resistance
GA	Grade Assistance
TA	Total Assistance
TR	Total Resistance
HP	Horsepower
MPH	Miles-Per-Hour
Depreciation	Dollar value reduction, measured in time
Loadability	The degree of efficiency attainable in loading a material
TMPH	Ton-Miles-Per-Hour
D	Distance
88	Distance moved in fpm when traveling at the rate of 1 mph
FPM	Feet-Per-Minute
IIT	Interest, Insurance, Taxes

NOTES

NOTES

NOTES

International®

PAY LINE DIVISION

_____

HOURLY OWNING & OPERATING COSTS

_____

_____

HOURLY OWNERSHIP COSTS

Depreciation:

Purchase Price (Including options/shipping/taxes/etc.) $_____

Tire Replacement Costs (-)_____

Amount to be Depreciated $_____

Hourly Depreciation = $\frac{\text{Amount to be Depreciated (_____)}}{\text{5 x Hours/Year (_____)}}$ = $_____

Interest/Insurance/Taxes (IIT)

Hourly Cost of IIT =

$\frac{\text{Purchase Price (\$_____) x IIT (_____) x 0.6}}{\text{Hours/Year (_____)}}$ = $_____

TOTAL OWNERSHIP COSTS $_____

HOURLY OPERATING COSTS

Fuel:	_____gph	$_____	per gallon	$_____
Engine Oil:	_____gph	_____	per gallon	_____
Transmission Oil:	_____gph	_____	per gallon	_____
Final Drive Oil:	_____gph	_____	per gallon	_____
Steering and/or Hyd. Oil:	_____gph	_____	per gallon	_____
Chassis Lubricant:	_____lbs/hr	_____	per lb.	_____

Filter Costs for Average Conditions: (all filters) _____

Hourly Tire Costs: $\frac{\text{Tire Replacement Costs (\$_____)}}{\text{Hours of Service (_____Hrs.)}}$ _____

Estimated Repair Costs: _____% x Hourly Depreciation ($_____) _____

Operator's Wage (including fringe benefits, insurance, etc.) _____

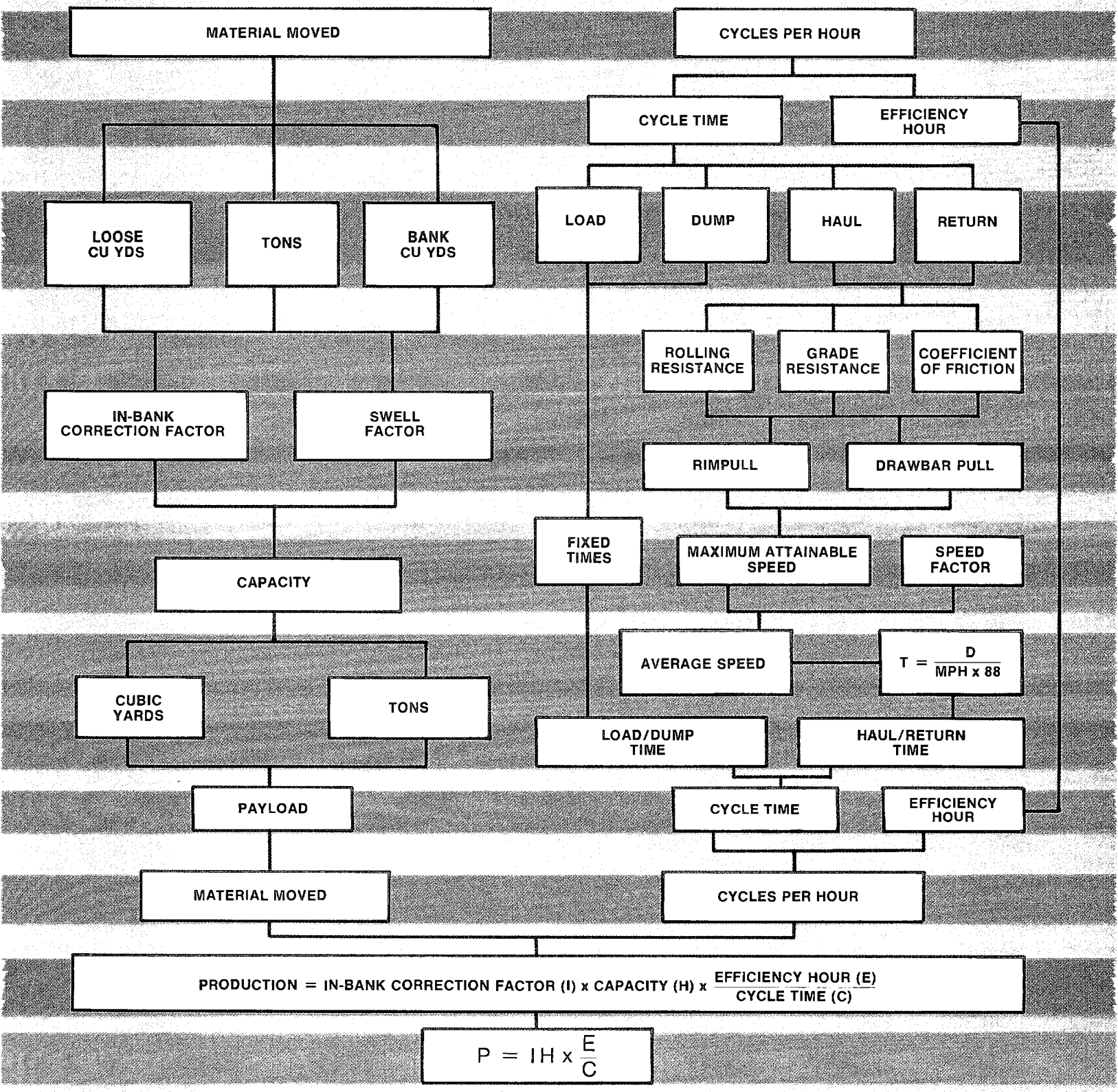
TOTAL OPERATING COSTS $_____

TOTAL ESTIMATED HOURLY OWNERSHIP & OPERATING COSTS $_____

Formulas based on 5 years of actual useful life. For alternative number of years, refer to Earthmoving Principles.

NOTE: This is an estimate only and no guarantee is made, nor implied, that actual job costs will not be higher or lower than those shown.

PRODUCTION



COST

TABLES

INTERNATIONAL HARVESTER

AD-50060-E 11-75 LITHOGRAPHED IN THE UNITED STATES OF AMERICA

Assuming:

① The total mining costs of WDG represent 1/3 of the total costs over the ten year period, then:

② Any "ore" found must have the recovered value of at least 3 times the Total Mining Cost Value in order to be of interest.

Example: If you find a body at the depth of 150 feet, with a 4:1 stripping ratio, and produced at 250 TPD, the Total Mining Cost is $20 million for the ten years.

a) a million ton ore body of 0.05 opt recoverable gold @ $350 per ounce = 1,000,000 tons x $17.50 value/ton = $17,500,000 total value. And this will not even pay the mining costs, let alone the milling, refining, etc.; thus you'd need about 0.2 opt @ $350 = $70/ton = $70,000,000 so that the $20 mill x 3 = $60 million is a smaller figure and the property should be seriously investigated.

COST/TON OF MATERIAL MOVED ($)

$7.00
6.00
5.00
~~4.00~~
4.00
3.00
2.00
1.00

EXAMPLE USING THIS DATA

A PROPERTY HAS A 500 TPD PRODUCTION ESTIMATE BUT A 3:1 STRIPPING RATIO -- WHAT WOULD TOTAL MINING COST ESTIMATE BE

1) LOCATE A for 3:1 RATIO
2) COST IS ABOUT $5.00/TON
3) TOTAL COST FOR MINE (EST)
   3 WASTE TO 1 ORE OR A FACTOR OF 4

THEN 4 (500 TPD) X 350 WORK DAYS/YEAR X 10 YRS X 5.00/TON (FROM 2 ABOVE)
= $35,000,000

THIS AGREES WITH 500 TPD BETWEEN 2:1 & 4:1 STRIPPING RATIO

STRIPPING RATIO	ORE TONS DAILY	TOTAL MINING COSTS
1:1	500 TPD	$24,850,000
4:1	250 TPD	$20,055,000
2:1	500 TPD	$29,557,500
A	ASSUME 3:1	500 TPD
8:1	250 TPD	$~~8,190,000~~ 37,000,000
4:1	500 TPD	$38,412,500
8:1	500 TPD	$47,880,000

STRIPPING RATIO	ORE TONS DAILY	TOTAL MINING COSTS
1:1	1000 TPD	$43,540,000
2:1	1000 TPD	$53,550,000
4:1	1000 TPD	$71,925,000
8:1	1000 TPD	$113,400,000

10 YEAR MINE LIFE
350 WORK DAYS/YR

150 FT — PIT DEPTH — 200 FT

COST/TON MATERIAL MOVED($)

$2.00

1.50

1.00

STRIPPING RATIO	ORE TONS DAILY	TOTAL MINING COST
1:1	5000 TPD	$30,450,000
2:1	5000 TPD	$51,100,000
4:1	5000 TPD	$115,500,000
8:1	5000 TPD	$181,130,000

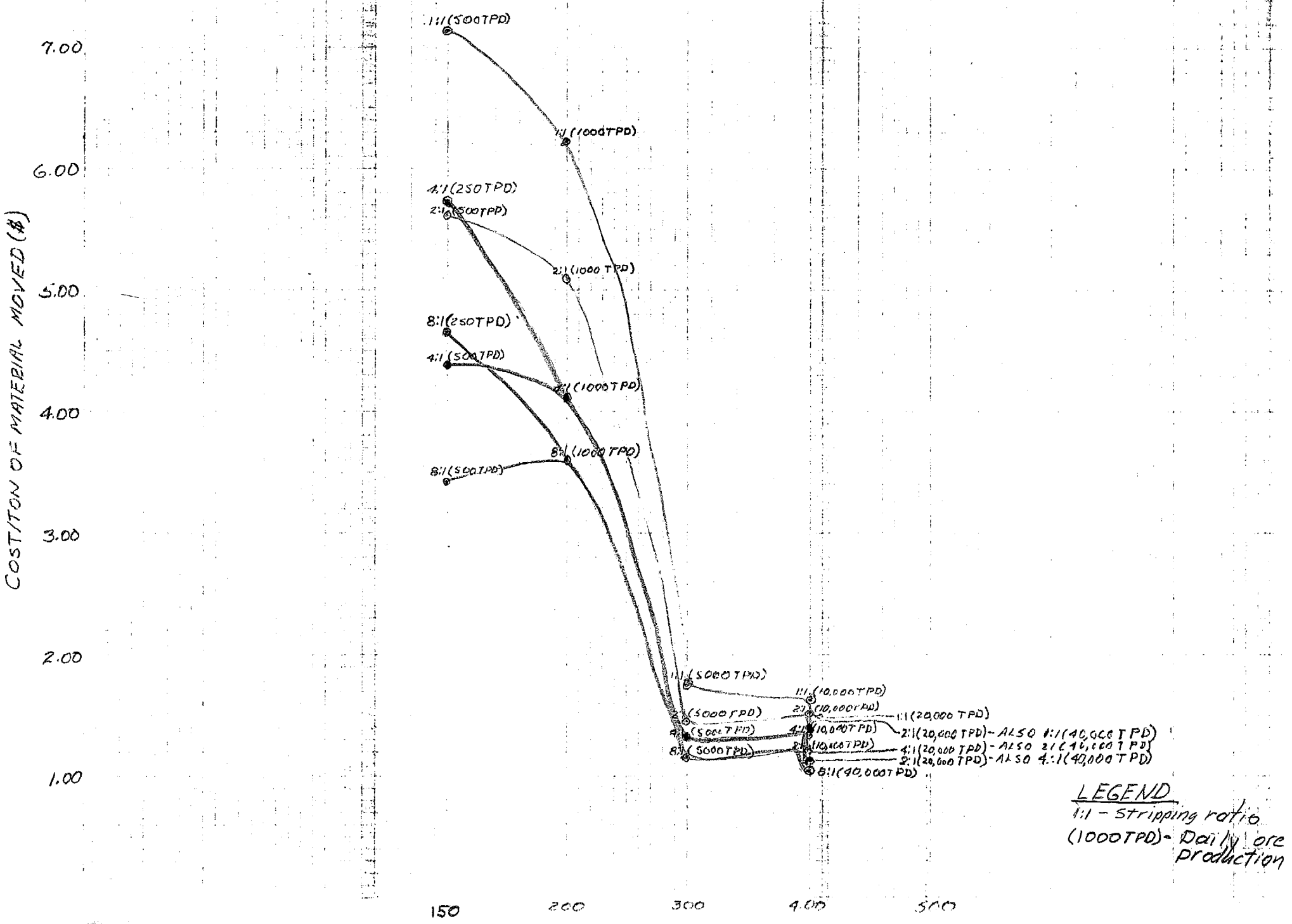
STRIPPING RATIO	ORE TONS DAILY	TOTAL MINING COSTS
1:1	10,000 TPD	$113,400,000
2:1	10,000 TPD	$107,100,000
1:1	20,000 TPD	$212,800,000
1:1	40,000 TPD	$386,400,000
4:1	10,000 TPD	$236,250,000
2:1	20,000 TPD	$289,800,000
2:1	40,000 TPD	$529,200,000
8:1	10,000 TPD	$387,500,000
4:1	20,000 TPD	$434,000,000
4:1	40,000 TPD	$805,000,000
8:1	20,000 TPD	$711,900,000
8:1	40,000 TPD	$1,335,600,000

10 YEAR MINE LIFE

350 WORK DAY/YEAR

300 FT — PIT DEPTH — 400 FT

MINING LIFE IS 10 YEARS



FROM: F. T. GRAYBEAL

TO: ~~WL Kurtz~~/~~JD Sell~~
DM Smith, Jr
EW Perkins
PG Vikre
JC Balla
DD Harper
RS Gray / EB Nicholls
DM Fletcher / RE Gale
HC Williamson
L. Montoya

RECEIVED
JUL 30 1984
EXPLORATION DEPARTMENT

7/26/84

REMARKS BY T.C. OSBORNE

EXECUTIVE VICE PRESIDENT, ASARCO INCORPORATED

TO A MEETING OF SECURITIES ANALYSTS

THURSDAY, JULY 26, 1984

File where? Mining costs

ASARCO'S COST OF MINING COPPER

OVER THE PAST YEAR THE QUESTION OF THE RELATIVE COST OF PRODUCING COPPER IN U.S. MINES COMPARED TO FOREIGN MINES HAS RECEIVED A GREAT DEAL OF ATTENTION FROM THE MINING AND FINANCIAL COMMUNITIES, FROM THE GOVERNMENT, AND FROM THE METAL INDUSTRY ITSELF. THIS IS NOT SURPRISING IN VIEW OF THE CRITICAL CONDITION IN WHICH THE U.S. COPPER INDUSTRY FINDS ITSELF, AND OF THE PUBLICITY SURROUNDING THE INDUSTRY'S PETITION FOR RELIEF FROM EXCESSIVE IMPORTS WHICH WAS FILED LAST JANUARY WITH THE INTERNATIONAL TRADE COMMISSION.

AS ONE WHOSE AREA OF CORPORATE RESPONSIBILITY INCLUDES ASARCO'S MINING DEPARTMENT, I HAVE TO CONFESS THAT I FEEL FRUSTRATED BY MUCH OF THE COMMENTARY I'VE SEEN AND HEARD OVER THE PAST SIX MONTHS WITH RESPECT TO THE COST OF PRODUCING COPPER IN THE UNITED STATES. I'M FRUSTRATED BECAUSE SO MUCH OF THE COMMENTARY HAS BEEN BASED ON BAD DATA AND MISTAKEN PRESUMPTIONS, AND HAS BEEN JUST PLAIN WRONG.

AGAIN AND AGAIN I SEE THE THEME REPEATED THAT FUNDAMENTALLY THE OVERSEAS MINES ARE HIGH GRADE AND THE U.S. MINES ARE LOW GRADE, THAT OVERSEAS MINERS EARN LOW WAGES AND U.S. MINERS EARN HIGH WAGES, AND THAT THEREFORE OVERSEAS INEVITABLY MEANS LOW COST AND DOMESTIC MEANS HIGH COST. ACCORDING TO

THIS CONVENTIONAL WISDOM, THE COMBINATION OF THESE HIGH COSTS WITH STODGY DOMESTIC MANAGEMENT MAKES INEVITABLE A DRASTICALLY SHRINKING ROLE FOR U.S. PRODUCTION BASED ON ECONOMIC REALITIES. SOME OF THE EDITORIAL COMMENTS SEEM TO SUGGEST THAT WE OF THE DOMESTIC INDUSTRY REALLY HAVE LITTLE OPTION BUT TO SIMPLY ROLL OVER AND ACCEPT THE INEVITABLE. THIS SORT OF GLIB CONCLUSION HAS, UNFORTUNATELY, BEEN ACCEPTED AS THE TRUE WISDOM NOT ONLY BY SUCH ENTITIES AS THE EDITORIAL BOARD OF THE NEW YORK TIMES, BUT ALSO BY SOME UNEXPECTED SOURCES BOTH IN INDUSTRY AND GOVERNMENT AND I'M AFRAID, EVEN BY A FEW INDIVIDUALS FROM AMONG THE DISTINGUISHED GATHERING IN THIS ROOM THIS MORNING.

HOWEVER, CONSIDERING THE GENERAL UNAVAILABILITY OF ACCURATE COMPARABLE COST DATA, I GUESS NO ONE CAN REALLY BE BLAMED TOO SEVERELY FOR GOING ASTRAY. EVEN A PRESTIGIOUS U.S. GOVERNMENT AGENCY WHICH DEALS WITH MINING RECENTLY HAD TO RELY ON U.S. COST DATA FROM THE LATE SEVENTIES, FACTORED FOR INFLATION, WHEN PREPARING A RANKING OF RELATIVE COSTS BETWEEN COPPER PRODUCING REGIONS. NOT UNEXPECTEDLY, SUCH METHODOLOGY PRODUCED A RESULT SUGGESTING THAT U.S. COSTS ARE THE HIGHEST IN THE WORLD BY MORE THAN 10¢ A POUND OVER THE NEAREST RIVAL. THIS IS, OF COURSE, NOT TRUE, BUT UNFORTUNATELY THIS KIND OF CONCLUSION TENDS TO GET PERPETUATED, FOR EXAMPLE, THE RANKINGS WERE USED BY A MAJOR U.S. OIL COMPANY IN ITS TESTIMONY BEFORE THE ITC OPPOSING OUR PETITION FOR RELIEF.

EVEN WHEN PEOPLE ATTEMPT TO APPLY RATIONAL METHODOLOGY

IT IS EASY TO GO WRONG IN ESTIMATING RELATIVE COSTS. THERE ARE TWO FUNDAMENTAL PITFALLS WHICH ARE DIFFICULT TO AVOID: THE FIRST IS FAILURE TO UNDERSTAND FULLY AND TO TAKE INTO PROPER ACCOUNT ALL THE MANY INTERACTING VARIABLES WHICH GO TO MAKING UP A MINING COST STRUCTURE. CLEARLY THE GRADE OF ORE, I.E. THE NUMBER OF POUNDS OF COPPER PER TON OF MATERIAL IN THE GROUND, IS AN IMPORTANT PARAMETER IN COMPARING MINES, BUT THERE ARE MANY OTHER VARIABLES WHICH HAVE A SIGNIFICANT IMPACT ON THE COST OF COPPER IN CONCENTRATE. I DON'T HAVE TIME TO GO OVER ALL THESE OTHER VARIABLES IN AN ORGANIZED WAY, SO I'LL JUST MENTION A FEW OF THEM AS MORE OR LESS RANDOM EXAMPLES.

FIRST, ASSUMING WE ARE DEALING WITH AN OPEN PIT MINE, THE WASTE-TO-ORE MINING RATIO HAS A STRONG INFLUENCE ON MINING COSTS BECAUSE GENERALLY IT COSTS ABOUT THE SAME TO MINE A TON OF WASTE AS A TON OF ORE. THE LATEST DATA I HAVE ON ARIZONA COPPER MINES LISTS THE AVERAGE WASTE/ORE RATIO AS 1.3 TO 1, WHICH CAN BE CONTRASTED WITH SOME OF THE ZAIRE PITS WHERE I UNDERSTAND THE RATIOS GET AS HIGH AS 11 TO 1. OTHER IMPORTANT VARIABLES THAT COME TO MIND ARE THE AMENABILITY OF THE MINERAL DEPOSIT TO MANIPULATION OF ITS MINING GRADE BY CAREFUL PLANNING, THE COST OF DRILLING AND BLASTING ORE AND WASTE WHICH VARIES WITH THE GEOLOGY, THE COST EFFECT OF DILUTION BY INTERNAL WASTE WHICH INEVITABLY OCCURS AT EVERY WASTE/ORE INTERFACE WITHIN THE ORE BODY, THE COST OF TRANSPORTING ORE TO THE CONCENTRATOR WHICH DEPENDS ON THE DEPTH OF THE

PIT AND THE LOCATION OF THE CRUSHER, THE COST OF CRUSHING AND GRINDING WHICH DEPENDS HEAVILY ON THE PHYSICAL PARAMETERS OF THE ORE, THE COST OF THINGS LIKE WATER SUPPLY TO THE MILL, THE COST EFFECT OF METALLURGICAL COMPLEXITY WHICH CAN RESULT IN METAL LOSSES, HIGHER REAGENT COSTS, A LOW CONCENTRATE GRADE AND HENCE HIGH FREIGHT AND SMELTING COSTS, ETC. ONCE THE COPPER IS IN CONCENTRATE, THERE IS THE HIGHLY VARIABLE COST OF TRANSPORTING CONCENTRATES TO THE SMELTER WHICH CAN MEAN ANYTHING FROM HAULING THEM A FEW THOUSAND YARDS TO A TORTUOUS JOURNEY OVER A LONG, POORLY MAINTAINED RAILROAD THROUGH AN INEFFICIENT PORT. ALSO, WE NEED TO TAKE INTO ACCOUNT THE AMOUNT OF BY-PRODUCTS AND THEIR VARIABLE PRICES WHICH CAN DRASTICALLY AFFECT THE DERIVED CREDITS AGAINST COPPER COSTS. ANOTHER IMPORTANT VARIABLE IS THE COST OF SOCIAL INFRASTRUCTURE, WHICH CAN RANGE ALL THE WAY FROM COMPLETE SERVICES FOR TENS OF THOUSANDS OF EMPLOYEES AND DEPENDENTS IN AN ISOLATED ENVIRONMENT, TO A SIMPLE UNPAVED PARKING LOT FOR EMPLOYEES WHO DRIVE TO WORK AS IS THE CASE AT MANY OF OUR DOMESTIC MINES.

I COULD GO ON BUT THE IMPORTANT POINT IS THAT THE CUMULATIVE EFFECT OF ALL THESE VARIABLES, PARTICULARLY IF MANY OF THEM GO IN ONE DIRECTION, CAN BE VERY SUBSTANTIAL AND CAN, IN FACT, LEAD TO A REVERSAL OF THE HIGH GRADE EQUALS LOW COST RULE. JUST AS ONE EXAMPLE, FEW WOULD QUESTION THE FACT THAT 0.5% COPPER IS VERY LOW GRADE ORE. THAT'S ABOUT THE PERCENTAGE OF COPPER RECOVERED PER TON

LAST YEAR AT THE PALABORA OPEN PIT IN SOUTH AFRICA, WHICH PRODUCED 116,000 TONS OF COPPER AT A SUBSTANTIAL OPERATING PROFIT. PALABORA IS ONLY ONE EXAMPLE OF A NUMBER OF VERY LOW GRADE MINES WHICH ARE ALSO LOW COST PRODUCERS.

THE SECOND MAJOR COMMON PITFALL IN DISCUSSING COST STRUCTURES IS A FAILURE TO RECOGNIZE THAT COST IS A DYNAMIC PARAMETER AT ANY MINING OPERATION; IN OTHER WORDS, A COST STRUCTURE IS RARELY SET IN CONCRETE OR RIGIDLY MAINTAINED OVER TIME. COSTS TYPICALLY GO UP AND DOWN AND SIDEWAYS. RECOGNIZING THAT ALL WE CAN DO IS TAKE SNAPSHOTS OF THE SITUATION, IT IS PLAINLY AN ERROR TO TAKE YESTERDAY'S SNAPSHOT AS TODAY'S REALITY. A GOOD ILLUSTRATION OF WHY COSTS MUST BE VIEWED IN THEIR CONTEXT IS AFFORDED BY THE FACT THAT DURING 1980, THE CASH COST OF PRODUCING COPPER IN CONCENTRATE AT OUR MISSION MINE COMPLEX IN ARIZONA, AFTER 61¢/LB. BY-PRODUCT CREDIT, WAS ONLY 22.5¢/LB. OBVIOUSLY WE WERE DEALING WITH A DYNAMIC SITUATION THAT YEAR, WHEREIN BECAUSE OF THE RUN UP IN MOLYBDENUM PRICES TO ASTRONOMICAL HEIGHTS, WE CHANGED OUR MINING PLAN TO CHASE WHATEVER MOLYBDENUM WE COULD FIND IN THE PIT WITHOUT REGARD TO THE GRADE OF COPPER, SO THAT DURING THAT YEAR OUR COPPER PRODUCTION

GRADE WAS ONLY 0.45% COMPARED WITH OUR LIFE OF THE MINE ORE RESERVE GRADE OF 0.61%. CERTAINLY YOU CAN SEE THAT LOOKING AT A SNAPSHOT OF 1980 WOULD BE MORE CONFUSING THAN HELPFUL IN TRYING TO ASSESS TODAY'S COST STRUCTURE AT MISSION.

A DYNAMIC VARIABLE THAT IS OFTEN OVERLOOKED IN COMPARING FOREIGN COPPER MINES WITH U.S. MINES IS THAT FOR GEOLOGICAL REASONS MANY FOREIGN MINES ARE FACED WITH INEVITABLY DECLINING GRADES AND WILL NEED PERIODIC INJECTIONS OF CAPITAL JUST TO STAY AT THE SAME LEVELS OF METAL PRODUCTION. BY CONTRAST, MANY OF THE U.S. MINES ARE ALREADY MATURE AND MINING PRIMARY SULPHIDES: ONE EXAMPLE IS OUR MISSION OPERATION WHERE WE SHOULD BE ABLE TO CONTINUE MINING AT THE AVERAGE ORE RESERVE GRADE OF AROUND 0.6% COPPER FOR THE NEXT THIRTY YEARS.

ANOTHER DYNAMIC VARIABLE WE HAVE SEEN WORKING IN THE INTERNATIONAL COPPER COST STRUCTURE DURING THE PAST SEVERAL YEARS HAS, OF COURSE, BEEN THE ABILITY OF FOREIGN GOVERNMENTS TO DRAMATICALLY CUT COSTS IN THE SHORT TERM BY CURRENCY DEVALUATIONS AGAINST THE U.S. DOLLAR. I RECALL THAT SOMETIME AGO THE HEAD OF THE ZAMBIAN COPPER COMPANY WAS QUOTED IN THE PRESS AS ANNOUNCING WITH SOME SATISFACTION THAT HIS OPERATIONS HAD TURNED AROUND AND WERE NOW IN THE BLACK AS OPPOSED TO THE RED, BECAUSE THE PRICE OF COPPER EXPRESSED IN KWACHAS

HAD GONE UP SO MUCH DURING THE FISCAL YEAR. WHAT HE SHOULD HAVE SAID, OF COURSE, WAS THAT HE HAD BEEN ABLE TO SLASH THE WAGES OF HIS WORKFORCE EXPRESSED IN DOLLARS, AT ONE STROKE BY DEVALUATION. WE HAVE SEEN THE SAME THING HAPPEN IN CHILE, MEXICO AND OTHER LATIN AMERICAN COUNTRIES WHERE OVERNIGHT REDUCTIONS IN DOLLAR EQUIVALENT WAGE STRUCTURES OF 50% AND MORE HAVE OCCURRED BY COURTESY OF GOVERNMENT FIAT. HOWEVER, I THINK IT SHOULD BE CLEAR TO EVERYONE THAT THESE NEW, LOW COSTS ARE IN NO WAY PERMANENT; THE WAGE STRUCTURES WILL SHIFT AND MOVE UPWARD AGAIN AS THE SUBSTANTIAL SOCIAL PRESSURES WORK FROM WITHIN. DEVALUATION IS A NICE NEAT WAY TO CUT U.S DOLLAR COSTS OVERNIGHT AND TO TURN CHRONIC MONEY LOSERS INTO INSTANT MONEY MAKERS BUT THE EFFECT BECOMES LESS EACH TIME IT IS DONE SO THAT THE COST SAVINGS ARE VERY LIKELY TO DIMINISH OR EVAPORATE WITH TIME.

BUT ENOUGH OF GENERALITIES: GIVEN THAT COSTS REFLECT INTERACTING VARIABLES AND THAT COST STRUCTURES CHANGE OVER TIME, WHAT IS THE PRESENT STATE OF PRODUCTION COSTS IN THE PART OF THE U.S. INDUSTRY WHICH REMAINS OPERATING? COSTS ARE A SENSITIVE SUBJECT FOR MANY REASONS, AND I DO NOT HAVE ACCESS TO COMPETITORS' FIGURES WHICH MAKES IT DIFFICULT TO TALK ABOUT AVERAGE COSTS. WHAT I CAN DO THIS MORNING,

HOWEVER, IS TALK ABOUT ASARCO'S OWN COST EXPERIENCE AT OUR ARIZONA COPPER MINES OVER THE PAST SEVERAL YEARS. AS YOU WILL SHORTLY SEE, THE COST REDUCTIONS HAVE BEEN QUITE DRAMATIC. FURTHER, I FEEL OUR U.S. COMPETITORS HAVE BEEN GOING THROUGH THE SAME PROCESSES OF COST REDUCTION, SOME PERHAPS NOT AS SUCCESSFULLY AS WE HAVE, BUT OTHERS PERHAPS WITH MORE SUCCESS.

IN A WAY ASARCO'S TWO OPERATING COPPER MINES ARE REPRESENTATIVES OF SPECIFIC TYPES IN THAT OUR MISSION COMPLEX (COMPOSED OF THE MISSION, EISENHOWER AND SAN XAVIER MINES) IS GENERALLY CLASSED AS A MEMBER OF THE MORE EFFICIENT GROUP OF U.S. MINES. BY COINCIDENCE, THE AVERAGE GRADE OF ITS ORE RESERVES AT 0.61% COPPER IS ALMOST EXACTLY THE AVERAGE GRADE OF SULPHIDE COPPER ORES MINED BY THE ENTIRE ARIZONA INDUSTRY OVER THE PAST TEN YEARS WHICH IS, I THINK, 0.59% COPPER. THE SILVER BELL MINE, BY CONTRAST, IS A RELATIVELY SMALLER OPERATION, WITH METALLURGICALLY COMPLEX ORE MIXED FROM TWO SEPARATE PITS AND WITH A CONSEQUENTLY BUILT-IN HIGHER COST STRUCTURE DESPITE ITS HIGHER RESERVE GRADE OF 0.68% COPPER. SILVER BELL IS IN THE UPPER COST HALF OF THE U.S. INDUSTRY, AND IS ONE OF THOSE MINES WHICH IS JUST HANGING ON A THREAD BETWEEN CONTINUED OPERATIONS AND SHUTDOWN AT THE PRICES WE HAVE SEEN SO FAR IN 1984. USING THESE TWO MINES AS EXAMPLES, I THINK YOU CAN EXTRAPOLATE OUR OWN ASARCO EXPERIENCE TO THE REST OF THE INDUSTRY AND REACH CONCLUSIONS WHICH HAVE SUBSTANTIAL VALIDITY.

REFERRING NOW TO THE HANDOUT SHOWING THE ACTUAL MISSION AND SILVER BELL FIGURES, YOU WILL SEE THAT IN EACH CASE THE COST OF PRODUCING A POUND OF COPPER DURING THE FIRST HALF OF 1984 IS COMPARED TO THE COST FOR THE FULL YEAR OF 1981. I'VE SELECTED 1981 BECAUSE IT WAS THE LAST NORMAL YEAR BEFORE WE BEGAN OUR COST REDUCTION CAMPAIGN IN 1982, AND TO GO FURTHER BACK WOULD RESULT IN DISTORTIONS FROM THE 1980 STRIKE AND FROM ABNORMALLY HIGH SILVER AND MOLYBDENUM BY-PRODUCT PRICES. THE COST LISTED AS MINING, MILLING, ETC., INCLUDES ALL ON-PROPERTY CASH DIRECT AND INDIRECT COSTS, AS WELL AS THE COST OF STATE AND INDIAN ROYALTIES, AND CHARGES FOR DIRECT SERVICES FROM OTHER ASARCO DEPARTMENTS SUCH AS CENTRAL ENGINEERING, ETC. YOU WILL NOTE THAT IN 1981 THE COST OF COPPER IN CONCENTRATE WAS 53.3¢ PER POUND, IN 1984 IT IS 36.6¢. THIS IS A FAIRLY DRAMATIC REDUCTION OF 31% IN THE FACE OF AN ACTUAL INCREASE IN THE GNP DEFLATOR OVER THE SAME PERIOD OF TIME OF ABOUT 15%. BY-PRODUCT CREDITS WERE 9.9¢/LB. OF COPPER IN 1981, AND 5.5¢ IN 1984, REFLECTING LOWER MOLYBDENUM AND SILVER PRICES THIS YEAR. CREDITING THESE BY-PRODUCT VALUES AGAINST THE COST OF COPPER, WE END UP WITH A CASH COST OF 43.3¢/LB. IN 1981 COMPARED WITH 31.1¢ IN 1984, A REDUCTION OF 28% DESPITE INFLATION AND REDUCED BY-PRODUCT CREDITS THIS YEAR.

THE COST TO THE MINE OF FREIGHT, SMELTING, REFINING AND MARKETING HAS ALSO BEEN REDUCED, FROM 42.6¢/LB. OF COPPER IN 1981 TO 32.1¢/LB. IN 1984. THIS 24% REDUCTION REFLECTS THE ECONOMIC FORCES AT WORK IN THE CONCENTRATE SELLING MARKET WHICH HAVE RESULTED IN SUBSTANTIALLY LOWERED CUSTOM SMELTING AND REFINING CHARGES. THE NET RESULT OF ALL THE ABOVE IS THAT THE CASH COST PER POUND OF COPPER AT MISSION IN 1984 TO DATE AMOUNTS TO 63.2¢/LB. AS OPPOSED TO 85.9¢/LB. IN 1981, REPRESENTING A REDUCTION OF ABOUT 26%. I MIGHT ADD IN PASSING THAT DEPRECIATION CHARGES AT THE MISSION COMPLEX AMOUNT TO ONLY ABOUT 2-1/2¢/LB.,SO THAT THE BOTTOM LINE FIGURES FOR 1981 AND 1984 AFTER DEPRECIATION (BUT NOT INDLUDING OFF-PROPERTY CORPORATE OVERHEAD) ARE RESPECTIVELY ABOUT 88.4¢/LB. AND 65.7¢/LB.

CAN THESE NEW LOW COSTS BE SUSTAINED INDEFINITELY? THE SHORT ANSWER IS YES, IN SUBSTANTIAL PART. OF COURSE, I'VE DESCRIBED COST STRUCTURES AS DYNAMIC, AND THERE IS NO QUESTION THAT SOME COST WILL CREEP BACK IN NEXT YEAR AND GRADUALLY OVER A PERIOD OF TIME.

TURNING NOW TO THE FIGURES FOR OUR SILVER BELL MINE, YOU'LL RECALL THAT THE MINE WAS SHUT DOWN FOR ALL OF 1982 AND MOST OF 1983. AGAIN THE FIGURES SHOW A DRAMATIC COST REDUCTION DURING THE FIRST HALF OF 1984 AS COMPARED TO 1981, THE LAST FULL PRODUCTION YEAR. ON THE SAME CASH BASIS AS AT MISSION AND AFTER INCLUDING ALL SMELTING AND REFINING CHARGES, THIS AMOUNTS TO A REDUCTION OF 19%, FROM 88.7¢/LB. TO 71.9¢/LB. EVEN WITH THIS REDUCTION, WE ARE, OF COURSE,

ON SHAKY GROUND AT SILVER BELL AT TODAY'S PRICE. HOWEVER, THIS IS NOT A COSTLY MINE TO SHUT DOWN BECAUSE MUCH OF THE STANDBY COST CAN BE COVERED BY REVENUES FROM RECOVERY OF COPPER FROM LOW-COST LEACH DUMPS, I.E., THIS IS THE KIND OF MINE THAT MIGHT BE HIT BY A TEMPORARY SHUTDOWN BUT IS NOT GOING TO DISAPPEAR PERMANENTLY.

HOW HAVE WE ACHIEVED THESE FAIRLY DRAMATIC COST REDUCTIONS? FIRST OF ALL LET ME SAY THEY HAVE NOT BEEN ACHIEVED BY ANY KIND OF COLLISION-COURSE, HIGH GRADING TACTIC. AS I'VE SAID BEFORE OUR CURRENT PRODUCTION GRADE AT MISSION IS WITHIN ONE HUNDREDTH OF ONE PERCENT OF THE LIFE-OF-MINE ORE RESERVE GRADE. SOME OF THE COST REDUCTION DOES REPRESENT DEFERRAL OF STRIPPING MOST OF WHICH, HOWEVER, WILL NOT NEED TO BE PICKED UP FOR MANY YEARS IF EVER. MANY SOURCES OF COST REDUCTION REPRESENT SMALL INCREMENTS ACROSS THE BOARD FAR TOO NUMEROUS TO LIST IN DETAIL IN A PRESENTATION SUCH AS THIS. THESE HAVE BEEN ASSISTED BY A FUNDAMENTAL CHANGE IN THE ATTITUDE OF THE WORKFORCE. THERE IS NOW A WILLINGNESS TO WORK HARDER AND TO AGREE TO CROSS TRAINING, AND COMBINING OF JOBS. SUGGESTIONS AS TO HOW TO DO THINGS MORE ECONOMICALLY HAVE COME FROM ALL QUARTERS. THERE HAS BEEN AN ACCEPTANCE THAT A SUBSTANTIAL NUMBER OF JOBS MUST BE ELIMINATED TO IMPROVE PRODUCTIVITY TO THE POINT WHERE THE REMAINING JOBS WILL SURVIVE.

ON THE ENGINEERING SIDE WE HAVE BEEN MUCH MORE FLEXIBLE IN CONTINUALLY ADAPTING OUR MINE PLANNING TO THE SITUATION. THIS HAS RESULTED IN REACHING ULTIMATE PIT LIMITS IN SEVERAL SPOTS MUCH SOONER THAN ORIGINALLY PLANNED, WHICH HAS PERMITTED CONSIDERABLE IN-PIT DUMPING OF WASTE WITH CONSEQUENT SUBSTANTIAL COST SAVINGS. AT THE EISENHOWER MINE, WHICH IS A JOINT VENTURE WITH ANAMAX, WE HAVE RENEGOTIATED OUR OBLIGATIONS FOR THE NEXT THREE YEARS TO THE BENEFIT OF BOTH PARTIES. FROM THE STANDPOINT OF ASARCO THE RENEGOTIATED AGREEMENT GIVES US MUCH MORE FLEXIBILITY THAN WE HAD BEFORE WITH RESULTANT LOWERED COSTS. BACK IN 1981 WE COMPLETELY MODERNIZED OUR MISSION TRUCK FLEET AT A COST OF $12.9 MILLION, AND REPLACED ENTIRELY THE FLOTATION SECTION OF THE MILL WITH MODERN OVERSIZED CELLS AT A COST OF $6.9 MILLION. THE FAVORABLE COST EFFECTS OF THESE AND OTHER CAPITAL INVESTMENTS, MADE AT THE END OF THE LAST COPPER BOOM, HAVE SERVED US EXTREMELY WELL IN THE AREA OF COST REDUCTION DURING THE PERIOD SINCE 1981.

I THINK THAT OUR COST REDUCTION EXPERIENCE AT MISSION HAS BEEN TYPICAL OF THE U.S. COPPER INDUSTRY DURING THE PAST SEVERAL YEARS. SOME PEOPLE SEEM TO CARRY A MISCONCEPTION, PERHAPS BY ANALOGY TO OTHER INDUSTRIES, THAT THE U.S. COPPER INDUSTRY HAS FALLEN BEHIND TECHNOLOGICALLY VIS-A-VIS FOREIGN COMPETITORS. ON THE CONTRARY, SINCE THE END OF WORLD WAR II THE U.S. COPPER INDUSTRY HAS BEEN AT THE CUTTING EDGE OF

NEW TECHNOLOGY AND INNOVATION IN OPEN PIT METAL MINING. THE POST WAR TRANSITION FROM RAIL HAULAGE TO TRUCK HAULAGE, THE CONTINUOUS INCREASE IN THE SIZE AND ECONOMY OF TRUCK AND DRILLING EQUIPMENT AND MANY OTHER INNOVATIONS, INCLUDING IN-PIT CRUSHING, HAVE BEEN PIONEERED IN THE U.S. AND HAVE REPRESENTED AN IDEAL BLENDING OF OPERATING AND MANUFACTURING EXPERTISE IN A FREE ENTERPRISE SYSTEM.

THE OPEN PIT MINES OF LATIN AMERICA, OF CHILE, OF PERU AND OF MEXICO, ARE EFFICIENTLY RUN AND ARE WELL MANAGED, BUT IT HAS BEEN U.S. TECHNOLOGY WHICH HAS GOTTEN THEM WHERE THEY ARE AND THE TRANSFER OF U.S. EXPERTISE TO WELL-TRAINED NATIONALS HAS PERMITTED THOSE OPERATIONS TO CONTINUE AT EFFICIENT LEVELS.

ONE OF THE KEY POINTS IN OUR ITC ESCAPE CLAUSE PETITION HAS BEEN THAT THE CONTINUED LEADERSHIP POSITION OF THE U.S. INDUSTRY AND THE CONTINUED UPGRADING OF OUR COPPER PROPERTIES HAVE BEEN PLACED IN JEOPARDY BY THE CAPITAL STARVATION WHICH HAS OCCURRED DURING THE PAST TWO YEARS OWING TO LOW PRICES AGGRAVATED BY EXPANDED CHILEAN PRODUCTION IN THE FACE OF SLUMPING DEMAND AND THE CONSEQUENT FORCING OF EXCESS FOREIGN COPPER INTO THE U.S. WHICH IS THE ONLY REALLY OPEN MARKET OF LAST RESORT DURING TIMES OF OVERSUPPLY. WE WANT TO CONTINUE UPGRADING OUR MINES: WE WANT TO CONVERT TO STILL LARGER SHOVELS TO MATCH OUR LARGER TRUCKS, WE WANT TO LOOK AT IN-PIT CRUSHING AND POSSIBLE CONVEYOR BELT ORE MOVEMENT, WE WANT TO IMPROVE PARTS OF THE TRUCKING CYCLE BY COMPUTERIZED

AUTOMATIC RADIO CONTROLLED SYSTEMS REPRESENTING THE STATE OF THE ART. HOWEVER, WE DO NEED THE RELIEF SOUGHT IN THE ITC PROCEEDING OR SIMILAR RELIEF THROUGH THE U.S. TRADE REPRESENTATIVE TO GIVE US THE MEANS AND THE TIME REQUIRED.

FINALLY, ON THE GENERAL SUBJECT OF WHERE THE U.S. SHARE OF WORLD PRODUCTION FITS IN THE WORLD COST PICTURE, I HAVE VERY LITTLE SPECIFIC UP-TO-DATE COST DATA TO GO ON BECAUSE THIS DATA IS VERY DIFFICULT TO OBTAIN ON A TRULY FACTUAL AND COMPARATIVE BASIS, AND AS I'VE TOLD YOU THE PICTURE IS CONSTANTLY CHANGING. HOWEVER, BECAUSE SO MANY OTHER PEOPLE HAVE MADE BRAVE COMPARISONS BASED ON NON-EXISTENT OR FAULTY DATA, I FEARLESSLY OFFER UP MY OWN INTUITIVE FEELING ABOUT HOW THE PRESENT WORLD COST STRUCTURE FITS TOGETHER. I'VE SHOWN MY ESTIMATES (AND THAT'S ALL THEY ARE) ON A SHEET WHICH YOU HAVE WITH YOU, TOGETHER WITH A LISTING OF THE SHARE OF THE WORLD MINE PRODUCTION OF COPPER REPRESENTED BY EACH PARTICULAR COUNTRY OR REGION. I MAKE NO PARTICULAR CLAIM FOR THE VALIDITY OF THE FIGURES SHOWN, OTHER THAN THAT THEY ARE PROBABLY AS VALID AS ANY OTHERS YOU MAY BE LIKELY TO RUN ACROSS.

AS YOU CAN SEE FROM THE LISTING, I'M CONVINCED THAT CURRENT U.S. COST OF PRODUCTION OF COPPER LIES CLOSE TO THE MIDDLE OF THE PACK ON A WORLD BASIS, NOT AT THE HIGH COST END OF THE SPECTRUM AS MANY SUPPOSE. AS THE FOOTNOTE INDICATES, IF WE SUBTRACT CHILEAN PRODUCTION, WHICH AMOUNTS TO ABOUT 20% OF WESTERN WORLD SUPPLY, I THINK CURRENT U.S. PRODUCTION COSTS ARE VERY CLOSE TO THE AVERAGE COSTS OF THE REST OF THE WORLD. FURTHER, I THINK THAT THE DYNAMICS MAY BE WORKING IN THE U.S. FAVOR INASMUCH AS THE FOREIGN PRODUCTION CANNOT CONTINUE TO BENEFIT INDEFINITELY BY CONTINUED LABOR COST REDUCTION THROUGH DEVALUATION. GIVEN THAT U.S. PRODUCTION AT 17% OF THE TOTAL IS A LARGE ENOUGH BLOCK TO BE IMPORTANT IN SUPPLYING EVEN STAGNANT WORLD DEMAND, THERE DOES NOT APPEAR TO BE ANY ECONOMIC JUSTIFICATION WHATEVER TO TALK ABOUT THE DISAPPEARANCE OR FUNDAMENTAL NONVIABILITY OF THE U.S. INDUSTRY. ON THE CONTRARY, IF THE IRRESPONSIBLE MARKETING STRATEGIES OF THE MAJOR FOREIGN PRODUCERS CAN BE MODIFIED AND THE FINANCIAL ACTIVITIES OF THE INTERNATIONAL LENDING AGENCIES WHICH SUPPORT THESE IRRATIONAL STRATEGIES CAN BE RATIONALIZED TO SOME EXTENT, THEN THE U.S. INDUSTRY WILL HAVE NO TROUBLE SURVIVING AND INDEED REMAINING A STABLE MAJOR SOURCE OF WORLD SUPPLY AS WELL AS AN ESSENTIAL STRATEGIC ASSET OF THE NATION. AND, IF THE STEADILY FALLING STOCKS ON THE TERMINAL EXCHANGES AND OTHER INDICATORS PORTEND AS THEY HAVE IN THE PAST, A COMING UPWARD TREND IN THE COPPER PRICE, ASARCO WILL BE ABLE TO RESTORE ITS RETURN ON INVESTMENT IN COPPER PRODUCTION TO AN ADEQUATE LEVEL.

ADDENDUM TO REMARKS
BY T.C. OSBORNE
JULY 26, 1984

ASARCO MISSION COMPLEX
COPPER PRODUCTION COST
(¢ CASH PER POUND COPPER)

	1981	First Half 1984	Cost Reduction
Mining, Milling, etc.	53.2¢	36.6¢	31%
By-Product Credit	-9.9	-5.5	-
On-Property Cash Cost	43.3	31.1	28%
Frt.,Smelt.,Ref.,Mktg.	42.6	32.1	25%
Total Net Cash Cost	85.9¢	63.2¢	26%

ASARCO SILVER BELL MINE
COPPER PRODUCTION COST
(¢ CASH PER POUND COPPER)

	1981	First Half 1984	Cost Reduction
Mining, Milling, etc.	51.3¢	41.6¢	19%
By-Product Credit	-5.5	-1.3	
On-Property Cash Cost	45.8	40.3	12%
Frt.,Smelt.,Ref.,Mktg.	42.9	31.6	26%
Total Net Cash Cost	88.7	71.9	19%

ACTUAL 1983 WORLD COPPER MINE PRODUCTION AND ESTIMATED RELATIVE 1984 PRODUCTION COSTS

Country	Mine Production Short Tons X 1000	% of Western World	1984 Estimated Prod. Cost (¢ Pound)
Chile	1372.5	20.4	50¢
U.S.A.	1152.7	17.1	72
Canada	688.9	10.2	74
Zambia	566.1	8.4	80
Zaire	553.9	8.2	70
N.Guinea/Aust.	493.6	7.3	65
Europe	359.4	5.3	65
Peru	347.0	5.2	58
Philippines	299.2	4.4	75
S. Africa	226.0	3.4	60
Mexico	210.5	3.1	75
Other	470.2	7.0	80
	6740.0	100.0	Av. 68.7

Note: Weighted average cost of 80% of world Production (excluding Chile) = 71.3¢.

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AMERICAN SMELTING AND REFINING COMPANY

SUBJECT

ACCOUNTING AND TAX TREATMENT OF MINE EXPLORATION AND DEVELOPMENT EXPENDITURES

KNOXVILLE, TENNESSEE

APRIL 8, 1973

AMERICAN SMELTING AND REFINING COMPANY

ACCOUNTING AND TAX TREATMENT OF MINE EXPLORATION AND DEVELOPMENT EXPENDITURES

(Presented at Asarco Exploration Department Meeting, April 8-11, 1973, Knoxville, Tennessee, by Robert Richter, Assistant Comptroller - Taxes. Collaborators in Preparation of the Paper: Paul A. Barrese, Assistant Tax Manager, and Edward J. Kelly, Jr., Chief Accountant).

Gentlemen, it is a great pleasure for me to have been invited to attend this Exploration Department Meeting. I must admit at the outset that my technical competence in the field of geology is absolutely nil. I wouldn't know the difference between a brecciated chalcopyrite and a magnetic, sedimentary sphalerite; if I tried to pretend that I did, it wouldn't be too long before my Pre-Cambrian Ertsberg would be showing.

John Collins has asked for a discussion of the accounting and tax treatment of mine exploration expenditures. I should make the point early that the method of handling these expenditures on the Company's books differs from that which is permitted for Federal income tax purposes. We will turn our attention first to the policies followed with respect to exploration and development expenditures in the book accounts.

Let me start by reading to you footnotes (i) and (j)

to the financial statements in Asarco's published Annual Report for 1972:

> "Exploration expenses - Tangible and intangible costs incurred in the search for new mining properties are charged against earnings when incurred. When a commercial ore body is discovered, the related exploration costs previously expensed are capitalized and credited to earnings."
>
> "Development costs to bring new mineral properties into production and for major programs of a special nature at existing mines are capitalized, and amortized on the ore reserve basis when production begins."

Prior to 1966, all exploration costs incurred on specific projects were charged to deferred expense on the balance sheet pending a determination as to whether the exploration was fruitful. If a commercial ore deposit resulted, the accumulated deferred charges with respect to the deposit were transferred to the property account as part of the cost of the mineral deposit. If a decision was reached to terminate the exploration activities on a project, the accumulated deferred charges on such project were written off in the profit and loss statement. Field office expenses, which are exploration of a general nature,

and on which no specific project appropriation has been requested, were charged to earnings currently.

Commencing in 1966, Asarco altered its accounting policy in regard to exploration expenses, prompted in some degree by Congress' passage of the Ullman Bill, but more particularly by the fact that we were carrying on our Balance Sheet an "asset" which experience had shown would be eventually written off as abandoned projects.

The Ullman Bill permitted current deductibility for tax purposes of domestic exploration expenses except for those outlays made for depreciable property and land acquisition costs. Asarco's new policy adopted in 1966 went beyond the Ullman Bill; the new policy, adhered to since that time, is to charge off currently to profit and loss all exploration expenses with few exceptions. This includes foreign as well as domestic expenditures and also includes option payments, rentals and depreciable property acquisition costs. The field office expenses, written off currently under former policy, continue to be so handled.

When a commercial ore body is discovered, the related exploration costs previously expensed are capitalized and restored to earnings on the books. Obviously, it is necessary to maintain records which identify with particularity the mineral prospects on which exploration expenses are being incurred. Also, detailed record keeping is required in order to identify those items of exploration expense written off on the books which are not deductible in the federal income tax return.

In connection with an exploration activity which may cover broad areas, it is desirable to assign or collect costs against subdivisions or designated target areas within the broad areas. The importance of this point will be brought out later in this paper under the detailed tax discussion of exploration expenses.

When it is determined that any exploration project is without commercial value, any interest or claims should be relinquished and appropriate notice of such relinquishment should be sent promptly to the land owner.

After the existence of a commercial ore body has been ascertained, all further costs are considered as development rather than exploration. Such costs include drilling to define the limits of the ore deposit, drilling to determine appropriate sites for permanent facilities such as a milling plant, removal of waste and stripping of over-burden in preparation for actual mining. More about development costs later on.

There is no need to take the time to go into further details about the book accounting treatment of exploration expenses. You are all familiar with the procedures required in obtaining New York Office appropriations for mineral exploration on specific projects and also with the reporting requirements as monies are spent. In the interest of time conservation, I'd like to move on now to the tax implications and considerations involved in exploration expenses.

There are two sections of the Internal Revenue Code which deal with exploration expenditures paid or incurred for the purpose of ascertaining the existence, location, extent, or quality of any deposit of ore or other mineral. The sections are Sec. 615 and Sec. 617. Neither of these sections applies to exploration expenditures incurred in connection with deposits of oil and gas which are governed by a separate set of tax rules which I do not intend to discuss here today. Everything that I propose to say is concerned with what we generally describe as "hard minerals."

As to Sec. 615, I will say that the tax rules thereunder are applicable only with respect to expenditures paid or incurred prior to January 1, 1970. Hence, I will not spend time on the details of the Sec. 615 provisions. So, we zoom right in on Sec. 617.

Under Sec. 617, a taxpayer is allowed an unlimited current deduction for exploration expenditures paid or incurred with respect to mineral prospects located in the United States or on the Outer Continental Shelf. The Sec. 617 allowance is not applicable to foreign exploration except in the case of a taxpayer who has not previously utilized in full the $400,000 maximum allowance provided for under Sec. 615. Inasmuch as Asarco long ago used up this $400,000, the exception is inapplicable and only domestic exploration expenditures qualify for Sec. 617 treatment in the case of Asarco.

You will recall that in discussing the treatment of exploration expenditures on the books, we stated that all such outlays are written off currently without regard to whether they are incurred domestically or on foreign mineral prospects. We must give consistent, uniform accounting treatment to like assets or transactions. When the Federal tax return is prepared, foreign exploration expenditures on prospects not dropped but still actively under examination must be deferred and may not be written off for tax purposes unless and until each prospect is dropped.

The allowance of an unlimited current deduction for domestic exploration expenditures is subject to a "recapture" provision in the case of any mineral prospect which ultimately becomes a producing mine or is sold. The recapture may be made in either of two ways, at the election of the taxpayer, as follows:

(A) If a mineral prospect becomes a producing mine, in the year in which such mine reaches the producing stage, the taxpayer may include in gross income for such year the entire amount of the previously deducted exploration expenditures; or

(B) The amount of any percentage depletion otherwise allowable with respect to any mine on which exploration

expenditures have previously been deducted shall be disallowed until the total disallowed depletion is equal to the exploration expenditures deducted on such mine.

In general, the second of the two choices will be elected by a taxpayer, that is, foregoing percentage depletion on a property after it comes into production, since usually the recapture period through this method can be spread over two or more years. In addition to the extended tax deferral period permitted by this option, there is the possibility in the case of a marginal mine that the percentage depletion deductions may never equal the amount of the exploration expenses previously deducted. If the taxpayer elects the first alternative, namely, the inclusion of the exploration expenditures in gross income for the year in which the property goes into production, he may find that the mine may have to be shut down before his aggregate depletion deductions equal the amount of the exploration expenses. Thus, if exploration expenses to be recaptured were $1,000,000 and depletion is running about $100,000 annually, at the end of three years, $300,000 will have been recaptured under the (B) alternative above. If the mine is then shut down, the remaining $700,000 does not get recaptured until production is resumed and depletion begins again. Of course, if the (A) alternative is adopted, the inclusion of the exploration expenses in gross income increases the basis of the property and in the event of sale or abandonment of the property, the higher basis

would provide tax benefit through a greater loss (or smaller gain).

In the case of a sale of a mineral prospect on which exploration expenditures have been written off for tax purposes, the amount of any gain resulting from the sale must be treated as ordinary income up to the amount of the exploration expenditures previously deducted and only the balance of the gain is eligible for capital gain treatment.

In the earlier discussion of how exploration is handled for accounting purposes, the statement was made that it was important to accumulate costs and expenses against small target areas or subdivisions within broader areas of exploration activity. Let us assume a broad area of mineral interest which covers several hundred square miles and an exploration program involving several hundred thousand dollars. If the whole area consists of five or six groups of claims, it would be important to apportion the total costs of the program among the five or six groups of claims. It may ultimately turn out that only one group yields a commercial ore body. In such a case, perhaps the prospecting rights with respect to the four or five other groups of claims can be relinquished and the accumulated costs of exploration thereon which have been deducted in the tax return (assumes domestic exploration) will not be subject to recapture. Without the apportionment of the total exploration costs among the five or six groups of claims, however, Internal Revenue Service could argue that the whole area consisted of a single area of interest and that all the costs were attributable

to the one commercial deposit found, thus making all of the costs recapturable. The same apportionment of costs among segments of an exploration program over a large area is desirable in the case of foreign prospecting in order to be able to write off and deduct the costs applicable to the non-productive segments.

Thus far, I have spent time discussing the treatment of exploration expenses on the books of account and in the Federal income tax returns in a manner which assumes that we all know what exploration expenses comprise. I guess that the accountants, the geologists and the tax specialists could all agree that diamond drilling, certain mapping, soil sampling, aerial photography and a host of other activities are embraced in exploration costs. But the perplexing part of the matter is that many of these same activities may also constitute mine development! So how can any of us be sure whether we are talking about exploration expenses or mine development expenses?

Back in January, 1966, I prepared a memorandum for Mr. Collins on this subject of distinguishing between exploration and development expenses. I reviewed this memorandum just last week and found that in large part, it is still applicable today in spite of the enactment of the Ullman Bill; inasmuch as I wrote it, I will presume to commit plagiarism and reiterate parts of that memorandum.

Under the U.S. tax laws all expenditures prior to ascertaining the existence of ores and minerals in commercially marketable quantities are considered to be exploration expenditures. All expenditures made after ascertaining the existence

of ores or minerals in commercially marketable quantities are classified as development expenditures.

At the election of the taxpayer, development expenditures, whether in the pre-production or production stage of any mine, may be written off currently for U.S. tax purposes or deferred and amortized ratably as the units of the produced ore or minerals benefited by such expenditures are sold. The election provided under the Internal Revenue Code is a very liberal one in that it may be made "mine by mine" and "year by year." In other words, a taxpayer may elect in any year to write off development expenses on one mine and to defer development expenses on another mine. In the next year, he may elect to do just the opposite with respect to development expenses incurred on the same two mines.

Just as in the case of exploration expenditures, for tax purposes, development expenditures do not include items of a character subject to depreciation. However, depreciation expense on property used in exploration becomes an element of exploration expense and so too, depreciation expense on property used in development is considered part of such development expense.

We have pointed out earlier in this paper that Asarco's policy on exploration expenditures is to charge them all to profit and loss on the books currently, whether foreign or domestic, tangible or intangible. Asarco's policy with respect to pre-production development expenditures on the books

is different. We are now dealing with an asset, a commercial ore body, and therefore all such expenditures are capitalized in an account called Mineral Land No. 2 and they are amortized as the ore uncovered by the development costs is mined and sold. Development expense at operating properties is ordinarily written off to profit and loss currently on the books, although occasionally extraordinary development expenditures even at a producing mine may be deferred and amortized if the development work consists of expenditures which will open up ore reserves which will be mined over a substantial future period such as 10 years.

For tax purposes, generally taxpayers will elect the current deduction of development expenditures rather than deferral and amortization. This is because the deduction may be applied against taxable income from other sources thus producing immediate tax benefit. In addition, getting the development expenditures written off currently means that there will be no amortization charges against net income from the property for purposes of percentage depletion after the property goes into production, thus increasing the depletion allowance in those cases where the allowance is limited to 50% of net income.

The question of when a mining prospect passes from the exploration stage to the development stage is an area of great controversy between taxpayers in the mining industry and the Internal Revenue Service. The reason, of course, is that even though both exploration and development expenses may be

deducted, exploration expenses must be recaptured as previously explained, but development expenses are not recapturable. Obviously, it is to the advantage of the Internal Revenue Service to take the position that the exploration stage was of longer duration than the taxpayer asserts.

Under the tax regulations, the development stage of a mine is deemed to begin at the time when, in consideration of all the facts and circumstances (including the actions of the taxpayer), deposits of ore are shown to exist in sufficient quantity and quality to reasonably justify commercial exploitation by the taxpayer. The phrase "including the actions of the taxpayer" is very important; it is based on the old adage that "actions speak louder than words." Among taxpayer actions helping to establish that a property has passed from the exploration stage to the development stage are the following:

(1) If there is an option to purchase the property, the exercise of such option as early as possible, consistent with prudent conclusions as to the favorable nature of the deposit.

(2) Submission of a report by the geologist in charge of the project setting forth estimated ore reserves, assays, estimated tons of recoverable metals, together with an opinion that the property can be operated profitably at certain metal prices.

(3) Commencement of stripping operations or the sinking of a shaft.

(4) Construction of access roads.

(5) Designing of the pit and a plan for mining the ore.

(6) Engineering work for construction of a mill and auxiliary facilities.

In any event, it is to the taxpayer's advantage to assert the earliest possible defensible date, within the intent of the tax statute, for the commencement of the development stage of a mine because it gives the taxpayer a better starting point in the bargaining and compromise negotiations which customarily take place with the Internal Revenue Service in this realm of settling tax liability.

Gentlemen, I think it's time I stopped this discourse. Everything that I have said is concerned with the every-day, pedestrian housekeeping chores of recording exploration expenditures in a careful manner. This is necessary so that Asarco can report your work correctly to the shareholders in its financial statements and also to facilitate the maximum utilization of provisions of the U.S. Internal Revenue Code which, either through permanent tax savings or tax deferment, can result in the availability of more working capital for you to carry on your search for new mineral deposits. Only you can bring in the new Silver Bells, the new Missions, the new Galenas. But we in the Comptroller's Department can help

by making Asarco's exploration dollars stretch farther through proper accounting and tax handling of expenditures thereon.

Identical ore deposits in the United States, Canada and Mexico won't yield identical profits because of the . . .

SOCIETY OF

BEAR CREEK MINING COMPANY
SURETY LIFE BUILDING
1935 SOUTH MAIN STREET
SALT LAKE CITY 10, UTAH

November 28, 1960

R. D. Hutchinson
T. H. Walthier
R. E. Gilbert

Subject: Income Tax - Bear Creek Exploration

The following excerpt from a letter from our New York headquarters will constitute additional explanation for the request that General Reconnaissance and Examinations be separated in as many small geographical areas as possible.

"That part of our work that can be segregated and identified and which does not lead to a commercial deposit may be charged off as a current expense, so that in effect the company pays 48% of the cost, and the U.S. Government 52%.

"If the work does lead to a commercial deposit, the costs must be capitalized and recovered through the depletion allowance when the property is put into production. Since this would presumably be percentage depletion which the company would receive anyway rather than depletion related to the cost of acquisition, there is no additional return equal to the exploration cost. Consequently, it is advantageous to segregate and write off everything that can be practicably identified and segregated as a cost.

"For illustration, let us assume the hypothetical example of a deposit which was turned up in a General Reconnaissance program which cost $500.

"Let us further assume that it is possible to ascribe clearly $100 of the $500 to the discovery of the specific deposit, and that the other $400 yielded nothing worth pursuing further; in this case the $400 could be written off currently, and the $100 deferred on the books. If then we make this an Examination and spend, say, $3,000 more on it and wash it out, the $100 from the General Reconnaissance and the $3,000 from the Examination may be written off.

"But if the work in the Examination stage is encouraging and we make a Project of it and spend $50,000 more, then we have two possibilities:

(1) The deposit is no good and we drop it. In this case we could write off $ 100 from General Reconnaissance stage costs
$ 3,000 " Examination " "
$50,000 " Project " "

(2) The deposit is good and we keep it. In this case we could not write off any of the $53,000 but would recover it through the depletion allowance in the computation of income tax when the property goes into production. But inasmuch as this would be a percentage of income, regardless of what this property had cost us, we wouldn't receive anything additional to what we would have received anyway.

"The difficulty our Comptroller's Department has with the Internal Revenue Service is in demonstrating that only $100 of the General Reconnaissance program in our example should be capitalized; the Service seeks to put all $500 of the General Reconnaissance against the rare finds of commercial deposits. The same is true in the other stages of our work, too. The reason for breaking the Duluth Gabbro job into eight examinations a couple of years ago was so that if we had found one good commercial deposit, the money spent on the other seven could have been identified and written off. Without specific segregation of costs, we are in a weak position to insist that the cost of all eight should not be capitalized against the one good deposit."

The previous communications on the distinctions between various stages of our exploration as General Reconnaissance or Examination or Project remain valid, and the criteria for such distinctions will remain the same as discussed during our November 9-10, 1960, meeting in Salt Lake City.

PAUL A. BAILLY

PAB:ps

cc: D. R. Cook
Central District

B. C. M. S.
TUCSON