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STAFF APPRAISAL REPORT

COLOMBIA

CERRO MATOSO NICKEL PROJECT

September 24, 1979

Industrial Projects Department

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CURRENCY EQUIVALENTS

Currency Unit: Colombian Peso (Col\$)

Col\$1 = 100 centavos (ctv)

Currency Exchange Rates

Col\$42.40 = US\$1.0
Col\$1,000 = US\$23.58

WEIGHTS AND MEASURES

1 meter (m)	= 3.281 feet (ft)
1 kilometer (km) ³	= 0.622 miles (mi)
1 cubic meter (m ³)	= 35.315 cubic feet (ft ³)
"	= 264.2 US gallons (gal)
"	= 6.29 barrels (bbl)
1 metric ton (MT)	= 2,206 pounds (lb)
1 metric ton (MT)	= 1.1 short tons (st)
1 dry metric ton (DMT)	= 1.1 dry short tons (dst)
1 wet metric ton (WMT)	= 1.1 wet short tons (wst)
1 kilowatt (kW)	= 1,000 watts
1 Megawatt (MW)	= 1,000 kilowatts
1 Megavoltampere (MVA)	= 1,000 kilovoltamperes (kVA) ⁶
1 Gigawatthour (GWh)	= 1,000,000 kilowatthours (10 ⁶ kWh)
1 kilovolt (kV)	= 1,000 volts

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

CARBOCOL	- Carbones de Colombia, S.A.
CMSA	- Cerro Matoso, S.A.
COLPUERTOS	- Empresa Puertos de Colombia
CONICOL	- Compania de Niquel Colombiano, S.A.
CONPES	- Consejo de Politica Economica y Social
CORELCA	- Corporacion Electrica de la Costa Atlantica
DNP	- Departamento Nacional de Planeacion
ECOMINAS	- Empresa Colombiana de Minas
ECONIQUEL	- Empresa Colombiana de Niquel, Ltda.
ECOPETROL	- Empresa Colombiana de Petroleos
ELECTRICORDOBA	- Electrificadora de Cordoba
IFI	- Instituto de Fomento Industrial
INCOMEX	- Instituto Nacional de Comercio Exterior
INGEOMINAS	- Instituto Nacional de Geologia y Minas
INSCREDIAL	- Instituto de Credito Territorial
ISA	- Interconexion Electrica, S.A.
SENA	- Servicio Nacional de Aprendizaje

COLOMBIAN FISCAL YEAR

January 1 - December 31

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COLOMBIA

CERRO MATOSO NICKEL PROJECT

STAFF APPRAISAL REPORT

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- 9-3 Cerro Matoso: Sources and Uses of Funds Projections
- 9-4 Cerro Matoso: Balance Sheet Projections
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- 10 Foreign Exchange Savings

MAP IBRD 12480

SELECTED DOCUMENTS IN THE PROJECT FILE

<u>REFERENCE</u>	<u>BRIEF TITLE</u>
A. <u>General Legislation</u>	<ol style="list-style-type: none"> 1. Colombia: Mining Statutes, 1977 2. Colombia: Resolutions 18 and 19 (1977), and 27 (1978) on Mining of Nickel 3. Colombia: Decree 444 of 1967, on Customs Regulations
B. <u>The Project</u>	<ol style="list-style-type: none"> 1. Bechtel: Feasibility Study, June 1976 2. Bechtel: Back-up Data for Feasibility Study 3. Bechtel: Updated Capital Costs (Plant, March 1979) 4. Hanna: Pilot Project, 1975-76 (3 volumes) 5. Hanna: Environmental Study, 1978 6. Hanna: Geological Cross Sections, 1100 NW - 1450 NW 7. Hanna: Collar Elevations and Bottom of Ore Maps 8. Ford Bacon: Letter Report to World Bank, 1976 9. Hanna: Report on Selection of Bechtel as Consultant 10. Hanna: Updated Capital Costs (CMSA Scope, March 1979)
C. <u>Power</u>	<ol style="list-style-type: none"> 1. ICEL: La Electrificacion en Colombia, 1976-77
D. <u>Townsite</u>	<ol style="list-style-type: none"> 1. Colombia: Socio-Economic Study of Montelibano, 1976 2. HABITAR: Urban Plan for Montelibano
E. <u>Contracts</u>	<ol style="list-style-type: none"> 1. Cerro Matoso: Draft Subscription Agreement, 1978 2. Cerro Matoso: Draft Sales Agreement 3. Cerro Matoso: Concession Contract and Supplemental Contract 4. Cerro Matoso: Technical and Administrative Services Contract 5. Cerro Matoso: Draft Bechtel Contract 6. Cerro Matoso: Chase Manhattan Draft Loan Documents 7. Cerro Matoso: Exim Bank Draft Loan Documents

I. INTRODUCTION

1.01 The Government of Colombia and Cerro Matoso, S.A. (CMSA) have requested a Bank loan of US\$80 million equivalent to finance exploitation of the Cerro Matoso nickel laterite deposit, located near the provincial town of Montelibano (Map IBRD 12480). The Project will involve the mining and beneficiation of an annual average of approximately 780,000 dry metric tons (DMT) of ore, grading about 2.7% Ni, to produce 19,164 metric tons (MT) of nickel contained in ferronickel with a grade of 37.5% Ni. Cerro Matoso's entire output will be sold on a long-term, take-or-pay basis to Billiton Metals (a Dutch Corporation of the Shell Group) for resale primarily in the European and Japanese markets.

1.02 Project preparation is well advanced. The ore body is well-known and extensive pilot plant testing has been carried out. Letters of intent have already been issued to the prospective suppliers of the rotary kiln and dryer and the electric smelting furnace--which together constitute about 55% of the total equipment cost--and, based on a start of implementation in June 1979 1/, it is expected that the plant will be operational in the second quarter of 1982. Construction management and supervision of engineering and procurement will be provided by Bechtel (US).

1.03 The plant will be owned and operated by Cerro Matoso S.A., a Colombian corporation in which 45% of the equity will be held by ECONIQUEL, a Government-owned Colombian Corporation, and 55% will be held by private shareholders (20% by CONICOL, S.A., a US Company in which the Hanna Mining Co. holds 97% of the shares, and 35% by Billiton Overseas, Ltd., a British subsidiary of the Shell Group). Hanna--which currently mines a similar type of ore in the US--will be retained to provide technical assistance for at least the first five years of operations.

1.04 Total financing for the Project, including interest during construction and working capital, is expected to be about US\$340 million equivalent, including US\$216 million in foreign exchange. In addition to the Bank loan, which will finance 37% of the Project's foreign exchange requirements, financing will be provided by a US\$25.6 million loan package from US Exim-Bank, up to US\$120 million in loan funds from Chase Manhattan Bank (US) and by equity from the shareholders. The Bank loan will be the first major loan for a single industrial project in Colombia since the 1963 loan to Acerias Paz del Rio, the country's largest steel mill. 2/ The Project was originally submitted to the Bank in 1971 but underwent considerable modification thereafter. It was eventually pre-appraised by the Bank in 1976 and an appraisal mission, consisting of Messrs. Hilton, Kotschwar and Soncini, of the Industrial Projects Department, visited Colombia in March-April 1978.

II. THE NON-FUEL MINING SECTOR IN COLOMBIA

A. Sectoral Composition

2.01 Historically, this sector has been relatively insignificant, with the possible exception of gold and iron ore. Although, as indicated in

1/ Notice to proceed was issued July 2, 1979.

2/ IBRD Loan No. CO-345 of June 28, 1963.

Annex 2-1, there are geological indications of, inter alia, copper, lead-zinc, asbestos, bauxite and phosphates, exploration efforts so far have been minimal, chiefly owing to a lack of incentives for investment in high-risk mining projects (paras. 2.06-2.08). The result has been that the share of GDP originating in the mining sector is even lower in Colombia (0.9% in 1976) than in such countries as Mexico (1.2%) and Argentina (1.2%) and considerably lower than in mineral-rich countries such as Bolivia (15.4%) and Chile (13%).

1. Current Operations

2.02 Metallic Minerals: As shown in Annex 2-2, output of metallic minerals, except for iron ore, is insignificant. Iron ore, however, is currently mined on a larger scale by Acerias Paz del Rio in Boyaca, for use in its steel plant at Belencito. The only significant unexploited metallic ore body in Colombia, well enough known as to be considered commercially proven, is the Cerro Matoso nickel deposit.

2.03 Precious Metals: Gold has traditionally been mined by artesanal methods, mostly from placer and, on a small scale, from vein-type deposits. Only three medium-sized companies employ any degree of mechanization. The metal is refined locally to separate the associated silver and platinum and is sold to the Banco de la Republica. Officially, production in 1977 was 263,000 troy ounces of gold, 26,000 troy ounces of platinum and 100,000 troy ounces of silver.

2.04 Emeralds: Colombia has a virtual world monopoly in the production of gem grade emeralds. In 1973, official figures showed 109,000 carats produced. However, the mines had to be closed in 1974 because of law and order problems and no official production has been reported since. In 1977, Empresa Minera Boyacense--a joint venture between private interests and the Government's mining agency--was granted a five-year concession for the exploitation of Muzo, the major deposit formerly in production.

2. Exploration

2.05 Exploration is currently being carried out by AMOCO (US) in northern Choco, in order to delineate a possibly significant porphyry copper deposit grading 0.6%-0.7% copper. Also in Choco, the Instituto Nacional de Geologia y Minas (INGEOMINAS), which is the Government's geological service agency, is exploring another porphyry prospect with UNDP assistance. In the course of UNDP's program, at least seven geochemically anomalous zones have also been found in the central and coastal ranges of the Colombian Cordillera, and the possibility of substantial copper porphyry discoveries appears to be good.

B. Government Mining Policy

2.06 Historically, mining policy has been ill-defined and investment in the sector has received a low priority. Foreign capital in non-petroleum minerals has been minimal, and very little credit has been available to local entrepreneurs. Of total commercial bank credit extended from 1971 to 1976,

only 0.5% was for extractive industries and outstanding mining credit at mid-1976 was less than US\$8 million.

2.07 The basic principles of Colombian mining legislation are embodied in Decree 1275 of 1970. Generally, all mineral deposits are the property of the State. All new foreign investment in the mining sector must be approved by the Ministry of Mines and Energy. There are no significant tax incentives to stimulate foreign investment in the sector and mineral rights are now granted much more selectively, with title to large areas being reserved for state entities.

2.08 Although the overall picture is not conducive to rapid development, the Government has recently begun actively to promote joint ventures between state entities and foreign corporations. Although, in certain subsectors, specialized agencies have been created (eg., ECONIQUEL for nickel, CARBOCOL for coal and COLURANIO for uranium), the Government's usual vehicle for such investments is Empresa Colombiana de Minas (ECOMINAS). Since a major constraint on development of the mineral sector has been inadequate investment in exploration and mine development, the Government has also established INGEOMINAS, which is involved in mineral exploration. However, INGEOMINAS has only limited funding and without easier access to domestic credit or significant incentives to foreign investors, it is unlikely that this and the other entities can lead to a radical restructuring of what has been historically a neglected sector.

C. Developmental Priorities

2.09 Outside petroleum, the Government's priority is exploitation of the country's important coal reserves, particularly the Cerrejon project, where CARBOCOL is in association with INTERCOR, a subsidiary of EXXON (US), and where Bank assistance is envisaged.

2.10 In the public sector, the Government intends to continue its policy of direct participation, either through ECOMINAS or through specialized agencies, and to take advantage of the technical expertise of expatriate partners acting as operators. In the private sector, there is so far little attempt at coordinating the broad range of Government policies which affect the large number of individual firms. However, it is clear that there is a need for expanded technical assistance, greater access to credit, a more market-oriented pricing policy, greater emphasis on promoting the mergers of small, uneconomic mines and coordination and simplification of the process of granting mineral concessions. This will entail a considerable strengthening of the Government institutions serving the mining sector and may require the creation of new financial institutions for exploration and mining.

III. THE NICKEL MARKET

A. Background

3.01 As indicated below, market prospects for nickel at the present time are unclear and rather modest. As shown in para. 3.38, there is a

possibility that, even by 1985, there will still be an albeit small surplus nickel capacity and there must, therefore, be some question whether nickel prices will rise to levels which would support major new greenfield projects. In this context, Cerro Matoso enjoys three distinct advantages.

- (a) a firm take-or-pay contract for up to 100% of the product (paras. 3.50-3.54);
- (b) an orebody with 2.6% Ni, ^{1/} almost double that of most other prospects and considerably better than many existing operations (para. 5.15); and
- (c) estimated capital and operating costs which are substantially lower than other nickel prospects and which, indeed, compare favorably with most projects implemented over the last ten years (para. 8.08).

3.02 At the present time, Cerro Matoso is the only greenfield nickel project under serious consideration, although a number of other prospects are being investigated with a view to implementation by 1985 if the market warranted them (para. 3.22). Whether these other projects will materialize is, however, in doubt since there is no consensus at the present time whether the overcapacity which presently exists is a temporary aberration which will work itself out by 1981 (which is a position generally endorsed by nickel producers), or whether it reflects a fundamental downward shift in the demand curve for nickel (which is a view put forward in a number of independent studies, e.g., the December 1977 report by Australian Mineral Economics Pty.) If the latter view should prevail, Cerro Matoso may be the last greenfield project for some years. However, as indicated in Chapter IX, even under such a pessimistic scenario, Cerro Matoso would still be financially viable and, indeed, could do better than a number of recently implemented projects, including sulphide operations in Australia.

3.03 Given the lack of general agreement on market trends, the present analysis provides ranges for both future demand and capacity based on, inter alia, GDP and steel growth rates and alternative hypotheses as to the likelihood that specific projects will actually come on stream. The resulting supply/demand balance (para. 3.38) indicates as a best estimate that, although Class I nickel prices are likely to remain depressed through the early-1980s, by 1985 prices are likely to have risen to approximately US\$2.95/lb in 1979 terms (as compared to about US\$2.08-US\$2.20 in early 1979) and that they will continue at or about this level thereafter. Even should there be no real price increase, however, the Cerro Matoso Project would remain viable (para. 9.18) although at such prices established producers, such as Greenvale (Australia) or Marinduque (Philippines), could not cover their full costs.

B. Structure of the Industry

3.04 One of the major changes which has recently taken place is in the structure of the industry. Historically, nickel has been the most highly concentrated natural resource industry in the world. As recently as 1950, the International Nickel Company of Canada (INCO) controlled 85% of production

^{1/} The ore extracted during the 25-year concession, under the envisaged mining plan, will yield an average grade of 2.7% Ni (Annex 5-2).

in market economies and even in 1970, it still held 50%. However, this is changing. In spite of the fact that the three producers who have traditionally dominated the industry (INCO and Falconbridge of Canada and Societe le Nickel of France) still control over 50% of the market, a number of newcomers have recently entered and competition has now increased, particularly in the production of Class II nickel (para. 3.07). Annex 3-1 gives a brief description of the three major producers and of six of the more important recent entrants (AMAX, Freeport Minerals and Hanna of the US; Sherritt Gordon of Canada; Western Mining of Australia; and the Anglo-American Corporation of South Africa) and indicates the inter-linkages within the industry.

3.05 In spite of the difficulties they have experienced in entering the market, these smaller producers often command considerable financial resources and (as in the case of AMAX) they have been able to absorb considerable losses in their nickel operations in order to increase their market share at the expense, primarily, of INCO:

Market Penetration by Recent Entrants (Excluding CPEs)
(in percent)

	<u>1955</u>	<u>1965</u>	<u>1970</u>	<u>1974</u>	<u>1976</u>
<u>Established Producers</u>					
INCO (Canada)	67.1	61.1	43.9	39.1	35.0
Societe le Nickel (France)	5.1	8.7	10.8	9.6	11.5
Falconbridge (Canada)	<u>9.4</u>	<u>9.0</u>	<u>7.1</u>	<u>6.4</u>	<u>6.1</u>
Subtotal	81.6	78.8	61.8	55.1	52.6
<u>Other Producers</u>					
Sherritt Gordon (Canada)	6.5	3.3	1.9	2.1	2.1
Hanna (US)	4.1	3.1	2.2	2.2	2.0
Western Mining (Australia)	-	-	3.4	7.2	8.0
Others	<u>7.8</u>	<u>14.8</u>	<u>30.7</u>	<u>33.4</u>	<u>35.3</u>
Total	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
Free Market Production (000 MT)	n.a.	321	510	573	600

3.06 In addition, state mining companies in the USSR and Cuba have managed to maintain about 22%-23% of the total world market and are clearly not subject to the same economic pressures as the established producers. What the intrusion of the newcomers and the increasingly aggressive role of state companies mean is that INCO (and, to a lesser extent, Falconbridge and Societe le Nickel) can no longer control output so as to influence prices and optimize long-term profits. While one should not overestimate the degree of competitiveness in the industry, there are a number of additional companies (including major petroleum and steel producers) actively considering nickel production and, in addition, there is the longer-term threat of deep-sea mining (para. 3.25)--all of which militate against a return to the classic oligopoly of the last 50 years.

C. The Role of Nickel

3.07 Nickel's value lies primarily in its ability to alloy with other elements to impart increased strength and ductility. It is, however, not a homogenous commodity and certain uses are restricted to specific types of nickel:

- Class I nickel is essentially pure, with a nickel content approaching 100%, and has unrestricted use;
- Class II nickel varies from 20% to 95% nickel and has more or less restricted uses.

3.08 The major forms of Class I nickel include electrolytic cathodes (produced by INCO and Falconbridge), pellets (INCO), powder (INCO), granules (Falconbridge), briquettes (AMAX and Western Mining) and "rondelles" (Societe le Nickel). The most important forms of Class II nickel are ferronickel (produced by Falconbridge, Societe le Nickel, Hanna and INCO), oxide sinter (Cubaniquel and INCO) and INCOMET (INCO). Ferronickel is produced most commonly in the forms of pigs or ingots and usually has a nickel content of 20%-40%. Oxide products, on the other hand, often contain up to 90% nickel, with an average nickel content of around 75%-77%. In 1976, Class I products held about 55% of the world market and ferronickel and nickel oxide--both Class II products--held about 35% and 10%, respectively.

3.09 The normal use of nickel is in the manufacture of six groups of semi-finished products:

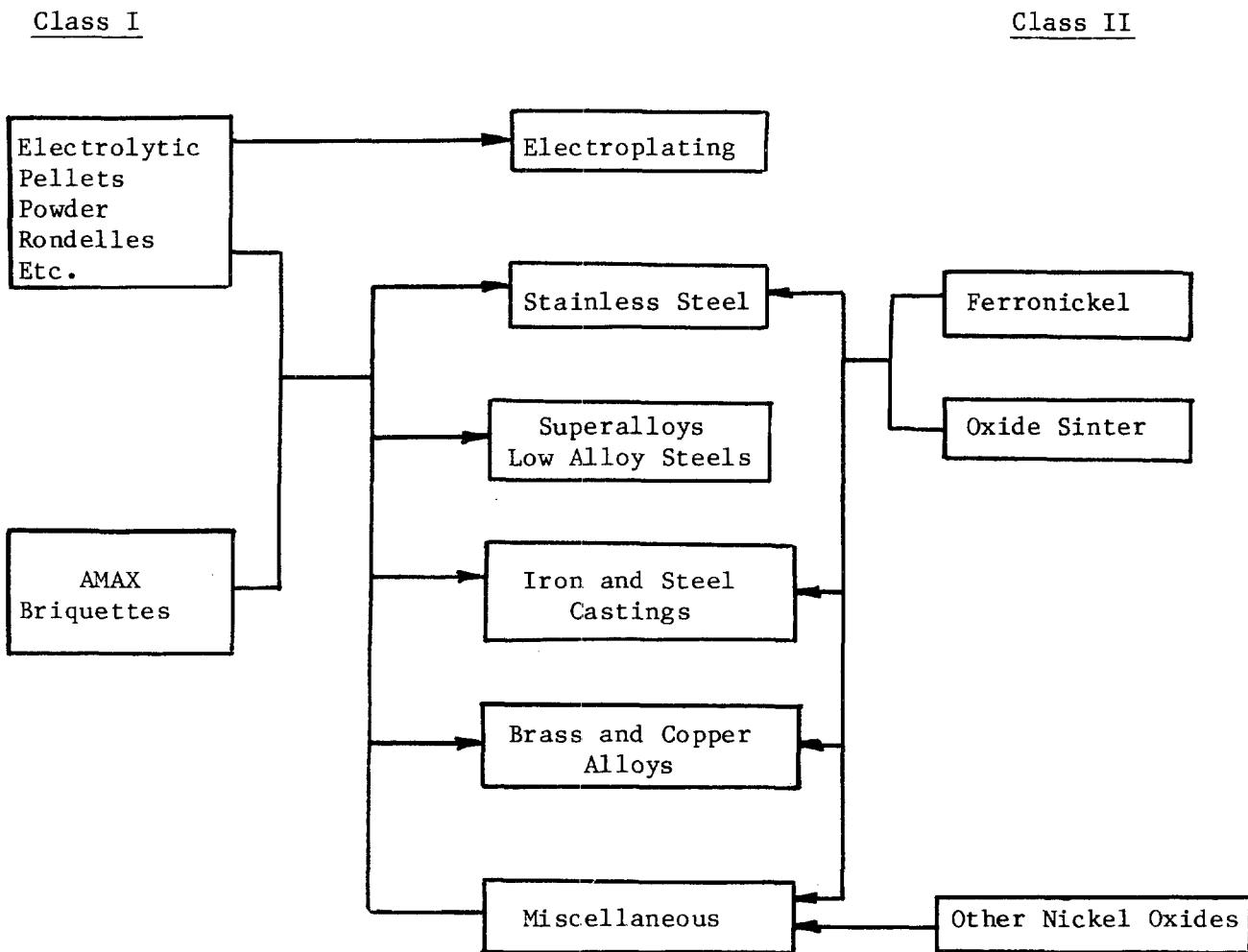
Nickel Used by Major Semi-Fabricated Product Group

% of
Nickel Use

1. Stainless Steel	50	a) ferritic steel (< 0.5% nickel) b) austentic steel (8%-12% nickel) c) martensitic steel (0.5%-2.5% nickel) d) age-hardened steel (3%-8% nickel)
2. High Nickel Alloys	16	a) general corrosion and heat-resistant alloys (30%-70% nickel) b) superalloys (with aluminum or titanium) c) electrical and magnetic alloys (60%-80% nickel) d) controlled expansion alloys e) copper and brass alloys
3. Nickel Plating	13	
4. Low Alloy Steels	7	
5. Iron and Steel Castings	5	
6. Other Uses	9	a) catalysts, batteries, etc.
		<u>100%</u>

3.10 Of these, as indicated below, ferronickel can be used for all purposes except for plating and in superalloys and low alloy steels:

Applications of Class I and II Nickel



3.11 Indeed, for the major user of nickel - the stainless steel industry - cheaper grades of ferronickel may actually have an advantage over Class I product:

- (a) as the average size of the electric furnace increases, metal losses through vaporization become significant and the economic incentive to charge as little expensive material as possible increases;

- (b) the introduction of Union Carbide's AOD steelmaking process 1/ allows a lower grade of nickel, with higher impurities, to be used by making it easier to control the chemistry of chromium, silicon, manganese and sulphur; and
- (c) there is up to US\$8/ton of savings in Fe units from using a ferronickel charge with about 60%-80% Fe, which is not insignificant in a highly competitive steel market.

3.12 Along with, for example, aluminum and molybdenum, nickel is a "modern" metal with many of its applications occurring in high-technology fields. In 1973, for instance, 16% of nickel consumed in market economies was used in the chemical industry, 13% in electronics, 8% in petroleum and 6% in the aircraft industry. Only 3% was used in the construction industry. Nickel is, however, potentially vulnerable to substitution. To some extent, there is already substitution of low-nickel (and high-chromium) ferritic steels for more expensive, high-nickel austenitic steel, particularly in the US where, historically, austenitic steels have accounted for the bulk (65%-70%) of stainless produced. There is also considerable research into the substitution of ceramic parts for nickel in gas turbines. However, at present prices, these trends are unlikely to pose a major threat to the historic role of nickel. Perhaps more important is the growing use of plastics and coated steel in the automobile industry which may erode traditional outlets for Class I nickel.

D. The International Nickel Market

1. Historic Consumption of Nickel

3.13 Since nickel is a relatively modern metal, it has historically enjoyed a higher growth rate than most others. Indeed, since 1900, the average annual growth rate has been about 6% and from the end of World War II to 1974/76 the average annual rate was even higher, although demand has tended to exhibit 4-6 year cycles closely related to crude steel production. As shown below, however, 1974 represented a peak and the current growth is only about 3% per annum:

1/ Argon Oxygen Decarburization--this process consists of a bottom-blown tilting converter utilizing oxygen, argon and sometimes nitrogen.

World Nickel Consumption: 1950-1976
(000 MT Nickel) /a

	1950	1961	1966	1972	1973	1974	1975	1976	Average Growth Rate	Average Growth Rate
									1950-76	1961-74
USA	91	108	170	157	182	195	136	155	2.1%	4.7%
FR Germany	6	22	34	43	55	61	43	57	9.3%	8.4%
France	4	15	25	31	30	41	39	34	8.6%	8.0%
Italy	2	8	13	21	23	20	17	22	9.6%	7.4%
UK	16	27	34	30	32	34	26	31	2.6%	1.7%
Sweden	3	9	14	23	27	32	22	24	7.8%	10.2%
Others	3	9	11	16	19	22	19	22	7.9%	7.2%
Western Europe	33	89	130	164	186	209	165	190	6.9%	6.8%
Japan	1	21	36	88	114	119	90	121	20.0%	14.5%
Others	4	9	17	28	35	39	31	36	8.8%	12.0%
Market Economies	128	226	353	437	516	562	422	501	5.4%	7.3%
USSR	)			100	100	105	115	121)		
PR China	)	30	95	115	20	16	18	18)	7.0%	3.8%
Others	)	—	—	—	24	28	30	34	35)	—
CPEs		30	95	115	144	146	153	167	174	7.0%
Total	158	321	468	581	662	715	589	675	5.8%	6.3%

/a Figures may not add up due to rounding.

3.14 One of the reasons for the lower growth rate at present is the relative decline in military expenditures in the US following the termination of the Viet Nam war. A more important reason is the increasing economic maturity of the developed market economies. As indicated below, the more highly developed economies tend to have a higher per capita consumption of nickel but a relatively low marginal propensity to consume. As more countries approach or surpass US income levels, a significant flattening of their respective nickel consumption growth rates can be expected to occur (para. 3.32) and this will have a serious impact on future demand for nickel.

	Primary Nickel Consumption and GNP					Average Growth Rate of Per Capita Consumption 1960-75
	GNP/Capita 1975 terms (US\$ 000)	Real GNP Growth Rate		Nickel Consumption Per Capita		
		1960-75	1970-75	1960	1975	
				-----(lb)-----		
USA	7,120	2.5%	1.6%	1.30	1.40	0.5%
FR Germany	6,670	3.5%	1.9%	0.89	1.52	3.6%
France	5,950	4.2%	3.4%	0.73	1.64	5.6%
Italy	2,810	3.9%	1.7%	0.34	0.67	4.7%
UK	3,780	2.2%	2.0%	1.11	1.00	(0.7%)
Sweden	8,150	3.1%	2.3%	2.65	5.91	5.5%
Japan	4,450	7.7%	4.0%	0.47	1.77	9.1%

Source: World Bank Atlas, Australian Mineral Economics Pty. Study.

3.15 It should, however, be pointed out that, even over the post-1974 period, consumption of Class II nickel has increased substantially faster than that of Class I. Indeed, the average annual growth rate of Class I nickel from 1966 to 1975 in market economies was only 0.4% while that of Class II product was 9.4%. In Japan, where economic recovery was faster than in the US and Western Europe, the average growth rate for Class II nickel was 13.2%. Although in the major markets there was a sharp downturn for all forms of nickel in 1974/75, in each market the recovery by Class II nickel has been considerably faster than that for Class I product. The reason for this is clearly, at least in part, a function of the greater cost-consciousness which world steelmakers are now having to show in a highly competitive steel market.

2. Historic Supply of Nickel

3.16 Until the late 1950s, nickel mine production was dominated by Canadian sulphide ores which, in 1950, contributed about 95% of total nickel supply in market economies. Since then, however, declining ore grades in Ontario, changing steel technology and the entry of new firms into the industry have led to greater geographic dispersion which has, in large part, been associated with the shift to exploitation of lateritic ores which constitute about 80% of world nickel reserves.

World Mine Production of Nickel
(000 MT - Nickel Content)

Country	Predominant Ore Type	Average Rate of Growth										
		1950/51	1960	1965	1970	1972	1973	1974	1975	1976	1965-75	1973-76
Canada	Sulphide	119	195	235	278	235	249	269	242	263	0.3%	1.9%
USA	Laterite	1	11	12	14	14	13	13	13	13	-	-
Australia	Sulphide/ Laterite	-	-	-	30	36	40	46	67	75	-	22.8%
South Africa	Sulphide	1	3	5	12	12	19	22	21	22	15.5%	5.0%
Greece	Laterite	-	-	-	9	11	14	15	16	15	-	-
Philippines	Laterite	-	-	-	-	-	-	-	10	15	-	-
Indonesia	Laterite	-	-	2	11	14	16	16	15	14	22.5%	(0.2%)
Botswana	Sulphide	-	-	-	-	-	1	3	6	13	-	>100.0%
Dominican Rep.	Laterite	-	-	-	-	17	30	31	27	24	-	(7.8%)
New Caledonia	Laterite	6	54	61	139	108	116	137	133	119	8.3%	-
Other Market Econ. Market Econ.	-	2	6	17	22	21	21	20	27	12.5%	6.5%	5.9%
USSR	Sulphide	31	58	80	110	110	110	120	125	130	4.6%	5.6%
Cuba	Laterite	-	15	29	37	37	35	34	37	37	2.4%	0.2%
Other CPEs CPEs	-	4	7	9	9	10	10	12	12	5.5%	4.7%	4.2%
Total World		<u>158</u>	<u>342</u>	<u>437</u>	<u>666</u>	<u>625</u>	<u>674</u>	<u>737</u>	<u>744</u>	<u>779</u>	<u>5.4%</u>	<u>5.0%</u>

3.17 Historically, the supply of refined nickel has also been dominated by Canadian producers--although both INCO and Falconbridge have tended to refine much of their nickel through subsidiaries located abroad, in Wales and Norway respectively. The criteria for location of refining facilities is, however, affected by the type of ore being processed. For high-grade sulphide operations, such as those which INCO and Falconbridge have historically controlled, proximity to final markets is critical and transportation costs are less important because of the possibility of concentrating sulphide ores or shipping them as intermediate matte. One result of this is that Canada--which presently still controls about 34% of world mine production--only refines about 23% of the total, while Japan, the US, the UK and Norway--with insignificant mine capacity--together refine almost 30% of the total. The distribution of refined nickel production is given in Annex 3-2.

3.18 The increasing importance of laterites will, however, demand in-situ processing since it is technically and economically infeasible to concentrate these ores. Because smelting of laterites is extremely power intensive (para. 6.01), the availability of reasonably-priced electric power may become critical--particularly in areas like New Caledonia where the existing infrastructure is virtually non-existent. At present the only significant trade in unprocessed lateritic ore is from the Philippines, Indonesia and New Caledonia to Japan. Even this, however, may soon be curtailed as Japan is forced to close its domestic smelting operations for ecological reasons. At present, Japan is not a significant importer of finished nickel (the US and the FR Germany are the two major markets for finished nickel imports with 35% and 10% of total imports, respectively) but this is changing, and Japan will become a major market for Cerro Matoso's production (para. 3.52).

3. Projected Supply of Nickel

3.19 Up to recently, short-term market prospects for nickel were rather bleak. At the end of 1977, there was an enormous overhang of producer inventories equivalent to approximately six months' sales, which is two times higher than normal. INCO estimated that, over the period January 1975-June 1977, approximately 190,000 MT (419 million lb) of finished nickel were added to total producer inventories, of which INCO alone had added over 100,000 MT. It is believed that INCO's inventories at the end of 1977 were greater than its total deliveries during that year and, as of April 1978, it was reported that INCO's inventories still totalled approximately 160,000 MT. Due to production cutbacks and a strike at INCO's facilities in Sudbury (Canada), however, nickel inventories were declining during the second half of 1978 and the first quarter of 1979 and, by the end of May, were reported to have reached a normal level. The reason for this overhang, the magnitude of which is indicated below, is predominantly the over-optimistic demand forecasts made in the 1960s on the basis of the rapid post-war growth rate for nickel (para. 3.13). A direct result of this was heavy investment in new (and, owing to the lack of infrastructure, relatively high-cost) nickel mines which have increased total installed nickel capacity to approximately 900,000 MT.

World Capacity, Production and Consumption of Primary Nickel
(000 MT)

		1973	1974	1975	1976	1977
<u>Capacity /a</u>	: Market Economies	n.a.	612	640	666	692
	Centrally-Planned	n.a.	167	180	188	195
	Total		779	820	854	887
<u>Production</u>	: Market Economies	519	573	570	600	544
	Centrally-Planned	155	164	174	179	(184) /b
	Total	674	737	744	779	728
<u>Consumption</u>	: Market Economies	516	562	422	501	490
	Centrally-Planned	146	153	167	174	(182) /b
	Total	662	715	589	675	672
World Production/Consumption		1.02	1.03	1.26	1.15	1.08
World Production/Capacity		n.a.	0.95	0.91	0.91	0.82
Capacity/Consumption		n.a.	1.09	1.39	1.27	1.32

/a An estimate of production potential in the absence of a market constraint.
/b Preliminary.

3.20 To this presently available capacity must be added incremental capacity from projects which are either underway or are more or less committed. These include additional sulphide production from Australia and substantial lateritic-based production from developing countries:

"Relatively Firm" - Incremental Nickel Capacity
(000 MT - Contained Nickel)

		1980	1985	1978 Status
1. <u>Firmly Committed</u>				
	Indonesia (INCO - Laterite)	45	45	Start-up
	Guatemala (EXMIBAL - Laterite)	12	20	Start-up
	Greece (LARCO - Laterite)	15	15	Implementation
	Yugoslavia (FENI - Laterite)	16	16	Implementation
	Brazil (TOCANTINS - Laterite)	5	5	Implementation
	Brazil (CODEMIN - Laterite)	-	7	Detailed Engineering
	Sub-total	93	108	
2. <u>Highly Probable</u>				
	Colombia (Cerro Matoso - Laterite)	-	23	Impl. Start: June 79
3. <u>Probable</u>				
	New Caledonia (SLN-Laterite)	18	18	Engineering
	Venezuela (Loma de Hierro-Laterite)	-	10	Feasibility
	Australia (Various-Sulphide)	25	50	Feasibility
	Sub-Total	43	78	
	Total	136	209	

3.21 Among the projects listed above which are not already firmly committed, Societe le Nickel's New Caledonia project will directly feed its new smelter at Le Havre (France) and the Venezuelan project (like those in Brazil) is geared directly to the local market and, hence, is less influenced by world market trends.

3.22 In addition to this, there are up to 400,000 MT of "discretionary" capacity which could come on stream by 1990 if market prospects were to improve or if non-economic factors were to dictate production. As shown below, a range of probabilities can be attached to the likelihood that these projects will come on stream:

"Discretionary" - Incremental Nickel Capacity
(000 MT - Contained Nickel)

	<u>1985</u>	<u>1990</u>	<u>Mid-1978 Status</u>
1. Likely			
Guatemala (EXMIBAL - Laterite)	-	25	Expansion
Indonesia (INCO - Laterite)	-	45	Expansion
Cuba (Moa Bay - Sulphide)	7	7	Feasibility
Cuba (NICARO - Laterite)	3	3	Feasibility
Cuba (Punta Gorda - Laterite)	30	30	Feasibility
USSR (Various - Sulphide)	35	35	-
Rhodesia (JCI - Sulphide)	5	5	Engineering
Yugoslavia (Goles - Laterite)	5	5	Engineering
South Africa (Platinum by-products)	5	5	-
New Caledonia (BRGM/AMAX-Laterite)	-	20	Pre-Feasibility
Sub-Total	<u>90</u>	<u>180</u>	
2. Possible			
Canada (Falconbridge-Sulphide)	10	10	Hold
Canada (INCO - Sulphide)	15	15	Hold
Canada (MG/TECH - Sulphide)	10	10	Feasibility
Brazil (BAMINCO - Laterite)	10	23	Hold
Brazil (COCEGEO - Laterite)	5	10	Pre-feasibility
Australia (Various - Sulphide)	15	30	Hold
Indonesia (PTPNI - Laterite)	-	50	Hold
New Caledonia (INCO - Laterite)	-	20	Pre-feasibility
New Caledonia (SLN/AMAX - Laterite)	-	20	Pre-feasibility
Philippines (Various - Laterite)	-	25	Identification
Burundi (Musongati-Laterite)	-	27	Pre-feasibility
Sub-Total	<u>65</u>	<u>240</u>	
Total	<u><u>155</u></u>	<u><u>420</u></u>	

3.23 Of these projects, the highest probabilities can be attached to those which are expansions (such as EXMIBAL and INCO's Indonesian project) and to those which may be implemented without reference to market conditions (e.g. the Cuban and USSR projects). Of the other "likely" projects, the AMAX/BRGM

Joint Venture is particularly attractive since it is the only unexploited deposit which has a Ni content even approaching that of Cerro Matoso (para. 5.15). Infrastructure requirements are, however, very much heavier for the AMAX/BRGM prospect.

3.24 A critical factor in determining whether an individual project will or will not be implemented is its capital cost per annual lb, since depreciation and interest charges together can constitute up to 45% of total costs in early years. 1/ As indicated in para. 8.08, the capital cost of recent projects has varied from a low of about US\$6/lb to around US\$10/lb in 1979 terms. With the exception of Cerro Matoso which could be implemented for about US\$6/lb, it is unlikely that any of the "discretionary" greenfield projects listed above would be realizable for less than US\$10-US\$12/lb. Assuming average production costs for new projects of around US\$1.40/lb, this would mean that these projects could not be viable at prices less than about US\$2.60-US\$2.90/lb. For some of the more expensive underground Australian projects, where production costs are likely to be up to US\$2/lb, the threshold price would be above US\$3/lb.

3.25 In addition to land-based nickel, there is the additional prospect of marine nickel from deep-sea manganese/nickel nodules. Although deep-sea mining is technically feasible, it is not yet clear whether political problems can be overcome or at what nickel price it would become competitive. Indications are, however, that, on cost grounds, deep-sea mining might eventually compete with greenfield lateritic projects, but probably never with Canadian sulphide operations. In the shorter term, legal problems are, however, so intractable that it is unlikely that significant quantities of sea-bed nickel could come on the market before 1990 at the earliest and undersea nickel is therefore excluded from this analysis.

3.26 An additional source of nickel, which is likely to be increasingly important, is secondary nickel from scrap. As the real unit cost of primary nickel supply increases--as it must as a consequence of the increasing importance of lateritic ores and as the low-cost sulphides ores from Sudbury are depleted--the economic incentive to recycle nickel will increase.

3.27 Historically, world-wide only 50-60,000 MT of scrap nickel have been consumed annually, although whenever there has been a significant price increase for primary nickel there has been a corresponding surge in scrap usage since scrap nickel generally sells at a 10%-15% discount. At present, the proportion of scrap nickel used (about 6% in the US in 1976) is considerably lower than that of aluminum (27%) or copper (47%), at least in part owing to the need for raw material quality control in producing nickel alloys. However, in the present and projected steel market, stainless manufacturers will be anxious to keep down raw material costs and, given improvements in scrap recovery (particularly in recovering "white" metals) and continued efforts to increase the flexibility of the furnace charge, this will favour increased use of scrap in stainless steel production.

1/ Based on figures for the Greenvale project in Australia, where, in 1978 terms, total cost/lb is about US\$3.05 of which depreciation is about US\$0.46 and interest charges about US\$0.88, or about 44% of total cost. This, however, may be exceptional since interest and depreciation constitute only about 22% of total costs at FALCONDO in the Dominican Republic.

3.28 Taking into account the foregoing, the table below illustrates the ranges of potential land-based supply that could be anticipated from 1980 to 1990:

<u>Projected Nickel Capacity</u> (000 MT - Contained Nickel)			
	<u>1980</u>	<u>1985</u>	<u>1990</u>
1. <u>Primary Nickel</u>			
Existing Capacity /a	864	781	707
Incremental Capacity			
Firmly committed	93	108	108
Highly probable	43	78	78
Likely	-	90	180
Possible	-	65	240
Sub-Total	1,000	1,122	1,313
2. <u>Secondary Nickel</u>	80	80	80
<u>Total</u>	<u>1,080</u>	<u>1,202</u>	<u>1,393</u>

/a An attrition rate of 2% per annum has been assumed.

3.29 If only those projects which are considered to be firmly committed or highly probable are implemented, total capacity will be in the range of 1.05 million MT by 1985.

3.30 It will be noted that the majority of new projects are based on laterite deposits. Although the carbonyl process allows laterites to produce Class I product, most lateritic-based projects will produce either ferronickel or oxide sinter. By 1985, therefore, one can assume that approximately 55% of capacity will be capable of producing Class II nickel. This is in line with the projection by AMAX that consumption of Class II product will equal that of Class I nickel by 1983 (para. 3.49).

4. Projected Nickel Demand

3.31 The main factors which observers have suggested have resulted in a fundamental shift downwards in the overall demand curve for nickel are:

- (a) the lower GNP growth rates now anticipated for developed market economies;
- (b) the greater economic maturity of Japan and many Western European economies;
- (c) the relative decline of military-related expenditures in the US and Western Europe;

(d) the increasing importance of ferritic (low nickel) stainless steels; and

(e) the increasing use of plastics and other nickel substitutes in uses other than for stainless production (e.g., for automobile trim).

3.32 The most important of these is the lower economic growth rate forecast. The latest Bank projections foresee real GDP growth rates for OECD (North) countries as averaging 4.2%-4.3% during the 1978-90 period, with the growth rate in the US and the major economies of Western Europe being only in the 3.8%-4.0% range. As shown below, the Bank has also projected that steel/GDP ratios for developed economies will actually fall while the income elasticities of demand for steel (which measure essentially the same thing) in developing countries will do no more than remain approximately constant:

Projected Steel/GDP Growth Ratio and Elasticity of Demand for Steel

A. Projected Steel/GDP Growth Ratios

	<u>Past Data</u>	<u>1977-1980</u>	<u>1980-1990</u>
US	0.71	0.51	0.47
Japan	1.35	0.50	0.44
EEC	0.84	0.58	0.53

B. Projected Income Elasticities of Demand for Steel

	<u>Past Data</u>	<u>1977-1990</u>
N. Africa & Middle East	1.71	1.71
Other Africa	1.39	1.39
Asia	1.36	1.36
Latin America	1.87	1.20

Source: IBRD Economic Analysis and Projections Dept., April 1978.

3.33 Historically, total nickel consumption has grown faster than the overall consumption of steel (6.2% per annum for the period 1955-75 vs. 5.8% for steel) and, as we have already seen (para. 3.15) Class II consumption has grown significantly faster than that of Class I nickel. Nickel consumption--and, particularly, Class II nickel consumption--however, is more closely correlated with the growth of stainless steel than that of raw steel in general. The proportion of stainless steel as a percentage of the total steel market has increased, at an annual average rate of about 7%, from only 0.8% in 1962 to approximately 1.3% in 1977.

3.34 Based on the Bank's GDP growth projections and the steel elasticities indicated above, the Bank has estimated that steel consumption will rise more slowly over the next ten years than over the last twenty years:

Bank Projections of World Steel Consumption Growth Rates
(in percent)

	<u>1949-1976</u>	<u>1976-1980</u>	<u>1980-1985</u>	<u>1985-1990</u>
US	2.3	4.2	1.9	1.4
Japan	12.0	3.2	5.3	3.7
EEC	3.6	2.0	2.7	1.5
Other Developed Countries	<u>6.3</u>	<u>6.6</u>	<u>2.9</u>	<u>2.1</u>
Sub-Total	4.5	3.7	2.9	2.0
Developing Countries	7.3	8.0	7.7	8.7
Centrally-Plan Econ.	<u>6.2</u>	<u>4.4</u>	<u>4.3</u>	<u>3.3</u>
Total	<u>5.2%</u>	<u>4.4%</u>	<u>4.0%</u>	<u>3.5%</u>

Source: IBRD Economic Analysis and Projections Dept., April 1978.

3.35 These projections are generally in line with those put forward by other institutions, e.g., a 1977 study by the AISI forecast a world steel consumption figure for 1985 of between 1.0 and 1.1 million MT, as compared with Bank estimates of between 0.97 and 1.0 million MT, and a UNIDO study forecast a 1985 total of 1.07 million MT. A recent IISI study, however, forecasts a somewhat higher total steel growth rate of 4.4% for 1985-90, on the basis of growth rates of 3.2% for industrialized countries, 8.1% for developing countries and 4.3% for centrally-planned economies.

3.36 The general consensus that the rate of growth of steel consumption in developed economies will slow considerably, has serious implications for nickel since the bulk of stainless steel is produced and consumed in those markets for which the lowest growth rates are projected (Annex 3-3). While stainless steel will probably continue to increase its share of steel production in developed countries at approximately the same rate as heretofore, it will remain insignificant in the fastest growing section of the steel market--the developing countries. Assuming that, in developed economies, stainless production continues to outpace raw steel production by the same margin as during the 1955-75 period, but that it does no more than hold its own in developing countries and centrally-planned economies, the average annual growth rate for world consumption of stainless steel would be approximately 4.5%-5.0% from 1976 to 1980 and 4.0%-4.5% from 1980 to 1985. Based on the historic relationship between nickel consumption and stainless steel production, this would imply growth rates for nickel consumption of around 4.5% per annum to 1980 and about 4.0% from 1980 to 1985. As already indicated, however, it may be overly optimistic simply to extrapolate historic nickel/steel or nickel/stainless relationships since the market for Class I nickel is likely to be affected by substitution and since, even in stainless, there is a shift to lower-nickel alloys. Among more pessimistic observers, the December 1977 study by Australian Mineral Economics Pty. (AME) projected a 1976-87 trend growth rate for consumption of primary nickel of only 3.4%

per annum, at least in part owing to the assumption that the nickel intensity of fixed capital investment will fall as more economies move into the mature category and as the range of available substitutes--particularly for Class I nickel--increases.

3.37 The impact of projecting a number of long-term growth rates is indicated in the table below:

Alternative Growth Forecasts for World Nickel Demand (including CPEs)
(000 MT Nickel Contained)

<u>Hypothesis</u>	<u>Base Year</u>	<u>1980</u>	<u>1985</u>	<u>1990</u>
A. Nickel Growth Rate Based on Historic Nickel/Steel Ratio, using Bank Steel Projections:	675 /a	810	1,015	1,220
B. Nickel Growth Rate Based on Historic Nickel/Stainless Steel Ratio, using Stainless forecast derived from Bank Steel Projections:	675 /a	800	990	1,170
C. As in A, except based on 1974 nickel consumption:	715 /b	940	1,180	1,420
D. As in B, except based on 1974 nickel consumption:	715 /b	930	1,150	1,400
E. AME Dec. 1977 Forecast /c:	675 /a	770	911	-
F. Bank Commodity Forecasts, February 1979 /d: -		825	1,080	1,400

/a Actual 1976 consumption.

/b Actual 1974 consumption.

/c Based on trend growth rate of demand for primary nickel of 3.4% from 1976 to 1987 (based on revised consumption date for 1976).

/d Based on consumption forecasts prepared by Bank Commodities Department, February 1979.

As can be seen, excluding the pessimistic AME study which assumed an OECD GDP growth rate of only 3.0%, there is a considerable consensus that by 1980 demand will be 800-900,000 MT, that by 1985 it will be 1.0-1.2 million MT and that by 1990 it will be in the range 1.20-1.40 million MT.

5. Projected Supply/Demand Balance

3.38 As can clearly be seen in the table below, which compares likely ranges of supply and demand, it is probable that surplus capacity will continue until at least the early 1980s. To some extent this can be compounded by the high levels of inventories (para. 3.19), although these are being run down as producers were cutting back 1978 production to about 60%-65% of

capacity and both INCO and SLN suffered the effects of strikes. 1/ By 1985, however, a market for the higher-cost discretionary capacity referred to in paras. 3.22 to 3.24 should develop, and by 1990 additional land-based nickel will be required if deep-sea mining does not come on stream as anticipated:

Projected World Nickel Supply/Demand Balance: 1980-90
(000 MT Contained Nickel)

	<u>1980</u>	<u>1985</u>	<u>1990</u>
Production Capacity	1,080	1,050-1,200	970-1,400
Likely Demand	<u>800-900</u>	<u>1,000-1,200</u>	<u>1,200-1,400</u>
Anticipated Surplus (Deficit)	180-280	0-50	(230)-0

E. Nickel Prices

3.39 The price outlook through to the early 1980s is, clearly, not promising, although the projected supply/demand balance would indicate that prices will have to rise by the mid-1980s if higher-cost discretionary capacity is to be brought on stream.

1. Historic Prices

3.40 In the past, the nickel industry has been subject to a producer pricing system, led by INCO. As shown below, this has led to relatively stable nickel prices (compared with, for example, the cyclicalities associated with copper) and to stable discounts for various impure grades. 2/

Historic Nickel Prices, 1971-78
(US\$/lb)

	Average Posted Producer Price		European Free Market Price	
	Current	Constant Apr. 1979	Current	Constant Apr. 1979
1971	1.33	3.10	1.35	3.14
1972	1.40	2.94	1.35	2.84
1973	1.53	2.67	1.48	2.59
1974	1.74	2.42	2.00	2.79
1975	2.07	2.50	1.87	2.26
1976	2.20	2.63	2.07	2.48
1977	n.a.	n.a.	2.00	2.18
1978	n.a.	n.a.	1.93	2.09

n.a.--not applicable (para. 3.41).

1/ In 1978, Falconbridge was down to 50% of capacity in Canada, and FALCONDO was operating at only 45% in the Dominican Republic. However, by March 1979, these figures were reportedly at 65% and 66%, respectively.

2/ Average discounts from Class I posted prices for Class II products have been: (i) ferronickel--5%; (ii) oxide sinter--15%; and (iii) INCOMET--10%.

3.41 However, during the oversupply of the last 2-3 years, the newer entrants to the industry began significant discounting from INCO's posted price and, since early 1977, INCO--whose present average costs are still substantially below those of its competitors--has dropped its published prices and has competed aggressively, thereby exacerbating the downward pressure on prices. Although the precipitous price decline of the second half of 1977 bottomed out in 1978 and prices actually began to stabilize and improve during the first quarter of 1978 when producers maintained their existing price levels, a new round of price reductions took place early in the second quarter and set the trend for the remainder of the year. Only by the end of 1978, when inventories were reduced by production cut-backs and a strike at INCO, which was settled only in early June 1979, did prices begin to improve and the major producers (INCO, Falconbridge and SLN) returned to the posted price system. During the first quarter of 1979, prices showed a marked upward trend, ^{1/} but it would be premature to expect this trend to firm up considerably while inventories, although reduced, are still a factor. As shown below, it is difficult--even taking into account the oligopolistic nature of the industry--to sustain marked real price increases in the face of the continuing oversupply.

Nickel Surpluses/Deficits and Changes in World Market Prices

	Surplus/Deficit		Price /a (Apr. 1979 Constant Terms) (US\$/lb)	Price Change Over Previous Year (%)
	Market Economies	Total World		
	----- (000 MT)-----			
1971	68	91	3.12	(5)
1972	(11)	2	2.89	(8)
1973	(19)	(6)	2.63	(9)
1974	(6)	2	2.61	(1)
1975	105	111	2.38	(9)
1976	95	106	2.56	8

/a Average of Posted and European Free Market Prices (para. 3.40).

2. Projected Prices

3.42 Based on the surplus capacity indicated in para. 3.38 and the present inventories to be worked off, it would be unrealistic to project a major real price increase for nickel before the mid-1980s. Nevertheless, there is a consensus that the 1977/78 prices were abnormally low and that there must be some adjustment to historically more normal levels which will at least earn a reasonable return to low-cost producers such as INCO and Falconbridge. This may already be beginning to take place, although it should be noted that the Windarra sulphide mine in Australia began what is expected to be a two-year

1/ First quarter 1979 average nickel producer prices (Class I nickel) in US\$/lb are as follows: January: 2.08; February: 2.10; March: 2.20; April: 2.46. In May 1979 INCO announced a price increase of US\$0.35/lb, and by June prices reached the US\$3.00/lb level, but it is uncertain if this price level will be maintained after INCO resumes full production.

shutdown at the end of June 1978 owing to depressed nickel prices. By the mid-1980s, however, real price increases above what have historically been considered normal levels will become necessary if discretionary capacity, which is likely to cost over US\$10/lb in 1979 terms, is to be brought into production. As sea-bed mining of manganese/nickel nodules becomes more important, prices will tend to stabilize or, in the view of some observers (and as has been conservatively assumed in this report), may even show a slight decline.

3.43 Given the dependence of Class II production on stainless steel and the low steel growth rates which are forecast for developed economies, it is likely that the historic spread between Class I and Class II prices will continue. If the steel market in general, or the stainless market in particular, were to grow faster than presently anticipated, however, this discount may close and, indeed, it has been suggested that consumers may be willing to pay a premium for the additional Fe units in ferronickel.

3.44 Based on the foregoing analysis, the price forecasts presented below are a reasonable reflection of the likely impact of the projected supply/demand picture. The recent behaviour of the nickel market and the changes which have occurred in the structure of the industry do, however, indicate that these forecasts should be used with caution:

Price Forecasts for Nickel, FOB Cartagena /a
(US\$/lb)

	<u>1978 Range /b</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>
Class I Nickel (Constant April 1979)	-	2.62	2.74	2.84	2.95	2.95	2.95	2.95	2.91	2.89
(Current)	1.93-2.09 <u>/c</u>	3.14	3.48	3.85	4.24	4.48	4.73	5.02	5.29	5.49
Ferronickel (Constant April 1979)	-	2.46	2.57	2.66	2.78	2.78	2.78	2.78	2.75	2.71
(Current)	1.85-2.00 <u>/c</u>	2.96	3.27	3.61	3.99	4.22	4.45	4.72	4.94	5.15

/a Owing to the fact that most of Cerro Matoso's product is to be sold in Europe and Japan and that transportation costs are negligible, the price forecasts have not been adjusted to reflect any premium or discount for sale FOB Cartagena.

/b Actual average prices, 1978.

/c Average prices for Class I nickel during the first quarter of 1979 were US\$2.13/lb and for Class II US\$2.08/lb.

F. The Market for Cerro Matoso

3.45 Taking account of the uncertainties surrounding the world nickel market, the critical factors which will affect the viability of the Project will be the competitiveness of Cerro Matoso product and the existence of a take-or-pay contract for Cerro Matoso's output.

1. Competitiveness of Cerro Matoso Product

3.46 Cerro Matoso's ferronickel will be in the form of pigs weighing approximately 20 kg and having approximately the specifications shown below:

Specifications of Cerro Matoso Ferronickel /a
(in percent)

	<u>Maximum</u>	<u>Minimum</u>	<u>Normal</u>
Nickel	40.0	35.0	37.5
Cobalt	1.0	-	0.75
Chromium	0.2	-	0.1
Phosphorous	0.03	-	0.02
Carbon	0.03	-	0.02
Sulphur	0.03	-	0.02
Silica	0.7	-	0.5
Copper	0.2	-	0.1
Iron	Balance	Balance	Balance

/a Source: Draft Sales Agreement with Billiton, February 1979.

3.47 These specifications on the whole compare favorably with other ferronickels as shown in Annex 3-4. However, although Cerro Matoso product will be lower in carbon, sulphur and silica than those of a number of its competitors, Hanna's own ferronickel from Riddle, Oregon will probably remain the premium product from the point of view of minimal impurities. Since Cerro Matoso's product is likely to be fully comparable with other forms of ferronickel, its ultimate competitiveness is, therefore, closely tied to that of ferronickel generally which, in turn, is tied to the market for stainless steel where about 75%-80% of ferronickel is used.

3.48 As already discussed, although stainless steel is likely to continue to grow in importance in developed countries, overall steel growth rates in those countries are likely to be low. Nevertheless, there are a number of factors which are working in favor of ferronickel in general and Cerro Matoso's product in particular:

- (a) the free iron in ferronickel results in a savings of up to 10% in Fe units which may be important;
- (b) the Ontario operations of INCO and Falconbridge are increasingly subject to disruption over labor contracts and a one-month's stoppage would lose more nickel than Cerro Matoso's annual output;
- (c) much of the domestic Japanese nickel smelting industry is expected to shut down by 1980/81, at which time a major new market--which has historically been exceptionally cost conscious--will open up in which Class II product will compete at an advantage and in which Cerro Matoso will suffer no locational disadvantage; and

(d) it is likely that by the early 1980s virtually all stainless steel will be manufactured in AOD vessels (para. 3.11), which will greatly increase steelmakers' tolerance of impurities and open additional markets to ferronickel.

3.49 An October 1977 study, prepared by AMAX 1/, confirms that by 1983 the split between Class I and Class II nickel will be about 50:50 (as opposed to approximately 55:45 at present) and that the potential annual market for Class II products (which is defined as being 90% of the nickel used in stainless steel, 90% of nickel used in copper and brass alloys and 50% of nickel used in ferrous castings) will be about 300,000 MT by 1980 and approximately 500-600,000 MT by 1985. Cerro Matoso's annual output of 20,000 MT (para. 5.01) would be only about 4% of this total and, given the ready acceptance which FALCONDO's very similar product has had and consumers' preference not to rely on a single supplier, there should be no problem in disposing of this quantity.

2. Marketing Arrangements

3.50 According to the sales arrangements, which have been substantially finalized, Cerro Matoso will sell 100% of its product to Billiton Metals and Ores B.V. of the Royal Dutch/Shell Group on a 13-year, take-or-pay basis after the start of commercial production and that the price will be an average of the actual prices paid in the markets where the nickel is sold, less a discount. This discount will be between US\$0.13/lb, at prices up to US\$2/lb (representing, at that point, 6.5% of the nickel price), tapering to 5%, at prices of US\$5/lb and up. Without such an arrangement, the viability of the Project would be in some doubt. Final signature of a contract agreeable to the Bank will be a condition of loan effectiveness and the contract will not be amended except with prior Bank approval.

3.51 Although Billiton has long been involved in metals trading and is dominant in tin production, its experience in nickel is limited. However, in August 1977, it obtained a 50% interest in the recently-closed Windarra mine in Western Australia, which in 1976 produced about 13,000 MT of nickel in concentrates. Billiton is also involved, with Lockheed (US), AMOCO (US) and other partners, in an undersea mining consortium.

3.52 Although, as indicated in para. 4.10, Billiton has extensive experience in mineral exploration and production, what it really brings to the Project is its marketing expertise. Billiton has individual, wholly-owned marketing organizations in Holland, FR Germany, the UK and the US. It also has trading subsidiaries in France and Holland. It is, therefore, particularly well placed to distribute Cerro Matoso ferronickel in the European market. In addition, it intends to sell in Japan and it was originally envisaged that Nisshin, Toyo Menka and Kawasaki would join the Project as equity partners. Although this has not occurred, it is still expected that Nisshin and Kawasaki will be significant purchasers of Cerro Matoso product.

3.53 Should Cerro Matoso's production exceed the design capacity of the plant, the remainder would be taken by Billiton on an option basis or be sold

1/ L.G. Bonar; The Changing Options of Adding Nickel to Steel, presentation to the Metal Bulletin's First International Ferro-Alloy Conference, Zurich, Oct. 1977.

on the spot market, initially on a reimbursable cost basis by Hanna and subsequently by Cerro Matoso itself. Since Hanna's own ferronickel production will at best hold constant, it is expected that there will be little problem disposing of this through traditional contacts on the world market. It is not expected, for the time being, that there will be any domestic consumption of Cerro Matoso's ferronickel.

3.54 In the opinion of the Bank staff, the proposed sales arrangement with Billiton is critical to the success of the Project since it will remove from Cerro Matoso the real possibility that, in what may continue a depressed market in its early years of operations, the Company would be unable to sell its product and that it would, therefore, accumulate excessive inventories at a time when it is least able to bear their cost. While the price risk clearly remains with Cerro Matoso, as indicated in the financial analysis in Chapter IX, the Project is expected to be far better placed to survive nickel prices up to 20% or 30% lower than those which have been projected than many of the other mines which have opened during the last 5-10 years.

IV. THE COMPANY AND ITS SPONSORS

A. Background

4.01 The Cerro Matoso project has had a long and complex history. The orebody was located by the Richmond Petroleum Co.--a subsidiary of Standard Oil of California (Chevron)--in the early 1950s, and the initial Concession Agreement was signed in 1963. Subsequently, Richmond and the Hanna Mining Co. set up a 50:50 Joint Venture to finance further exploration in the general area and established an operating company, Minera Chevron, for exploration of Cerro Matoso.

4.02 The 1963 Concession Agreement was modified in 1970 to reflect the establishment of CONICOL S.A. as a subsidiary of Hanna and the consequently diminished role of Chevron. At the same time, a further Joint Venture agreement was entered into between CONICOL and Empresa Colombiana de Niquel Ltda. (ECONIQUEL), a subsidiary of the Instituto de Fomento Industrial (IFI). This Agreement defined the period of exploitation of the deposit as 25 years, extendable by 5 years. In addition, it set a deadline of 26 months, extendable by only 12 months, for construction of the plant. This period was to commence with the submission of information which was in fact presented in November 1977. Since notice to proceed was given in early July 1979, and it is expected that construction thereafter will take about 31 to 34 months, the 38 month deadline will clearly have to be renegotiated. The Government has indicated its willingness to grant such an extension. This, and the transfer of the Concession to the newly-formed Cerro Matoso, S.A., are a condition of effectiveness.

4.03 The 1970 Joint Venture Agreement was also amended to reflect the change in the relative shareholdings. Originally, the CONICOL:ECONIQUEL shareholding split of the joint venture was 67:33. This was subsequently changed to a 60:40 CONICOL:ECONIQUEL split, with ECONIQUEL picking up a higher share of pre-operating expenses.

B. Ownership

4.04 The Joint Venture led to the creation of Cerro Matoso, S.A., (CMSA) a Colombian corporation which was incorporated in March 1979. The shareholdings are: ECONIQUEL--45%; Billiton--35%; and CONICOL--20%. As discussed below (para. 9.15), financial covenants were agreed to ensure that CMSA maintains a sound financial structure.

C. The Sponsors and Shareholders

1. Empresa Colombiana de Niquel Ltda. (ECONIQUEL)

4.05 ECONIQUEL was established in 1970 as the vehicle for IFI's investment in the Cerro Matoso project. IFI is an agency of the Ministry of Economic Development which operates, under the authorization of Law 16 of 1973, to promote industrial development through public sector participation. At the end of 1977, IFI had equity investments totalling approximately Col\$2.6 billion (approximately US\$61 million) and loans outstanding of Col\$3.2 billion (US\$75 million). Amongst its investments in the mining sector are a 38.8% holding in CARBOCOL (para. 2.08) and a 37.5% holding in a soda ash plant. The Board of Directors of IFI includes representatives from the Ministry of Finance, the Central Bank, the Central Mortgage Bank and the Office of the President, as well as from the Ministry of Economic Development. IFI's authorized capital, at present, is Col\$5 billion (US\$118 million) and, if this is to be increased, approval must be forthcoming from the National Planning Office, the Ministry of Finance and the Economic and Social Council (CONPES).

4.06 Since ECONIQUEL is a subsidiary of IFI, the Chairman of its Board is IFI's Director-General. Also on the Board are the Minister of Mines and Energy and representatives of other Government agencies. ECONIQUEL receives its entire financing from IFI.

4.07 ECONIQUEL's Administration is headed by the Company's Director-General, who is appointed by the Board of Directors and is assisted by a 7-man Technical Committee. Although several positions on this Committee are presently unfilled, the quality of the personnel is high and it should serve effectively to liaise between the private sponsors and the Colombians during implementation and operations.

2. Compania de Niquel Colombiano S.A. (CONICOL)

4.08 CONICOL was established in 1970 as a Delaware-registered corporation. Originally, Chevron held 12-1/2% of its equity but, owing to dilution, this has now dropped to 3-1/2% and it is anticipated that Hanna, the only other shareholder, will eventually buy out the remainder. Although CONICOL's Bogota office is relatively small, the Company retains a full-time lawyer and includes shipping, importation and industrial relations departments which are headed by former civil servants who have ready access to senior Government officials and are well placed to expedite project implementation.

4.09 The Hanna Mining Co. is a publicly-owned, Cleveland-based mining and transportation Company, whose principal mining interests, given in Annex 4, include iron ore, coal and nickel in the US, Canada, Brazil and Guatemala. Selected recent financial indicators are shown below and illustrate that Hanna (like most other mining companies) has recently hit a depressed market. It should, however, be pointed out that Hanna's 1978 results were adversely affected by a 6-week shutdown at Riddle and by a strike which closed down the Iron Ore Company of Canada in early March. As is also evident, Hanna tends to be a financially prudent company, and its working capital and debt service ratios reflect this conservatism.

Hanna Mining Co: Recent Financial Indicators
(US\$ 000)

	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
Operating Revenues	204,790	272,227	331,644	363,535	331,042	327,469
Cost of Goods Sold	170,399	213,406	263,611	291,221	279,143	281,730
Net Income	22,524	16,745	47,096	53,119	45,458	25,554
Income Per Share (US\$)	2.25	1.90	5.33	6.00	5.13	2.88
Current Assets	n.a.	99,533	99,732	111,810	134,346	153,638
Current Liabilities	n.a.	47,993	48,888	58,670	67,544	66,564
Long-Term Debt	38,917	51,599	29,053	26,280	37,870	52,700
Total Equity	273,669	278,487	291,718	339,039	355,276	360,807
Current Ratio	n.a.	2.1:1	2.0:1	1.9:1	2.0:1	2.4:1
Debt:Equity Ratio	14:86	19:81	10:90	8:92	11:89	13:87
% of Net Sales from:						
Iron Ore	67%	67%	73%	76%	n.a.	n.a.
Ferronickel	19%	15%	13%	13%	n.a.	n.a.
Transportation	12%	13%	8%	6%	n.a.	n.a.
Other	2%	5%	6%	5%	n.a.	n.a.
Total	<u>100%</u>	<u>100%</u>	<u>100%</u>	<u>100%</u>	-	-

Source: Hanna Mining Co., Annual Reports.

3. Billiton Overseas Ltd. (Billiton)

4.10 Since 1970, Billiton has been a wholly-owned subsidiary of the Royal Dutch/Shell Group (Netherlands/UK) and, as such, does not publish separate financial reports. It is, essentially, Shell's metals and minerals division and is primarily involved in the marketing and production of tin, bauxite, lead and zinc, and the sales of tin, bauxite, alumina, zinc and copper. Recent indicative production and sales data are summarized below and illustrate the rapid growth that Billiton has undergone.

Billiton: Sales and Financial Data

	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
<u>Sales (000 MT)</u>					
Alumina	497	440	536	562	541
Bauxite	1,889	1,302	1,114	1,048	942
Copper	48	66	95	82	83
Lead	126	146	167	131	141
Tin	29	22	41	42	42
Zinc	137	145	199	136	121
<u>Financial Data (US\$ million)</u>					
Sales Proceeds	591.7	507.0	859.2	1,042.6	1,200.9
Capital Expenditures	22.0	23.0	22.0	35.0	55.9
Net Capital Employed	220.6	209.1	346.2	424.9	570.6

Source: "This is Billiton", September 1978, updated.

D. Financial Position

4.11 Selected financial indicators for the CONICOL/ECONIQUEL Joint Venture are shown below:

Cerro Matoso Joint Venture Balance Sheet
(US\$ 000)

	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u> (est.)
<u>Assets</u>					
Current	104	150	69	269	300
Fixed	13,934	17,149	19,663	21,659	24,688
Other	7	9	12	12	12
Total	<u>14,045</u>	<u>17,308</u>	<u>19,744</u>	<u>21,940</u>	<u>25,000</u>
<u>Liabilities</u>					
Current	39	229	197	230	200
Owner's Equity					
CONICOL	9,337	11,386	13,031	14,290	14,880
ECONIQUEL	4,669	5,693	6,516	7,420	9,920
Total	<u>14,045</u>	<u>17,308</u>	<u>19,744</u>	<u>21,940</u>	<u>25,000</u>

Source: Joint Venture, Auditors' Reports.

It has been agreed that the Joint Venture assets will be gradually transferred to CMSA, and that these sunk costs will not exceed US\$27 million.

E. Organization and Management of CMSA

4.12 The proposed Organization Chart for operations is given on the following page. Although this is still preliminary, the division of responsibilities is reasonable. The role of ECONIQUEL's Technical Committee will be of particular importance since it will: (i) act as technical and administrative supervisor; (ii) ensure the proper training of all Colombian personnel; (iii) ensure that the Colombians are supplied with complete technical and process information; and (iv) ensure that ECONIQUEL is adequately informed on all decisions contemplated or taken that affect the Project.

V. THE PROJECT

A. Scope

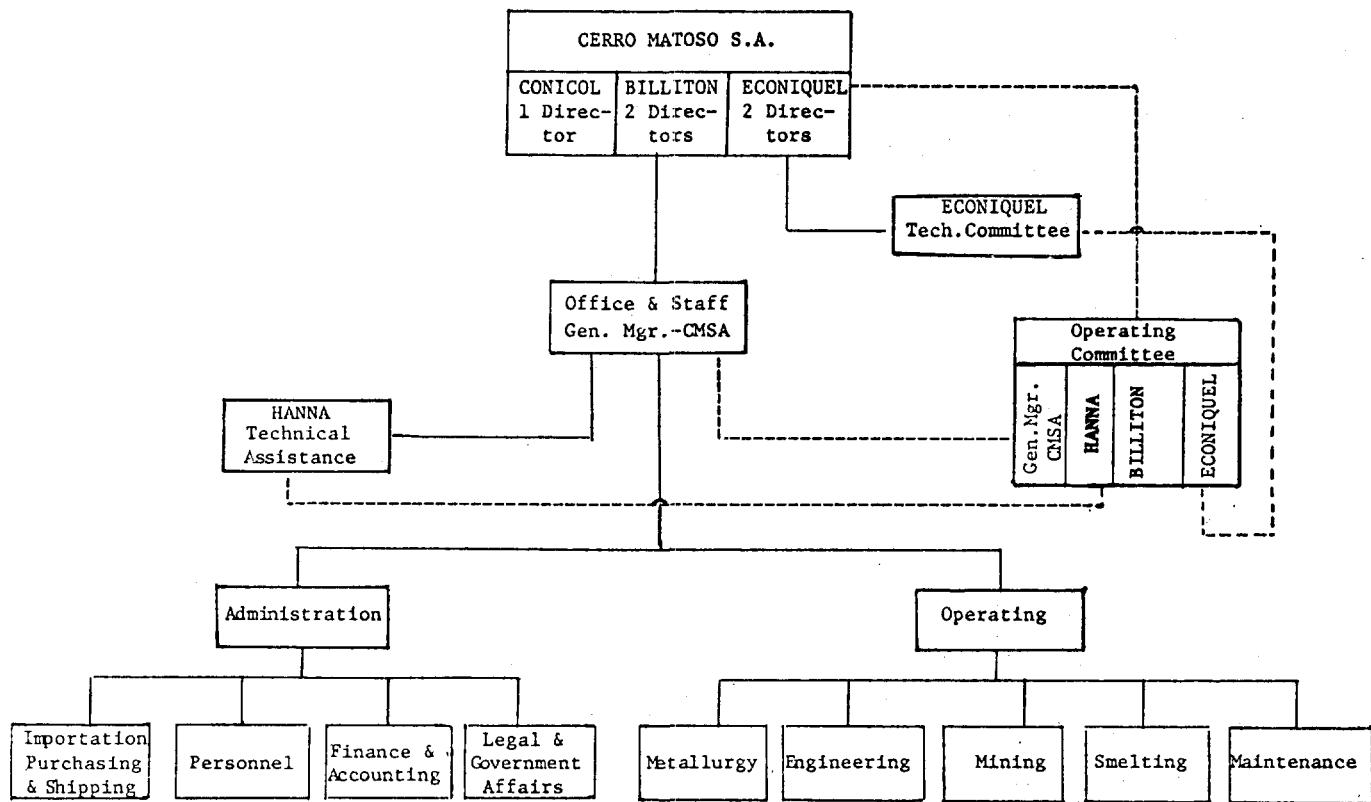
5.01 The Project consists of the development of an open pit mine to extract during a 25-years' concession an annual average of 780,000 dry metric tons (DMT) of lateritic ore containing an average of 2.7% nickel, which is to be processed into approximately 42.3 million lb (about 20,000 DMT) of nickel contained in ferronickel with an average grade of 37.5%. The single-line ore processing facilities will include: coarse crushing and ore stockpiling and blending facilities; drying, fine crushing and screening facilities with associated dry ore storage and conveyors; a coal handling and storage system; coal blending and facilities for the agglomeration of the ore-coal mixture; calcining in a rotary kiln; ore transfer and smelting in an electric arc furnace; slag handling and disposal; hot metal handling and refining; pig casting and shipping. Ancillary on-site facilities will include shops, warehouses, medical facilities, utilities, laboratories and offices. Related off-site facilities will include a townsite, river barge loading and unloading facilities, an access road, a natural gas pipeline and airstrip improvements.

B. Project Location

5.02 Cerro Matoso is located in northwestern Colombia in the Department of Cordoba, approximately 430 km south of the port of Cartagena (Map IBRD 12480). The maximum elevation of the orebody is 270 m above sea level although the gently rolling, surrounding terrain averages only about 60 m. The main land use in the area is low-density cattle grazing. The climate is tropical with an average annual rainfall of 190 cm.

5.03 The project site is connected by about 22 km of gravel road to the provincial town of Montelibano, with a population of about 10,000, where the future townsite will be located. Twelve kilometers of graded road connect Montelibano with the paved highway which leads south to the industrial center of Medellin (333 km) and north to the Atlantic ports of Cartagena and Barranquilla (538 km). Caucasia, approximately 30 km southeast of Montelibano, is located on the navigable Cauca river and offers a wharf site for the river barges which will bring in heavy equipment during implementation, and for shipping ferronickel out during operations.

CERRO MATOSO, S.A. - OPERATING ORGANIZATION



C. Project Description

1. The Orebody

(a) Geology

5.04 The ore body is a typical nickel laterite, similar to FALCONDO in the Dominican Republic, in which the nickel occurs in hydrous nickel-magnesium silicates. It was formed by the weathering and secondary enrichment of a peridotite plug. The peridotite body is about 2,500 x 1,700 m, bounded by steeply dipping faults. Most of it is capped by residual soil and decomposed and weathered ("saprolitized") rock which varies from zero to over 100 m in thickness. The lower part of this lateritic weathering zone constitutes the ore body. The end result of the weathering process by which the nickel was concentrated is a roughly layered deposit with a low nickel iron canga ^{1/} and lateritic soils overlying nickeliferous zones of partially weathered peridotite that, in turn, grades downward into the unaltered parent rock which forms the sterile footwall. Typically, the highest nickel values are found in partly weathered material overlying the parent rock.

5.05 The non-economic overburden consists of canga and laterite and the orebody itself of saprolite, saprolitized peridotite and silica boxwork. Saprolite is a partially weathered compact material which retains the texture and structure of the unweathered peridotite. About 75% of the proven reserves (Annex 5-1) consist of saprolite, averaging around 3.0% nickel, 10%-15% magnesia and around 15% iron. Saprolitized Peridotite is a soft, weathered material occurring along fractures and bordering joint blocks in the peridotite bedrock beneath the saprolite. In areas where the weathering and enrichment are sufficiently intense, ore grade material may result and roughly 15% of the proven ore reserve is classified as saprolitized peridotite. Silica Boxwork consists of massive banded veins of chalcedony and quartz occurring along minor joints and fractures in each of the major zones. Near the surface, most of this material is essentially barren but boxworks in the lower parts of the ore zone may carry appreciable amounts of nickel. About 10% of the proven reserves consists of boxwork ore of various types.

(b) Exploration

5.06 The various exploration programs carried out at Cerro Matoso can be divided into three phases: (i) From 1958 to 1962 fourteen test pits were sunk manually of which all but eight were too shallow to reach the nickeliferous saprolites. Thereafter, 66 holes were drilled on a 200 m grid system

1/ Canga: a hard ferruginous crust covering part of the orebody, consisting largely of lateritic soil cemented by hydrated iron oxides. Laterite: a soft earthy soil, generally found immediately under the canga. It typically contains less than 1.5% nickel, is leached of silica and represents the end-product of the normal weathering cycle. In a few areas, the lower part of the zone contains sufficient nickel to be included as ore. However, only about 2% of the proven reserves for the Project is derived from this zone.

and 4,500 lb of drill cuttings were sent to the Hanna laboratories for preliminary metallurgical testwork. This was followed in 1962 by a larger, 35 MT sample; (ii) In 1964, a second stage drill program was initiated with motor-assisted auger-chop drills. The program was designed to fill in the drilling grid to a 100 m spacing, to reach the bottom of the ore in the lower regions and to permit a preliminary estimate of ore reserves; (iii) From 1971 on, a diesel-powered Becker drill was designed specifically for Cerro Matoso. The drill began operating on a 100 m grid and covered the entire mining area. In addition, drilling sections 50 m apart were completed over an area containing sufficient reserves for the first 10 to 15 years of mining.

5.07 The initial drilling campaign yielded more than 1,500 drill samples. Since the start of the mechanized drilling program, an additional 31,000 samples were collected and processed. Prior to 1972, all samples were sent to Hanna laboratories, with 5%-10% being independently check-assayed. Currently, after the establishment of analytical facilities at Cerro Matoso, only one in thirty samples is checked by Hanna. A review of 225 check samples showed an accuracy of $\pm 0.05\%$ Ni, $\pm 1.5\%$ Fe, $\pm 0.47\%$ MgO and $\pm 1.51\%$ SiO₂.

5.08 In the opinion of Bank staff, the exploration program has been carried out in a competent and professional manner consistent with accepted practices commonly used for a deposit of this type.

(c) Ore Reserves

5.09 Total ore reserves were calculated in 1976. The ore reserve calculations were based on the standard "area of influence" method. This method gives good results on blanket-type deposits like Cerro Matoso, where the horizontal extension of the ore body is disproportionately much greater than the vertical dimension, and where the characteristics of a single sample interval cannot be projected for any great distance.

5.10 Because of the characteristic discontinuity of lateritic ore deposits, rigorous criteria were applied. The basic requirement was that at least 6 contiguous meters must assay more than 1.5% nickel to qualify for inclusion in the ore reserve. However, in order to obtain a minimum ore depth of 8 m, enough intervals of waste were included to make up for this depth. Isolated intrusions of material containing more than 1.5% nickel above or below the main ore zone were excluded from the reserve unless the intrusion would serve to increase the average grade of the waste layer to 1.5% or better. Internal waste intervals were included with ore zones unless they exceeded 10 m of thickness, in which event they were considered to be strippable.

5.11 Within the measured ore reserves, there is a higher grade central section. For estimation in this area a minimum vertical ore zone of 10 m was used and, as far as possible, only holes with a minimum of 10 contiguous meters of material assaying over 2% nickel were included. Mine planning has assumed that this area would be mined first, with mining subsequently expanding into progressively lower grades (para. 5.13).

5.12 The exact position of the top and bottom contacts of the ore zone can be expected to vary significantly over horizontal distances of 5 m or less. Although every effort will be made to establish the ore-waste contact during actual mining, it will obviously not be possible to avoid mining some waste with the ore and vice versa. It has been assumed that, for every m^2 of ore block in the hangingwall and footwall, 2.9 m^3 and 1.9 m^3 , respectively, are dilution. The chosen mining method is flexible enough to follow the contacts closely and to be able to separate waste and ore effectively. The assumed dilution factor, therefore, is to be considered conservative.

5.13 Application of the above criteria to the drilling data resulted in identification of three stages of reserves, to be exploited sequentially, which form the mineable reserves for the project as shown below:

Cerro Matoso: Summary of Ore Reserves and Contained Nickel

<u>Stage</u>	<u>Ore Reserves</u> (MT)	<u>Average Grade</u> (% Ni)	<u>Contained Ni</u> (MT)
<u>Stage I:</u>			
Sufficient for 9 years, (min. 10 contiguous meters over 2.0% Ni):	7,060,400	3.20	225,932
<u>Stage II:</u>			
Sufficient for 7 years (min. 8 contig. meters over 1.5% Ni):	5,252,400	2.72	142,865
<u>Stage III:</u>			
Sufficient for 14 years (min. 8 contig. meters over 1.5% Ni)	<u>12,655,100</u>	<u>2.22</u>	<u>280,943</u>
Total	<u>24,967,900</u>	<u>2.60</u>	<u>649,740</u>

5.14 In addition to these reserves, 41 million MT of ore between 1.0% and 1.5% nickel grade have been outlined in an area immediately adjacent to the orebody.

5.15 It is the opinion of the staff that the ore reserve calculations are based on sufficient and accurate data and have been carried out with due care in a competent and professional manner. The orebody has been explored in greater detail than usual and very stringent criteria have been applied. As indicated below, apart from some continuing operations in New Caledonia, this is the highest grade nickel laterite deposit presently known in the world:

Comparison of Ore Reserves

	Ore Reserve (Million MT)	Average Grade (% Ni)	Contained Ni (Million MT)	Final Product
<u>On Stream</u>				
EXMIBAL (Guatemala)	68	1.7	1.16	Matte
FALCONDO (Dominican Republic)	62	1.6	0.99	Ferronickel
Marinduque (Philippines)	77	1.2	0.92	Class I
<u>Planned</u>				
Cerro Matoso (Colombia)	25	2.6	0.65	Ferronickel
Gag Island (Indonesia)	104	1.6	1.66	Class I
BAMINCO (Brazil)	67	1.8	1.21	Ferronickel
AMAX/BRGM (New Caledonia)	50	2.5	1.25	Matte

2. The Mine

(a) Mining and Stripping

5.16 Since most of the Cerro Matoso ore occurs as a relatively shallow hillside deposit, the ore body is ideally suited for conventional, open-pit mining and the stripping ratio for the first 25 years is only approximately 1.3:1. The ore block to be mined during Stage I has been chosen to fit rationally into the overall mining plan and its initial exploitation will not prejudice development of Stages II and III later. The operating cost estimates assume that only 25% of total material will require light blasting whereas the remainder can be loaded directly by the shovels. As mine development proceeds, two distinct material types will be separately stockpiled. The iron-bearing canga will be moved to one stockpile, while footwall rock and lean laterite with nickel values between 1.0% and 1.5% will be placed in another stockpile for possible future use. Other stripped material will be placed in waste dumps. The mine development and production plan (Annex 5-2) calls for the stripping of about 4.6 million WMT before the start of operations. Pre-production stripping will begin two years before start-up on a single shift basis and will intensify during the last year. After production commences, stripping will be carried out on two shifts, six days per week.

5.17 The Cerro Matoso ore body displays a characteristic lack of mineralogical uniformity. To obtain optimum metallurgical results, it is important to maintain the most consistent feed possible. This dictates mining and blending of ore from several working areas. Three 7 m working benches are, therefore, planned to allow for selective mining. The mobile mining equipment chosen will allow for ample flexibility and mine planning will make available at all times approximately four times more exposed working face area than that required. Mining will be carried out on the first shift, 6 days per week, 300 shifts per year, utilizing the same six 31.8 MT trucks as in stripping. Excavation will be by hydraulic front shovels, one on each of the three benches. Combined production capacity of the three shovels will exceed the nominal one million WMT per year feed rate required.

5.18 The equipment selected is conservatively sized and can easily handle the material. Equipment cycles were based on a 6-hour effective shift which, in itself, provides a reasonable safety factor.

5.19 The mining method and equipment chosen are influenced by the need for mobility to maintain mining flexibility. The mining plan is therefore based on hydraulic excavators, end dumping trucks, mobile drilling equipment and dozers and provides a high degree of flexibility to cope with unforeseen operational difficulties.

(b) Ore Stockpiling and Blending

5.20 Quality control is essential in this type of process where the smelting characteristics of the slag, rather than the nickel content, govern efficiency. This in turn is governed by the magnesia:silica:iron ratios of the ore. Even a small range of variation can produce either a viscous slag with associated metallic nickel losses or an excessively fluid slag which causes erosion of the refractories in the electric furnace.

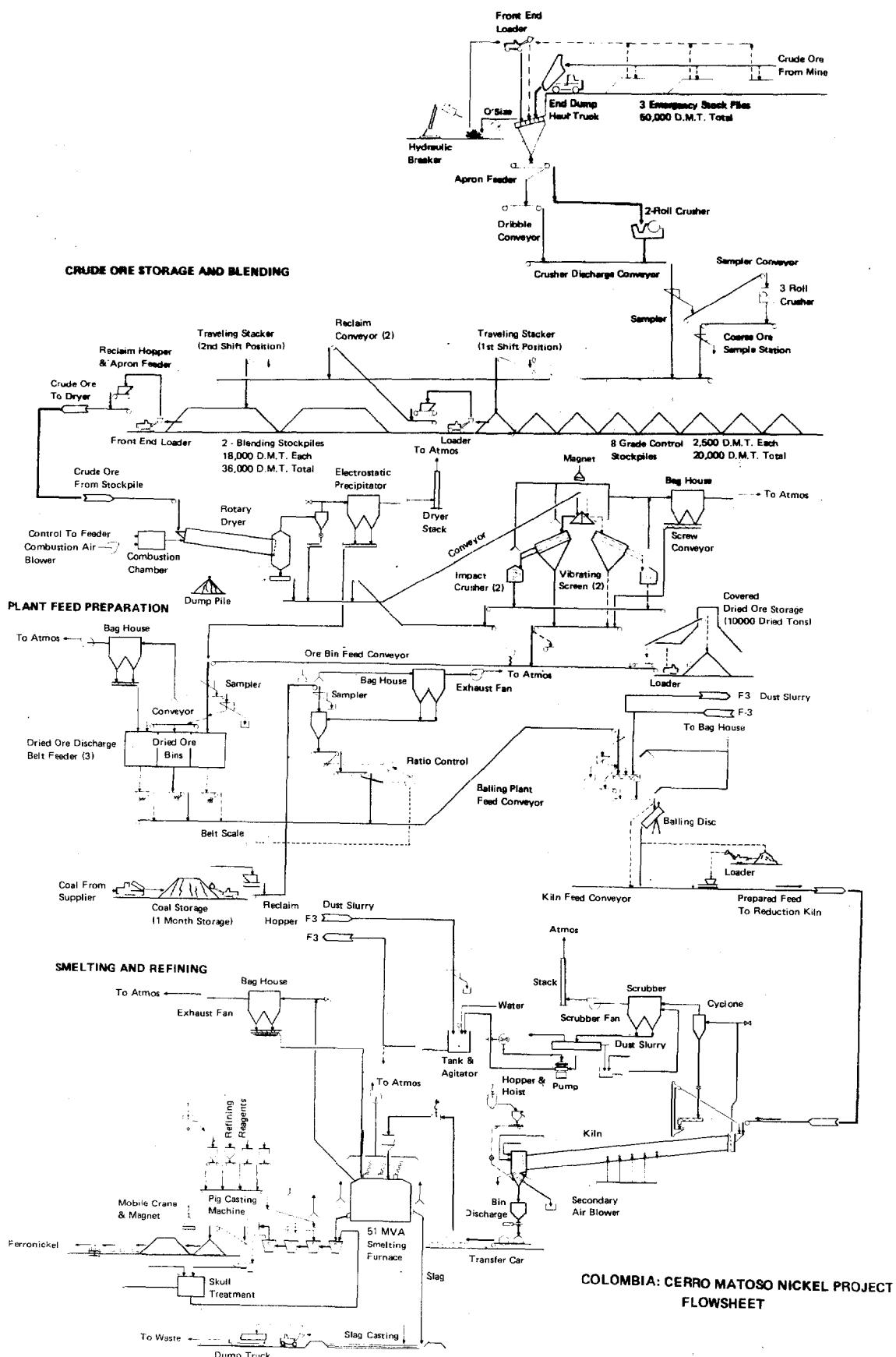
5.21 In order to optimize the composition of the smelter feed, a comprehensive quality control program has been designed including: (i) an emergency stockpile prior to the primary crusher; (ii) a mechanical sampling station between the crusher and stacker; (iii) eight stockpiles, each of which is capable of handling one full day's production and which are available for blending; and (iv) two blended stockpiles selected from the eight, each containing one week's ore supply to the processing plant. These are indicated in the flow sheet on the following page. The quality control procedures envisaged are based on sound assumptions and backed by statistical simulations which show that a standard plant feed can indeed be achieved with a high degree of probability. The approach can be regarded as conservative and is highly satisfactory.

3. The Process

(a) Pilot Plant Testing

5.22 Between 1971 and 1976 there were 3 phases of pilot plant testing: (i) 1971-72: A pilot plant, based on a Shaft Furnace/Electric Furnace (SF/EF) configuration, was built at Riddle, Oregon, and tests were carried out which showed that the Cerro Matoso ore could be converted, using this process, into a high-grade ferronickel; (ii) 1972-73: Small-scale tests were carried out in Norway by Elkem Spigerverket A/S, which verified that an alternative Rotary Kiln/Electric Furnace (RK/EF) plant configuration could also produce high-grade ferronickel and do so at a lower cost; and (iii) 1975-76: A 2.5 ton per hour RK/EF pilot plant was built at Riddle to verify the results of the Norwegian tests.

5.23 The RK/EF process produces ferronickel by selective reduction using coal as reductant. This is accomplished by drying run-of mine ore and by fine crushing and carefully proportioning and mixing the coal and ore. The mixture is agglomerated, dried and calcined in the rotary kiln, and then smelted in the electric furnace to produce ferronickel and slag. The ferronickel is



further refined to lower sulphur and phosphorus levels. The advantage of the RK/EF process is that it allows controlled reduction, which limits the amount of iron in the metal. Although the RK/EF combination is new in lateritic nickel smelting, the characteristics of the individual units are well-known and have been established individually in existing nickel matte operations.

5.24 Determination of the amount of nickel lost in the slag was among the most important metallurgical information obtained from the pilot tests. Based on losses in the slag and elsewhere, total recovery of nickel from the ore is estimated to be 92.3% in Stage I, 91.2% in Stage II, and 89.0% in Stage III.

5.25 The Riddle tests also provided data for the design criteria used in the feasibility study. A total of 4,215 DMT of Riddle ore and 3,400 DMT of Cerro Matoso ore were treated at Riddle, the former being used for "running-in" the plant and to simulate specific silica:magnesia ratios which were expected during the operating life of the mine.

5.26 The final phase of the Riddle tests was witnessed by Bank staff and it is the staff's opinion that the tests were carried out in an exhaustive and thorough manner. The behavior of Cerro Matoso ore actually expected during the various stages of mining must now be considered well known.

(b) Design Criteria

5.27 The pilot tests demonstrated that the RK/EF process can produce high-grade ferronickel using Cerro Matoso ores of widely varying compositions with equipment long established in the production of ferronickel and matte, thereby offering the advantage of minimizing the risk when scaling up to commercial size. A single-line plant was chosen in view of an estimated 30% reduction in total capital cost as compared to a dual-line plant.

5.28 The actual design calculations for the rotary kiln were done independently by a consultant retained by Hanna and by F.L. Smidth (Denmark), a major manufacturer of rotary kilns. Both arrived at almost identical parameters. Final size selection of 6.1 m x 185 m was arrived at after it was decided to lower the calcine discharge temperature from 900°C to 750°C-800°C in order to prevent the possibility of material build-up at the discharge end. This necessitated the lengthening of the final reduction zone. The kiln size was based on a smoothly lined kiln with no lifters 1/ or other internals. Though their addition would have considerably reduced size and cost, it was thought imprudent to risk the operating problems and increased maintenance experienced by EXMIBAL and P.T. International due to lifter failure. The technology of large kilns is well understood and, although the Cerro Matoso kiln will be the largest for a nickel laterite application, it is not expected that its sheer size will cause significant problems during startup and operation.

1/ Internal "scoops" to increase effective kiln area.

5.29 The hot ore transfer system will be designed to minimize reoxidation and temperature loss by the calcine from the time the ore leaves the kiln until it enters the furnace. In the pilot plant, 300°C-350°C were lost in this process. In similar commercial plants the temperature drop is only 50°C to 100°C, and calculations for commercial operations have been made on this basis. The greater loss in the pilot tests can be explained by the smaller quantities involved in each transfer and the method of distributing feed into the pilot furnace.

5.30 Smelting in the electric furnace completes the removal of chemically bound water and the reduction and melting of the feed material. Correctly estimating the amount of heat required was an important element in predicting the throughput of the commercial furnace and it is now estimated that power consumption and thermal conditions for the commercial furnace will be as shown below. On the basis of these requirements, it was determined that a 51 MVA electrode furnace would be required.

Anticipated Thermal Conditions for the Electric Furnace

	Average Power (kWh/MT Ore)	Feed Temp. (C°)	Feed LOI (%)	Slag Temp. (C°)
Stage I	520	700	0.5	1,620
Stage II	480	650	1.0	1,520
Stage III	470	650	1.0	1,500

5.31 As indicated in the following table, comparably sized electric furnaces are either being designed for nickel operations or have already come on stream, and two much larger 84 MVA units are now being built by Demag (FR Germany) for Yugoslavia:

Sizes of Electric Smelting Furnaces for Nickel Operations:

Location	MVA Capacity	Status
Cerro Matoso	51	Proposed
Guatemala	45	Operating
Indonesia	45	Operating
New Caledonia	47.5	Operating
Dominican Republic	40	Operating
Japan	60	Designed
Yugoslavia	84	Under Construction

5.32 Neither Elkem nor Demag, the only designers experienced in electric smelting furnaces of comparable size, foresee any particular design problems and independently came up with similar specifications. Since all design parameters were obtained from an extensive pilot plant campaign on Cerro Matoso ore, and based on an extensive review of the available data, it is the opinion of the staff that the process is appropriate and that no major problems should be anticipated during construction or operations.

(c) The Plant

5.33 Since ferronickel smelting is a continuous operation, all process facilities will operate three shifts a day, seven days a week. The various operating steps, which consist essentially of: (i) the drying of the crude ore; (ii) secondary crushing and screening; (iii) fine ore and coal preparation; (iv) calcination; and (v) smelting and refining, are described in some detail in Annex 5-3.

5.34 In the opinion of the staff, the proposed process and facilities are satisfactory. The flowsheet has been designed with as much flexibility as feasible, and the disadvantages of a single-line process have been minimized by inclusion of stockpiles and by independent double-line fine crushing and screening facilities.

4. Ecological Aspects

5.35 Although the Government has issued general anti-pollution guidelines, INDERENA (Instituto Nacional de Recursos Naturales), the Government agency in charge of enforcement, has not as yet prepared specific and legally binding legislation. As a result, the project sponsors have decided to build the plant so as to comply with the US (NIOSH) rules which currently govern Hanna's Riddle operation.

5.36 The RK/EF process will generate the following waste products and effluents: (i) slag, from the smelter; (ii) dust, generated in the dryer and kiln, secondary crushers, screens and on conveyor transfer and discharge points; (iii) stack gases, containing gaseous pollutants such as sulphur dioxide and carbon monoxide; and (iv) process water and sewage.

5.37 Molten slag will be run into casting pits, cooled, broken up and disposed of in outlying slag dumps. The slags are chemically stable and no degradation is expected. Dust will be collected at its source throughout the plant, as described in Annex 5-3. Fugitive dust in the mine will be controlled by water sprinkling trucks. The main sources of gaseous emissions will be the 30 m dryer stack, the 50 m kiln stack and the electric furnace stack. Since the ore is a silicate, no sulphur emissions will originate from the processed material. Since natural gas will be used for the drying and calcining processes, the only sulphur source will be the coal used as reductant. Some of the SO₂ from this source will be emitted to the atmosphere, although most of the sulphur will be eliminated with the refining slag. It is therefore anticipated that ground-level concentrations of SO₂ will be low enough fully to meet reasonable pollution standards. Carbon monoxide, which is generated in the electric furnace, will not be discharged to the atmosphere but will either be flashed under the furnace hood by introducing measured volumes of fresh air or flared at the stack by means of a pilot burner.

5.38 It has been agreed that CMSA will take all necessary measures to ensure that the Project is carried out and operated with due regard to ecological and environmental factors, including reclamation of exhausted mining areas and waste dumps.

5. Employment and Training

5.39 During operations, the mine and smelter will employ 716 staff, of which 497 are expected to be paid hourly wages and 219 to be salaried. During the first years of production, some of the senior technical and administrative positions will be filled by experienced expatriates. Among their responsibilities will be the training of Colombian counterparts to be recruited throughout the country. Since Montelibano, the provincial town 22 km away, can provide only a small percentage of the required labor force, it is anticipated that most hourly-paid labor will come from the industrial centers of Medellin and Cartagena. The table below gives a detailed breakdown of the anticipated manpower requirements.

Cerro Matoso: Operating Personnel Requirements

	Normal Operating	Vacation		<u>Total</u>
		<u>7th Day</u>	<u>Relief</u>	
Mine				
Mining and Stripping	57	-	2	59
Plant				
Crushing, Screening and Stockpiling	11		2	13
Reclaiming, Drying and Crushing	18	4	6	28
Coal, Mixing and Balling	13	3	6	22
Rotary Kiln	9	2		11
Smelting Furnace	42	9	6	57
Casting, Refining and Packaging	34	7	6	47
Skull Plant	2	-	-	2
Slag Removal	6	-	-	6
	<u>135</u>	<u>25</u>	<u>26</u>	<u>186</u>
		-		
Maintenance	208		20	228
Overhead and Administration	34	8	137	179
Townsite	30	-	1	31
Bogota Office	-	-	29	29
Management and Administration	-	-	4	4
Total	<u><u>464</u></u>	<u><u>33</u></u>	<u><u>219</u></u>	<u><u>716</u></u>

(a) Project-Sponsored Training Program

5.40 With the assistance of Hanna and SENA, CM&A will carry out a comprehensive training program covering foremen, operating labor and maintenance personnel. Adequate funds have been included in the project cost estimates to cover these requirements, and a detailed training schedule has been submitted to the Bank.

5.41 The most immediately critical needs are probably the mine foremen and operators who will have to be recruited early, in preparation for the 2-year program of preproduction stripping. Mine equipment operators will also have to receive approximately 6 months' training prior to the start of stripping. Out of the 471 plant operators, who will include approximately

48 foremen, it is estimated that about 350 will require some kind of training and that, of these, 30 will be employed in the mine, 160 in production and the remaining 160 in the maintenance department. Those who are to be trained for production will be enrolled in full-time classes 6 months prior to the start of operations. Also, for 6 months prior to the start of this program, 24 key operators and foremen will have been undergoing extensive training at Hanna's Riddle plant. The 160 maintenance tradesmen will receive courses specifically oriented to the plant's maintenance requirements. Although these courses will be under the direction of CMSA, they will be administered in close cooperation with the Government's vocational training agency, SENA. It is expected that 60 key skilled artisans will attend both a 4-month basic course and a 12-month advanced course. The remainder will attend only the 4-month course. It is expected that these training requirements will be met approximately according to the schedule indicated in Annex 5-4.

(b) SENA Training Programs

5.42 SENA, which was established by Decree 118 in 1957, is an autonomous public agency, administered by a National Council, and financed by a 2% pay-roll tax levied on all commercial and industrial enterprises, which has established a series of regional training centers throughout Colombia. In the industrial sector, it has training centers in Bogota, Barranquilla, Cali, Medellin and Sogamoso (in Boyaca), where the national mining center has recently been established.

5.43 Notwithstanding its impressive credentials and liberal funding, SENA will not be in a position to supply or to train artisans specifically for Cerro Matoso. It will, however, cooperate in setting up on-the-job training in conjunction with its normal courses.

5.44 SENA is now beginning to develop a comprehensive training program for mine-related skills, which will relate to the whole of the mining sector. This is being prepared specifically at the request of INTERCOR, the EXXON subsidiary which is involved in the Cerrejon coal project. The initial phase will be primarily concerned with mine and plant maintenance. Subsequently, it will be expanded to cover operations, and SENA currently has instructors under training as mine machine operators in Canada.

VI. INFRASTRUCTURE

A. General

6.01 Cerro Matoso is located comparatively close to an existing township and transport system and other facilities. Overall infrastructure requirements are therefore a great deal lighter than for most other greenfield nickel projects. However, as in other nickel laterite projects, the smelting and refining process is highly energy-intensive. Total energy consumption, as shown in Annex 6-1, is expected to be about 19.08 kWh per lb of nickel, which is in line with the energy consumption of Societe le Nickel's New Caledonia ferronickel operations, though approximately twice the average

consumption in sulphide operations. As a result, availability of reasonably priced electric power, natural gas and coal is critical.

B. Electric Power

6.02 Anticipated annual consumption during normal operations, detailed in Annex 6-2, is estimated at about 542 GWh, with an anticipated maximum demand of 73 MVA, of which the electric smelting furnace alone will consume 72%, or 390 GWh.

1. Power Supply 1/

6.03 The share of electricity in overall energy consumption in Colombia has grown from 19% in 1960 to 24% in 1975 as isolated facilities have gradually been interconnected and low-cost hydro-resources developed. Public electricity service, which supplies 93% of all electricity, is presently provided by municipally owned companies and national enterprises, as well as by a large number of their local subsidiaries.

6.04 The two companies that are involved with the Cerro Matoso Project are: (i) Interconexion Electrica S.A. (ISA) which was established to interconnect the systems of its major shareholder utilities, thus creating a national grid capable of sustaining large hydroelectric projects. ISA is soon to become the country's largest electricity enterprise and, by 1984 (upon completion of the San Carlos II hydropower station), it will own 36% of the country's generating capacity; and (ii) Corporacion Electrica de la Costa Atlantica (CORELCA), a public corporation, which is a shareholder in ISA, with jurisdiction in seven Departments including Cordoba, in which Cerro Matoso is located. Presently installed and future capacities for the two companies are summarized below:

Installed and Future Power Generating Capacity of ISA and CORELCA
(GWh)

	<u>1978</u>	<u>1984</u>	<u>Proportion of 1984 Total Installed Capacity</u>
ISA	460	2,530	36%
CORELCA	582	714	10%

6.05 Cerro Matoso's smelter will be supplied through CORELCA, from a new ISA interconnection (connecting the largely hydro-based Central system with the predominantly thermal Atlantic Coast system), since the selected right-of-way would pass reasonably close to Cerro Matoso (IBRD Map 12480). The ISA interconnection consists of a single circuit 500 kV transmission line, with a total length of 523 km, from the San Carlos substation in the Central region to Sabanalarga in the North. The southern section of the line, between San Carlos and Cerro Matoso, will be 210 km long. The system will incorporate two 500/230/34.5 kV terminal substations, each with an initial capacity of 450

1/ For a detailed view of the sector, see also Bank Staff Appraisal Report No. 1850-CO on the San Carlos I Hydro Power and 500-kV Inter-Connected Projects, dated December 30, 1977.

MVA; two intermediate 500/115/34.5 kV substations, one at Cerro Matoso, each with an individual capacity of 150 MVA; and a shunt compensation system with a capacity of 600 MVA reactive. The intermediate substation at Cerro Matoso will be located approximately 8 km east of the site. CORELCA will undertake to build a short 110 kV line to the plant line substation and CORELCA's local subsidiary, ELECTRICORDOBA, will build a 34.5 kV line, approximately 20 km long, into the town of Montelibano.

6.06 Close coordination of the construction schedules for the interconnection and Cerro Matoso will be required (Annex 6-3). Bids for the line construction (which is to be financed through another Bank Project 1/) were opened in April 1978 and ground was broken by January 1979. The line is now expected to be completed by April 1981. ISA received tenders for the substations (which are to be financed by Kreditanstalt fur Wiederaufbau of the Federal Republic of Germany) in June 1978. However, the bids received were declared unresponsive in February 1979 and a redevelopment of tenders will take place during the third quarter of 1979. Although the transformers and reactors are on order, it is not envisaged that construction on the substations will start before May 1980 and completion is not expected before May 1982.

6.07 The envisaged construction time for Cerro Matoso is 34 months, but power for furnace testing will be required 3 to 4 months before start up. If CMSA breaks ground in the third quarter of 1979, power will have to be available at the site between January and February 1982, or before the completion date of the substations. The Government is well aware of this and is considering either the installation of a gas turbine or the energization of the completed interconnection line at 230 kV at San Carlos as suitable interim solutions. It has been agreed that the Government will take all actions required to ensure a timely supply of electricity to the project and will make interim arrangements satisfactory to the Bank (para. 11.01).

2. Power Tariffs

6.08 Generally low rates have caused the Colombian power sector to experience financial difficulties in the past. The Bank and the Colombian Government have, therefore, agreed that, under the terms of the loans to the San Carlos and Interconnection projects, ISA will be required to earn a rate of return on total revalued assets of not less than 5.5% in 1978, 8% in 1979 and 9% thereafter. It was also agreed that CORELCA's return should not be less than 5% in 1978, 5% in 1979 and 1980, 6% in 1982 and 9% thereafter.

6.09 CORELCA and CMSA have substantially negotiated a contract including a tariff formula that would be applied in 1982 when the Project starts production. These tariffs, which are a critical cost item for the Project, depend basically on the proportion of hydro and thermopower fed into the system. 2/ An average tariff of US\$0.03 per kWh (in 1979 terms) has been used in the calculation of the power costs.

1/ The loans for the San Carlos Hydro (Loan No. 1582-CO, US\$126 million) and the Interconnection Project (Loan No. 1583-CO, US\$50 million) were signed in mid-July 1978.

2/ Depending on the hydrological conditions in the Central Region, and the incremental spinning thermal reserve capacity to be maintained by CORELCA for security of supply.

6.10 Since the power tariff is important to the financial viability of the Project and since the Bank has already obtained agreements on the tariff structure of the power sector, the signing of such a contract, on terms satisfactory to the Bank, will be a condition of effectiveness. Furthermore, it will be ensured that the contract for Cerro Matoso should be consistent with CORELCA obligations under the terms of the Bank loan for the San Carlos and Interconnection projects.

C. Fuel

6.11 The second largest operating cost component is the fuel used in drying and calcining. Either fuel oil or natural gas can be used although, in the longer term, the possibility of converting to coal may exist. Fuel requirements are detailed in Annex 6-4.

6.12 Based on economic evaluations the sponsors have now decided to use natural gas as fuel. A draft contract between CMSA and ECOPETROL assures that a timely gas supply will be available. The signing of such a contract will be a condition of loan effectiveness.

1. Availability and Cost of Natural Gas

6.13 Ninety percent of Colombia's gas reserves are located on the Atlantic Coast and are, therefore, potential sources of supply to Cerro Matoso. The major gas fields are the Guajira field, with a production capacity of 450 million ft³/day and the Jobo Tablones and Chinu fields, which together have a capacity of 38 million ft³/day. At these production capacities, the reserve life of the Guajira and Jobo Tablones/Chinu fields would be about 21 and 6 years, respectively. In August 1977, a potentially large gas deposit was discovered off the coast of Cartagena, at Galerazamba. Additional wells were drilled in late 1978 in order to define the reserves further, and exploration is also going on in other potentially productive areas (Map IBRD 12480).

6.14 All developed gas fields are interconnected by pipelines which transport the gas to the major centers of consumption on the Atlantic coast. A prefeasibility study by PROTEXA, a Mexican consortium, for a gas pipeline from the Atlantic Coast to Medellin (and later to Cali and Bogota) is presently under review by ALCANOS (a Colombian gas transportation company) and ECOPETROL. In its first phase, this line would reach Medellin with a nominal capacity of 198 million ft³/day. The gas for this line would presumably have to come from Jobo Tablones and Galerazamba. An investment of approximately US\$300 million is envisaged.

6.15 ECOPETROL has confirmed its willingness to supply Cerro Matoso with 7 to 10 million ft³/day. This gas will reach the nickel smelter by a 90 km pipeline from the Jobo Tablones field, which will be built and financed by Cerro Matoso.

6.16 The 1978 natural gas price of Col\$38.00 (US\$0.90) per 1,000 ft³ is a promotional price to give an incentive to switch from oil to gas. Government policy is to equalize the consumer price with the actual production and distribution costs in the short term, thereby reducing the present price differential per thermal unit as compared to fuel oil. In the longer term, however, it is envisaged that the wellhead price of US\$0.82 per thousand ft³ of gas will be escalated in accordance with the anticipated price increase of fuel oil. For this report, it has therefore been assumed that the cost of gas per thermal unit will be equal to or slightly lower than that of the world market price of fuel oil ^{1/}, or approximately US\$2.27 per thousand ft³.

2. Availability and Cost of Coal

6.17 Based on the pilot plant results, where a highly volatile coal was successfully tested as a reductant, anticipated consumption will be about 100 MT per day and a stockpile sufficient for approximately one month's consumption will be maintained at the smelter. The coal fields at Amaga, which supplied the test coal, are located approximately 40 km from Medellin (and about 370 km from Cerro Matoso) and are operated by a number of small companies. Since the coal required by Cerro Matoso is the fine fraction of mine production, for which there is no ready local market, no supply problems are anticipated. There is also a price advantage for fine coal, which sold, during 1978, for Col\$350/MT (US\$8.25) as compared to Col\$740 (US\$17.45) for lump coal. Including freight, the cost of coal at Cerro Matoso will be about US\$26/MT. Since no supply problems are anticipated, contracts can be negotiated during the plant's construction. One mine with whom tentative discussions were held is Carbonera San Fernando, which has sufficient uncommitted capacity to supply Cerro Matoso.

6.18 If Cerro Matoso is to convert from natural gas to coal as a fuel in the future, it would need approximately 120,000 MT per annum, in addition to the 30,000 MT required for reductant. No experience is available on the performance of the rotary kiln when fired with coal. For this reason, extensive pilot plant tests would be necessary before a decision on a conversion could be made.

D. On-Site Infrastructure

1. Temporary Facilities

6.19 The temporary plant construction camp will be erected adjacent to the plant site along the main access road from Montelibano. During initial construction, only skilled and experienced workers will be used. These workers are not available in Montelibano and therefore tent or trailer camps and pre-fabricated portable facilities will be provided. Accommodation for the construction labor force will consist of 3 separate camp units, each comprising four 100-men modules, supported by a centralized food service and recreation facility. There will also be outdoor recreation facilities and a packaged medical unit which may be moved to the townsite after construction and converted to a permanent facility. The campsite near Montelibano will have the same services on a reduced scale.

^{1/} Recent price increases in June 1979 were not included. It is, however, not clear whether the Colombian Government will reflect this increase in its gas pricing policy.

2. Construction Facilities

6.20 Buildings required during construction will be detail-engineered in Colombia. Aggregate for concrete is found in the nearby Ure River, and a crushing, screening and washing plant will be located adjacent to the plant site. Sand is available in several locations along the San Jorge River. A concrete batch plant, rated at 100 cubic yards per hour, will meet peak requirements for concrete output, and will be located near the plant site. Cement will be supplied in bulk from the Tolcementos plant, some 160 km distant. A concrete block plant, with a capacity of 1,000 blocks per hour, will also be installed near the townsite.

6.21 As noted above, permanent power is not expected to be available until the final phases of construction. As a result, initial generators will be sized to meet peak construction requirements. At the townsite, three 250 kW generators will be installed and at the plant, six 750 kW units will be required, two of which will become part of the permanent plant emergency power system.

3. Utilities

(a) Electric Power

6.22 Electric power will be supplied by CORELCA. At the plant's main substation, it will be stepped down to 34.5 kV, at which voltage it will be used to supply the high tension side of the electric furnace transformers. Two additional power transformers will reduce the voltage further to 4.16 kV for distribution in the plant.

(b) Natural Gas

6.23 Natural gas will be supplied to the plant by a proprietary line from the Jobo Tablones gas field (para. 6.15). A pressure reducing station will be provided. In case of supply failure, the plant can be fueled with diesel oil from tanks which have sufficient capacity to maintain operations for four days. This is considered a sufficient security margin.

4. Civil Works Design

6.24 The 55 hectare plant site will be rough graded and provided with a drainage system. Soils are sedimentary, generally clay, and allowable earth pressure for spread footings will be 2 kg/cm^2 . For heavy foundations, piles will be used. About 10 hectares will be gravel surfaced for in-plant roads, parking areas, coal and ore stockpiles. The perimeter will be fenced and guardhouses will be installed at all gates.

6.25 An independent engineering consultant was retained by the Bank in September 1976 to review the civil engineering and infrastructure design. His conclusions were that: (i) the proposed facilities accord with sound construction and engineering practices; (ii) estimates of quantities have been based on reliable data and all relevant factors have been taken into account; (iii) the construction schedule is reasonable; and (iv) due consideration has been given to the impact of the Project on the community.

E. Offsite Infrastructure

1. Townsite

6.26 In line with Government policy, it was decided to locate the new 225 hectare townsite at Montelibano, regardless of any possible advantages of a location closer to the plant. A master plan has been developed by HABITAR, a local planning group, and townsite engineering has been assigned to INTEGRAL, ^{1/} under the overall supervision of Bechtel.

6.27 Housing for salaried employees will be on a subsidized rental basis and family units will be built as part of the Project. Total salaried staff on site will be around 186, and it is assumed that the balance will be single, who will be housed in single staff houses or bachelor apartments.

6.28 The hourly-rated labor force will be approximately 500 persons and, of these, 150 to 200 men will either be accommodated in single employee quarters, or come from and prefer to live in the old town of Montelibano. Therefore, 300 to 350 housing units will be required to accommodate the balance and a standard house plan has been developed with flexibility to provide for different size families. In order to encourage stability, it is considered desirable that hourly-rated employees be homeowners. The Project will, therefore, only provide site and services for hourly-paid workers, and the employee will be expected to purchase his house himself. Financing would be provided partially by the borrower and partially through INSREDIAL, a Government agency which authorizes housing loans, or other financing agencies. No firm agreements have yet been reached on this, but the Government has stated that this plan satisfies the conditions for employee housing as included in the Concession Contract.

2. Transport

6.29 During construction, about 80,000 MT of freight are expected to be transported from the port of Cartagena, mostly by river but also over the road to the plant site. At normal operations, approximately 50-53,000 MT per annum of ferronickel will be barged down river or trucked to Cartagena for export. The mine will have its own trucks, to transport the ferronickel to the river port at Caucasia but the barges will operate under contract, as will other overland freight trucked into Cerro Matoso.

(a) Roads

6.30 Existing access roads are inadequate and must be upgraded and/or realigned. The first 12 km segment, from the main highway to Montelibano, will mainly follow the route of the existing road, but its sub-surface will be improved and it will be graded and gravelled. Three new bridges have already been constructed. A new alignment is, however, required for the 22 km section from Montelibano to Cerro Matoso. There are weight and size limitations on

^{1/} INTEGRAL is a Medellin-based consulting group which has worked extensively with the Bank in the power sector.

the main North-South highway to Cartagena which limit the maximum weight on the road to 45 MT and the maximum size to 5.6 m width and 4.5 m height. Over-size equipment for the smelter during construction would, therefore, have to come by river barge.

(b) River Traffic

6.31 Loading and unloading facilities will be constructed at Caucasia, on the Cauca River. The selected site, which is 53 km from the plant, is on relatively stable hardpan ground but will require limited dredging and sheet piling for bank stabilization. The river route to Cartagena is 517 km, via the Cauca, the Magdalena and the Canal del Dique, and turn-around time for river barge convoys is 13 days. The Project does not expect to encounter any difficulties when negotiating freight contracts for river transport.

(c) Port of Cartagena

6.32 The port of Cartagena is operated by Puertos de Colombia (COLPUERTOS), a Government agency. The facilities have recently been enlarged and modernized and cargo throughput in 1977 was 604,000 MT. There are two 200 m long concrete finger piers and 400 m of marginal wharf available for deep-sea ships. There is a total of 96,000 m² of usable storage area, of which 24,420 m² is under roof, and the possibility exists for expansion of yard storage area. The port has an excellent security record and a computerized cargo control department. During construction a major portion of incoming freight can be directly transloaded into river barges. Other freight, however, will have to be unloaded and temporarily stored for further shipment. For this, the port will make available an area of approximately 6,000 m², which after construction would be utilized for ferronickel storage. Diesel oil and other fuels can be loaded directly onto barges at the ECOPETROL distribution terminal outside Cartagena at Mamonal.

6.34 Liaison between the Project and the port will be handled through a project expediting office in Cartagena. In order to speed up equipment delivery, all shipments will go in bond to Cerro Matoso where they will be cleared through a customs zone specially created for this purpose. A Government authorization to this effect has already been granted.

VII. PROJECT IMPLEMENTATION

A. Project Management and Organization

7.01 During implementation, technical supervisory, engineering, construction and procurement services will be provided by Bechtel. Bechtel will also act as Project Manager on behalf of the owners and the scope of its work will include procurement, sub-contractor selection, supervision, scheduling and expediting for both process plant and infrastructure items. There will be two separate contracts covering work in San Francisco and in Colombia. The

signing of these contracts will be a condition of loan effectiveness. Bechtel's proposed organization chart for project implementation is given in Annex 7 and is based on the assumptions shown below:

Bechtel Proposed Consultant Requirements

	<u>Man-Months</u>		<u>Total Cost</u>	<u>Average Cost</u>
	<u>Expatriate</u>	<u>National</u>	<u>(US\$000)</u>	<u>per Man-Month</u> <u>(US\$)</u>
Field office	810	2,947	12,247	3,260 /a
Project office	397	2,196	7,804	3,010 /a
San Francisco office	<u>2,938</u>	<u>-</u>	<u>16,393</u>	<u>5,580 /b</u>
	<u>4,145</u>	<u>5,143</u>	<u>36,444 /c</u>	<u>3,924</u>

/a Includes payroll fringe benefits and relocation and settling-in allowances.

/b Includes allowances for indirect costs and out of pocket expenses.

/c Does not include Bechtel's fee which is estimated at US\$5.7 million.

7.02 In addition, it is expected that approximately 154,000 man-hours of local engineering services, primarily relating to infrastructure, will be provided by INTEGRAL Ltda. (para. 6.26).

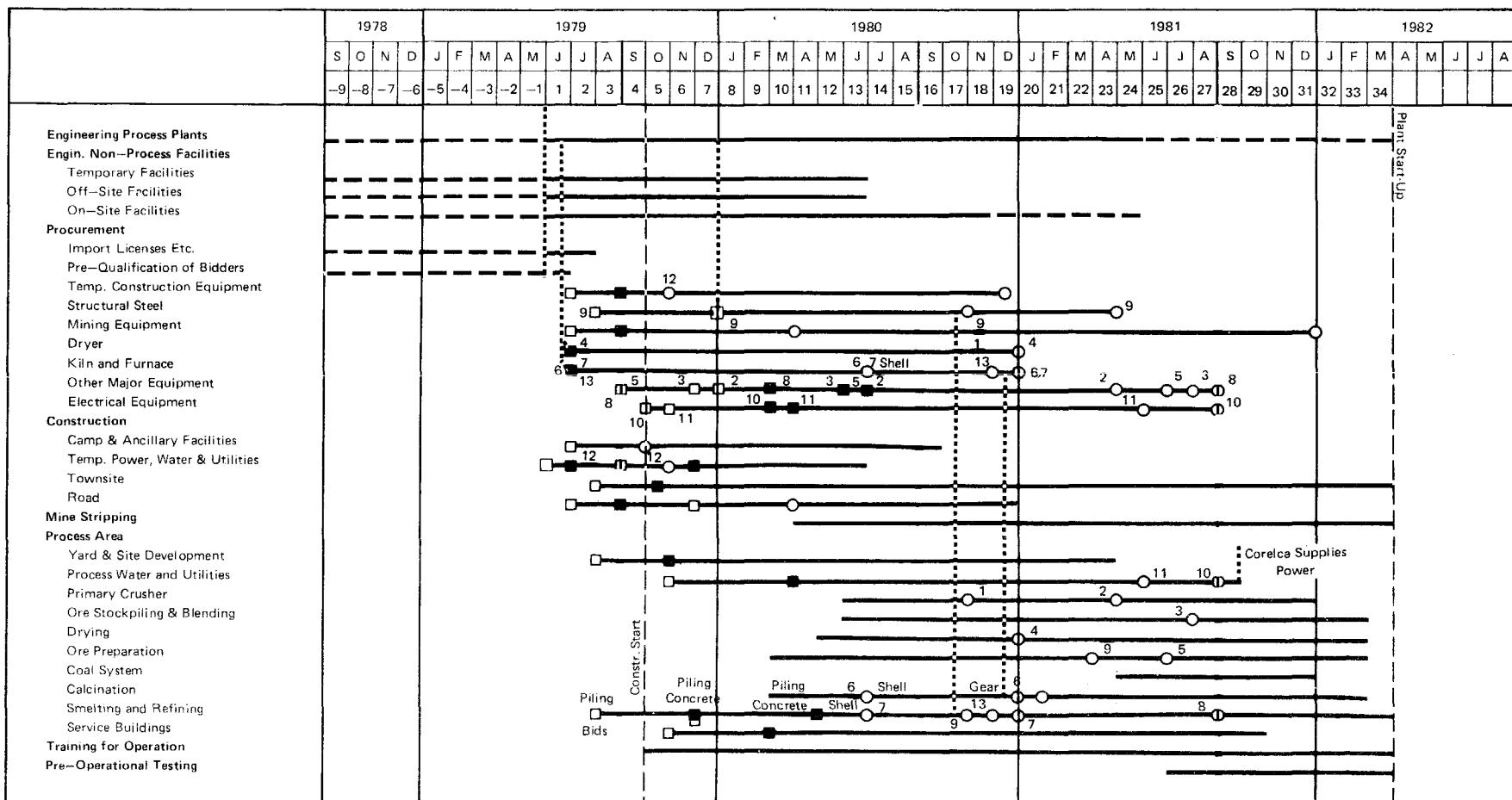
7.03 Although Bechtel will have overall responsibility for project implementation, Hanna itself will be responsible for selection of mining methods and equipment, establishment of mining and stripping plans and opening up of the mine. Since Hanna is an experienced lateritic nickel-mining company, this division of responsibility is appropriate.

B. Implementation Schedule

7.04 Project preparation is well advanced and letters of intent for the kiln, dryer and furnace have already been issued. The latter is the most critical item since the detailed design of the structural steel for the furnace building and, hence, the issuance of the steel bid packages, depend upon it. Contracts for erection of the construction camps, ancillary buildings and the concrete batch plant will also be awarded soon thereafter. Preliminary design work is required for the plant and equipment foundations to assure an early issue of the piling contract bid documents. Road design is essentially complete and traffic connected with the supply of construction materials and equipment can be maintained. In order to meet the schedule, it may be necessary to carry out some construction work concurrently with the engineering of that specific section. An implementation schedule is given on the following page. On the basis of the Notice to Proceed being given in the third quarter of 1979, plant start-up is expected for the first half of 1982, or within less than three years. The implementation schedule looks realistic and is attainable under normal circumstances. 1/

1/ For contractual purposes, a slightly more conservative estimate has been assumed.

COLOMBIA – CERRO MATOSO NICKEL PROJECT
IMPLEMENTATION SCHEDULE



Major Equipment — Delivery
(Months)

2. Roll Crusher	10	8. Refining System	18
3. Stackers	14	9. Struct. Steel	10 – 15
4. Dryer	14 – 18	10. Transformers	18
5. Baling Disc.	16	11. Switchgear	14
6. Kiln	12 – 18	12. Initial Power	2
7. Furnace	12 – 18	13. Transformer (Furnace)	18

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VIII. CAPITAL COSTS AND FINANCING PLAN

A. Capital Costs

8.01 As shown below, total financing required for the Project is estimated at US\$340.0 million equivalent (Col\$14.0 billion), of which US\$216.2 million, or 64%, is expected to be in foreign exchange:

Cerro Matoso: Capital Costs

	Col\$ Million ^{/a}			US\$ Million			%
	Local	Foreign	Total	Local	Foreign	Total	
Mine							
Mining Equipment	-	288.3	288.3	-	6.8	6.8	2.9
Drilling Development and Preproduction Stripping	123.0	118.7	241.7	2.9	2.8	5.7	2.4
General & Administration	248.1	212.0	460.1	6.7	5.0	11.7	5.0
Sub-total (Mine)	371.1	619.0	990.1	9.6	14.6	24.2	10.3
Plant							
Process Plant Equipment ^{/b}	118.7	1,662.0	1,780.7	2.8	39.2	42.0	18.0
Bulk Materials	602.8	360.4	963.2	14.4	8.5	22.9	9.8
Distributables ^{/c}	746.2	152.6	898.8	17.6	3.6	21.2	9.1
Sub-total (Plant)	1,467.7	2,175.0	3,642.7	34.8	51.3	86.1	36.9
Gas Pipeline	42.4	84.8	127.2	1.0	2.0	3.0	1.3
Plant Modification	-	106.0	106.0	-	2.5	2.5	1.1
Civil Works, Installation, Erection	1,021.8	212.0	1,233.8	24.1	5.0	29.1	12.5
Engineering & Project Services ^{/d}	695.4	1,221.1	1,916.5	16.4	28.8	45.2	19.3
Freight and Insurance	127.2	555.4	682.6	3.0	13.1	16.1	6.9
Duty and Taxes ^{/e}	101.8	-	101.8	2.4	-	2.4	1.0
Pre-Operating Expenses	248.8	412.9	661.7	9.0	16.0	25.0	10.7
Total Base Cost(Apr. 79 Terms)	4,076.2	5,386.2	9,462.4	100.3	133.3	233.6	<u>100.0</u>
Physical Contingency	368.9	398.6	767.5	8.7	9.4	18.1	
Price Escalation	474.9	589.4	1,064.3	11.2	13.9	25.1	
Working Capital ^{/f}	152.6	1,365.3	1,517.9	3.6	32.2	35.8	
Total Project Cost	5,072.6	7,739.5	12,812.1	123.8	188.8	312.6	
Interest During Const.	-	1,161.8	1,161.1	-	27.4	27.4	
Total Financing Required	5,072.6	8,901.3	13,973.9	123.8	216.2	340.0	

^{/a} Except for actual pre-operating expenses, a mid-1979 exchange rate has been used to convert the local currency equivalent.

^{/b} Including refractories for the kiln and dryer and furnace.

^{/c} Includes temporary utilities, construction camps, tools, consumables and miscellaneous construction services.

^{/d} Includes Bechtel and INTEGRAL contracts.

^{/e} Includes a 6% sales tax on local purchases.

^{/f} Includes working capital requirements in 1983 and 1984, i.e., to full production.

8.02 The total base cost of the Project is based on Bechtel's early 1979 update of their original feasibility study (June 1976), which had assumed a January 1977 start of implementation. These revised figures are in line with Bank staff estimates and are a fair reflection of the capital cost of the Project. 1/

8.03 Since letters of intent have already been issued for the kiln and dryer and electric furnace packages (which constitute approximately 55% of the estimated total equipment cost), a smaller physical contingency has been added to these items to cover design changes. For other items, a physical contingency of 10% has been used.

8.04 The local currency component is primarily civil works, labor and bulk materials; the foreign component is predominantly equipment and engineering services. The price contingency amounts to approximately US\$25 million (Col\$1 billion) and total physical and price contingencies are about 18% of the total base cost of the Project. This is in line with other industrial projects recently appraised and reflects the fact that the Project is very well defined and has a relatively short implementation period.

8.05 The estimates are based on the assumption that the Project will be exempted from all import and customs duties and INCOMEX, the Government's importing authority, has indicated that Cerro Matoso qualifies for this exemption.

8.06 Initial working capital requirements, which, together with the assumptions used, are given in more detail in Annex 8-1, are estimated to total US\$35.8 million (Col\$1.5 billion) through to full capacity production. Of this figure, only US\$16.3 million, which accounts for the working capital required at start-up in 1982, will be externally financed. The remaining US\$19.7 million will be financed by internally generated funds.

8.07 Interest during construction, which is estimated at US\$27.4 million (Col\$1.2 billion) through April 1982, has been calculated on the basis of the financing plan outlined below (para. 8.09) and loan disbursements commencing in late 1979.

8.08 The total project cost, in April 1979 terms, excluding price escalation, working capital and interest during construction, is about US\$6.0/annual lb. This compares favorably with other recent projects, such as Greenvale (approximately US\$10.0/annual lb), Marinduque (US\$8.1/lb), PT International (US\$9.1/lb) and EXMIBAL (US\$8.5/lb). Among greenfield projects, only FALCONDO, which was completed in 1971 at a capital cost per annual lb of around US\$6.3 in April 1979 terms, would be comparable. The competitiveness of Cerro Matoso is a function of the uniquely high quality of the deposit, the relatively low

1/ As indicated in para. 6.16, however, they are based on the assumption that gas and oil will be priced at world market levels. If Colombian fuel prices were to stay at present levels, there would be a capital cost savings of about US\$3.0 million, as well as a substantial reduction in operating costs.

infrastructure requirements and the comprehensive drilling and testing programs so far carried out (para. 5.15). No other greenfield project is likely to be realizable for less than US\$10-US\$12/annual lb in 1979 terms.

B. Financing Plan

8.09 The financing plan for the project is as follows:

Cerro Matoso: Financing Plan

	<u>US\$ million</u>	<u>%</u>
A. Equity		
(i) <u>Existing Equity /a</u>		
- ECONIQUEL	10.0	3.1
- CONICOL	<u>15.0</u>	<u>4.7</u>
Sub-total	<u>25.0</u>	<u>7.8</u>
(ii) <u>New Equity</u>		
- ECONIQUEL	41.3	12.9
- Billiton	39.9	12.5
- CONICOL	<u>7.8</u>	<u>2.4</u>
Sub-total	<u>89.0</u>	<u>27.8</u>
Total Equity	<u>114.0</u>	<u>35.6</u>
B. Long-Term Debt		
- IBRD	80.0	25.0
- US Ex-Im Bank /b	<u>25.6</u>	<u>8.0</u>
- Chase Manhattan	<u>100.9</u>	<u>31.4</u>
Total Long-Term Debt	<u>206.5</u>	<u>64.4</u>
Total Financing to 1982	<u>320.5</u>	<u>100.0</u>
C. Internal Funds for Working Capital 1983-84 /c	<u>19.5</u>	
Total Financing Required	<u>340.0</u>	

/a Unrevalued assets as at end-1978.

/b Of this amount, US\$12.8 million will be provided by Ex-Im Bank and US\$12.8 million by complementary private financing.

/c Working capital in 1982 (US\$16.3 million) is financed by loans and equity as part of the basic project cost.

8.10 On the basis of this financing plan, the equity ownership of CMSA at start-up would be ECONIQUEL 45%, Billiton 35% and CONICOL 20%, and this financing plan and ownership structure is appropriate for a project of this type. The schedule of equity payments will be made so that the debt to equity ratio will not exceed 73:27 during project execution, and will reach 65:35 upon Project Completion, as defined in para. 8.16.

8.11 The Chase Manhattan loan will be available as a revolving credit until early 1983, at which time it will be converted into a 6-1/2 year loan with one year of grace. Interest will be LIBOR plus 1-1/4%. For the present report, it has been considered that the loan will be for 10 years, including 4 years' grace, and an effective annual interest rate of 11-1/4% through mid-1981, and 10% thereafter has been assumed. The Chase loan will be secured, inter alia, by assignment of sales proceeds. The Bank will share equally in this and all other securities created for the external lenders.

8.12 The US Ex-Im Bank loan, which has been agreed to, will be for 13 years, including 3 years of grace. The Ex-Im Bank portion (US\$12.8 million) will carry an interest rate of 8-5/8%, and the private portion will be at a commercial rate, which has been assumed to follow a similar trend as in the Chase loan. Neither the Chase nor the Ex-Im Bank loan will carry a Government guarantee and both will be lent directly to CMSA. The Bank loan, which will also be lent directly to CMSA, will be for 14 years, including 4 years of grace, and will carry an interest rate which, together with a guarantee fee payable to the Government, will bring the cost to the borrower to 10% per annum. A commitment fee of 3/4% will be payable on the undisbursed portion. CMSA will bear the foreign exchange risk of other currencies to the US dollar, except for some offsetting of this by a reduction in the fee paid to the Government, where the cost of the loan exceeds 10% per annum in US dollar terms, over the life of the loan. It has also been agreed that the guarantee fee paid to the Government will not be, in any case, less than 1%.

8.13 With regard to overrun financing up to Project Completion, it has been agreed that the shareholders will make available up to US\$86 million in additional equity to cover cash flow deficiencies, should they occur. The Chase loan will be for up to US\$120 million and since only US\$100.9 of this will be drawn down as part of the basic project financing, it has been agreed that the difference--US\$19.1 million--be added to the overrun facility, bringing it to a total of US\$105.1 million.

8.14 Taking into consideration not only the strong project management team and detailed capital cost analysis, but also the Project's unique advantages relative to other nickel prospects (para. 5.15) and the consequent improbability that the sponsors would abandon Cerro Matoso prior to Project Completion even if the agreed overrun funds were to be exhausted, the limited overrun commitment indicated above is acceptable for this Project.

8.15 It has been agreed that until Completion of the Project, no debt will be contracted that would result in CMSA's total outstanding long-term debt exceeding US\$225.6 million, including the full amount of the Chase loan (para. 8.13).

8.16 It has also been agreed that Project Completion will be defined as:
(i) completion of physical construction of the plant and associated facilities;
(ii) operation of mine and plant facilities at 90% of the quarterly effective

production capacity 1/ over a continuous 90-day period; (iii) maintenance of an average of 80% of the annual effective production capacity 1/ over a continuous 12-months period; (iv) achievement of a 1.4:1 current ratio at the time of Completion; and (v) a demonstrated ability to service all long-term debt from internally generated funds during the 12-month period referred to under (iii) above.

C. Procurement

8.17 A letter of intent for the dryer and kiln, expected to cost about US\$13 million equivalent, has already been signed with F.L. Smidth (Denmark) after international competitive bidding (ICB) in conformity with the Bank's guidelines. For sound technical reasons (para. 5.32), the sponsors sought quotations for the electric furnace package only from Elkem (Norway) and Demag (FR Germany). Elkem's offer was substantially lower and Elkem has received a letter of intent. The proprietary part of the package, including engineering, is presently estimated at US\$4.1 million in 1979 terms. Based on the Bank financing the entire package, Elkem will bid the rest internationally as 8 sub-packages with a total estimated cost in 1979 terms of also about US\$4.1 million. The remainder of the equipment to be financed by the Bank (US\$24.5 million) will be procured according to ICB, except for approximately 16 equipment packages, totalling about US\$2.4 million and individually estimated at less than US\$0.25 million per package, which will be procured by international shopping according to Bank guidelines. The gas pipeline will also be bid internationally.

8.18 Colombian manufacturers are expected to supply about US\$10 million, or 14%, of the total equipment and bulk materials costs; local bidders will be given a margin of preference, under ICB, of 15% or the applicable duty, if lower, which a non-exempted importer would have had to pay.

8.19 It is expected that there will be approximately 18 installation, civil work and erection contracts, totalling US\$29.1 million. Although these will be bid internationally according to ICB, it is likely that most will be awarded to local contractors. However, owing to rigorous quality control, it is almost certain that only foreign contractors will be prequalified for installation of refractories. The total value of the contracts which might be awarded to foreign companies is estimated at a maximum of US\$5 million.

8.20 As indicated, Bechtel has been selected as project engineer. It is proposed that the Bank finance the foreign exchange cost of that part of the Bechtel contract covering services in Colombia, estimated at about US\$11.1 million. Presentation of signed contracts covering Bechtel's work both in Colombia and San Francisco, which are satisfactory to the Bank, will be a condition of loan effectiveness.

1/ Quarterly and annual effective production capacity have been defined as an output of 12,283,000 and 49,813,000 lbs of nickel contained in ferronickel, respectively.

8.21 Since the notice to proceed given on July 2, 1979 (para. 1.02), the detailed engineering has reached such a stage as to allow towards the end of the third quarter of 1979 the placement of firm purchase orders for the most critical equipment packages, the dryer, kiln and electric furnace. To cover the required down payments, a provision for retroactive financing of up to US\$2 million (or 2.5% of the total loan amount) has been made, to permit withdrawals from the loan account in respect of such payments, prior to the date of the loan agreement but after August 1, 1979.

D. Allocation and Disbursement of the Bank Loan

8.22 The Bank loan of US\$80 million will finance goods and services as shown in the table below:

Cerro Matoso: Allocation of Bank Loan

	<u>US\$ Million</u>	<u>%</u>	
Plant Equipment	24.5	30.6)	100% of foreign) expenditures or 90%
Dryer, Kiln and Electric Furnace	21.3	26.6)	of the ex-factory) cost of locally
Bulk Materials, incl. refractories	15.5	19.4)	manufactured goods
Bechtel On-site Contract	11.1	13.9)	100% of foreign) expenditures
Gas Pipeline	2.2	2.7)	
Unallocated	<u>5.4</u>	<u>6.8</u>	-
<u>Total</u>	<u>80.0</u>	<u>100.0</u>	

8.23 It is expected that, for those equipment items to be financed by the Bank, only about US\$4.4 million (or 5.5% of the Bank loan) will be for contracts awarded to local suppliers. As shown in Annex 8-2, the loan is expected to be fully disbursed by mid-1983.

IX. FINANCIAL ANALYSIS

A. Production Schedule

9.01 Production figures have been based on 3 mining stages over a 25-year life and are summarized below. These figures assume 90% plant availability with an allowance every 7 years for the relining of the kiln and every 10 years for the relining of the furnace.

Cerro Matoso: Summary Plant Capacity

	MT/hour (furnace)	KW/MT (furnace)	Ni Grade of ore (%)	Recovery (%)	Full Annual Production (000 lb. Ni contained)
Stage I	95.1	520	3.20	92.3	49,813
Stage II	103.1	480	2.72	91.2	45,336
Stage III	105.3	470	2.22	89.0	36,894

9.02 To allow for start-up problems and plant modification, lower smelter efficiencies have been assumed during initial operations:

Cerro Matoso: Assumed Smelter Performance during First Three Years

Year	% Recovery	% Operating Time	Annual Production (000 lb Ni)	Percent of Effective Capacity
1	87	63	32,897	66
2	90	80	43,175	87
3	92.3	90	49,813	100

9.03 The table below compares this start-up with other major nickel projects that have come on stream during the last five years. Of these, however, only FALCONDO is strictly comparable since both process lateritic ores, use electro-smelting and similar refining processes and produce high-grade (35%-40%) ferronickel. The main difference consists in calcining, where FALCONDO uses shaft furnaces.

Cerro Matoso: Learning Curve Comparison

Ore Type	Product	Production as % of Effective Capacity/a			
		Year 1	Year 2	Year 3	Year 4
Selebi-Phikwe	Cu-Ni Sulphide	Cu-Ni Matte	16	39	77
Marinduque	Laterite	Class I Ni	28	45	(65) (82)
FALCONDO	Laterite	Ferronickel	106	107	83 /b 90 /b
Cerro Matoso	Laterite	Ferronickel	(66)	(87)	(100) (100)

/a Figures in brackets are estimates.

/b Due to market constraints.

9.04 While it would be unreasonable to expect Cerro Matoso to match FALCONDO by producing over design capacity from the first year, the assumed learning curve is realistic. Hanna will not only operate a plant in which it is a major shareholder, but it has also been involved with the Project for a number of years and has conducted most of the pilot tests itself. The Cerro Matoso process is not particularly complex, and the proposed training program, in which Hanna will participate (para. 5.40), is adequate.

9.05 Based on the preceding learning curve and assuming commissioning in April 1982, the production build-up is forecast as shown below:

Cerro Matoso: Summary Production Build Up

	<u>Ore Mined (DMT)</u>	<u>Nickel Produced (000 lb)</u>	<u>% of Effective Annual Capacity</u>
April-December	1982	402	66
	1983	644	82
	1984	744	97
	1985	765	100

B. Operating Costs

9.06 Operating cost estimates in constant terms, which are detailed in Annex 9-1, are based on Bechtel's feasibility report. However, unit prices have been modified in line with the analysis presented in Chapters V and VI.

9.07 The operating cost per lb of nickel at full production is approximately US\$0.97 in April 1979 terms. 1/ As shown below, this is substantially lower than other recent plants.

Cerro Matoso: Operating Costs of Nickel Producers
(US\$/lb Apr. 1979 terms)

	<u>Ore Type</u>	<u>Reference Year</u>	<u>US\$/lb</u>
FALCONDO	Lateritic	1975	1.46
"	"	1974	1.51
"	"	1973	1.14
Falconbridge (Canada)	Sulphide	1976	2.05
Western Mining (Australia)	"	1977	1.37

9.08 The lower operating cost per lb projected for Cerro Matoso vis-a-vis FALCONDO is a function of: (i) the higher-grade ore body at Cerro Matoso (approximately 2.6% Ni as an average as opposed to 1.6% at FALCONDO); (ii) the fact that all power consumed at FALCONDO is internally generated with imported fuel oil; (iii) the use of naptha as the reductant in the shaft kilns at FALCONDO as opposed to coal; and (iv) the greater efficiency of rotary as opposed to shaft-type kilns.

C. Financial Projections

9.09 Detailed income statement, sources and uses of funds and balance sheet projections, in current US\$, are given in Annexes 9-2 to 9-4 and are summarized below:

1/ Based on an average Ni production of 42.3 million lb per annum over the life of the Project.

Cerro Matoso: Summary Financial Projections
(US\$ millions - Current Terms)

	<u>1982</u>	<u>1984</u>	<u>1986</u>	<u>1988</u>	<u>1990</u>
Production (000 lb)	24,678	48,159	49,822	49,366	49,822
Price (US\$/lb) /a	2.96	3.61	4.22	4.72	5.15
Net Sales Revenue	55.1	159.8	198.7	221.0	243.6
Royalty	-	4.9	8.1	9.9	11.5
Cost of Goods Sold	21.0	45.4	51.9	57.5	65.1
Operating Profit	24.8	93.2	120.5	133.5	144.9
Net Profit after Tax	(17.5)	30.5	52.4	71.9	83.4
- as % of Sales	-	19	26	33	34
Internal Cash Generation	24.8	96.1	129.5	144.9	158.0
Net Working Capital	16.3	35.8	44.5	50.9	57.0
Funds Available for Dividends	-	17.1	47.1	64.7	75.0
L-T Debt: Total Equity	67:33 /b	54:46	41:59	23:77	10:90
Current Ratio	1.5:1	1.8:1	1.7:1	1.5:1	1.7:1
Debt-Service Coverage (times)	1.7	2.0	2.4	2.8	7.4

/a From para. 3.44.

/b Owing to a US\$17.5 million loss in first operating year.

9.10 From 1984 onwards, Cerro Matoso will be in a healthy financial position, with a debt-service coverage of not less than 2.0 times and a current ratio of 1.5:1 or better. At full production in 1985, the profit break-even point will be about 50% of capacity and the cash break-even point 59% of capacity. Year-by-year break-even analyses and other financial indicators are given in Annex 9-5.

9.11 These projections have been made on the basis of assumptions indicated below:

- (a) Revenue: a discount of 5% and 3%, respectively, has been applied in the first and second years to reflect possible initial problems with quality control;
- (b) Depreciation: an accelerated method of depreciation (fixed percentage on declining balance) has been assumed, at the following rates:

Industrial buildings	5% per annum
Plant machinery and equipment	10% per annum
Vehicles	20% per annum

In addition, it has been assumed that pre-operating expenses and interest during construction will be amortized over 5 years;

- (c) Tax Incentives: it has been assumed that Cerro Matoso will benefit from duty exemptions (para. 8.05). The Project will also benefit from a depletion allowance which allows mining companies to deduct from the taxable base up to 10% of the "mine-head" value of the nickel, which is determined by the market price less transportation charges, processing costs and all other costs incurred after mining;
- (d) Government Royalty: according to the Concession Contract, an annual royalty will be payable at the rate of 8% of the mine-head value;
- (e) Transfer to Legal Reserves: 10% of net profits must be transferred to a compulsory reserve which accrues until it reaches 50% of the Company's subscribed capital;
- (f) Taxes: there are two applicable forms of taxation:
 - a corporate income tax, at the rate of 40%; and
 - local real estate taxes, which are assessed on the net plant value at the rate of 0.002% per annum;
- (g) Dividends: it has been agreed that no dividends will be paid if to do so would reduce the current ratio below 1.3:1 and that dividends in any one year may not exceed net profit after tax less transfer to reserves. A remittance tax of 20% is payable on profits remitted abroad; and
- (h) Hanna Technical Assistance: Hanna will charge Cerro Matoso US\$0.01/lb of nickel produced for administrative support and US\$0.015/lb for technical assistance. During the first five years, these rates will be increased with inflation up to a maximum of US\$0.0275/lb. It has been assumed that this technical support will be required over the life of the Project.

D. Financial Rate of Return and Distribution of Benefits

9.12 The pre-tax financial rate of return for the Project has been calculated in real terms and is expected to be about 17%. If costs incurred prior to 1979 are excluded and if the quality discount which has been assumed in 1982 and 1983 were also excluded (para. 9.11), the return would be 19.7%.

Cerro Matoso: Financial Rate of Return

(%)

Base Case	17.2
Capital Cost up 20%	14.3
Capital Cost down 20%	21.0
Operating Costs up 20%	14.6
Operating Costs down 20%	19.3
Benefits up 20%	23.0
Benefits down 20%	10.3
Exclusion of Sunk Costs and Quality Discount	19.7

9.13 Additional returns have also been calculated for each of the sponsors using, as costs, the total new equity to be injected into the Project and, as benefits, the dividends (net of remittance taxes for the private sponsors). As shown below, the returns to each sponsor are more attractive than the internal financial return might indicate:

Cerro Matoso: Financial Returns to Sponsors

	<u>ECONIQUEL</u>	<u>Private Sponsors</u>
Base Rate	22.0%	19.0%
Capital Cost up 20%	19.2%	16.4%
Benefits down 20%	18.6%	15.8%

9.14 The returns to the sponsors are estimated to start in 1984 with the first payment of dividends which accrue in the same ratio as their percentage of equity invested in the Project. The Government, however, in addition to ECONIQUEL's dividends, receives royalties and income tax, local and remittance taxes. In a typical year (1988), at full production, the inflow to the Government and the sponsors would be as outlined below and indicates that approximately 75% of total benefits accrue to the Government and its agencies (including ECONIQUEL). 1/

Cerro Matoso: Funds Flow to Sponsors and Government at Full Production in 1988
(US\$000 - current terms)

	<u>Government</u>	<u>ECONIQUEL</u>	<u>Private Sponsors</u>
Royalties	9,942	-	-
Income Tax	40,305	-	-
Remittance Tax	7,117	-	-
Local Taxes	263	-	-
Dividends	-	29,116	28,468
Total Benefits	<u>57,627</u>	<u>29,116</u>	<u>28,468</u>
% of Total Flow	50	25	25

1/ This excludes social charges paid by the Project to its workers, which are about 60%-65% of the total wage bill.

E. Financial Covenants

9.15 To ensure maintenance of a sound financial position and to safeguard the position of the lenders, even in the event that nickel prices do not increase as now projected (para. 3.44), the following covenants, in addition to those stipulated in paras. 8.15 and 8.16, have been agreed:

- (a) CMSA will not be permitted to declare or pay dividends if after payment of such dividends, the debt:equity ratio is above 60:40 or the Company's current ratio would be less than 1.3:1;
- (b) for three years after Project Completion, CMSA will not be permitted to make capital investments outside the Project of more than US\$10 million equivalent in any one year without the specific approval of the Bank; and
- (c) CMSA may not incur long-term debt in addition to that already identified in the financing plan presented in paras. 8.09-8.13 prior to Project Completion, and after Project Completion only if after incurring such debt the debt:equity ratio of the Company would not exceed 60:40.

9.16 In addition, the following security provisions in which the Bank will share pari passu with the other lenders have been agreed: (i) the assignment of the proceeds from all nickel sales to a special account, (ii) mortgage and pledge of assets; and (iii) assignment of the Concession and the key contracts entered by Cerro Matoso to carry out the Project.

F. Major Risks

9.17 In the opinion of Bank staff, technical risks are small. The ore body is well-known and of an exceptionally high grade. Mining will be a simple, truck and shovel, open-cast operation and will, in addition, be carried out with the management assistance of Hanna, which has had extensive similar experience. The processing of the ore, likewise, has been extensively studied and the final choice of the rotary kiln/electric furnace route is the product of detailed pilot plant work. Although the staff initially had reservations about the sizing of the kiln (para. 5.28) and furnace (para. 5.31), it is now apparent that these should not pose a problem and in terms of technical risk, the only area where some concern remains is the availability of adequate power at the time of project start-up (para. 6.10).

9.18 As discussed in Chapter III, however, the market for nickel is likely to remain depressed during the early operating years and--based on the supply/demand balance indicated in para. 3.38--it must be considered possible that prices may not rise as fast in real terms as has been assumed in this report (the annual average rate of real increase is approximately 5% from 1978-85). However, as shown below, except for 1982, CMSA would remain able to service its debt from internally generated funds even if prices were to fall

by 30% from the levels which have been projected. Indeed, if there were no increase in real terms from the US\$2.08/lb average level for the first quarter of 1979, the Project would still be able to maintain a debt service ratio of 1.3 times and above. The vulnerability of CMSA to price falls below US\$2.08/lb in 1982-84--though remote--is, however, a reason for not permitting a debt:equity ratio for the basic Project cost above that proposed.

Cerro Matoso: Debt-Service Coverage (Times) under Alternative Price Hypotheses

	<u>1982</u>	<u>1984</u>	<u>1986</u>	<u>1988</u>	<u>1990</u>
Base Coverage	1.7	2.0	2.4	2.8	7.4
Price at US\$2.08/lb (1979 terms) /a	1.3	1.4	1.9	2.0	5.4
Price down 20% /b	0.9	1.4	2.1 /c	2.0	5.2
Price down 30% /b	0.6	1.1	1.6	1.9	4.2

/a Average first quarter 1979.

/b From levels in para. 3.44.

/c Owing to tax liability being eliminated by loss carry-forward.

X. ECONOMIC ANALYSIS

A. Economic Rate of Return

10.01 The economic return has been calculated from the financial cost/benefit streams which have been amended: (i) to eliminate all taxes and duties; and (ii) to exclude all transfer payments, including social security charges. No shadow pricing of foreign exchange has been used and, since a tight labor market is anticipated in the region, there is no shadow pricing of skilled or unskilled labor. The costs and benefits associated with the housing policy which Cerro Matoso S.A. intends to follow (para. 6.28) have not been quantified since insufficient data is presently available. However, US\$1.0 million has been excluded from the capital cost stream to cover improvements to the existing town of Montelibano which are unrelated to the Project.

10.02 The basic economic rate of return, shown below, is 19.4%. If the quality discount assumed for 1981 and 1982 and sunk costs prior to 1979 are excluded, this return would rise to 22.2%.

Cerro Matoso: Economic Rate of Return

	(%)
Base Rate	19.4
Capital Cost up 20%	16.5
Capital Costs down 20%	23.4
Operating Costs up 20%	17.0
Operating Costs down 20%	21.8
Benefits up 20%	25.1
Benefits down 20%	12.9
Exclusion of Sunk Costs and Quality Discount	22.2

B. Foreign Exchange Effect

10.03 The estimated foreign exchange generation from the Project is detailed in Annex 10. In an average year of full production, net foreign exchange inflows are expected to be about US\$68 million equivalent in 1979 terms--or more than 50% of the Project's base foreign exchange cost.

C. Regional Impact 1/

10.04 Present Government strategy is directed at improving the distribution of the benefits of growth, inter alia, by implementing rural development programs aimed at low income groups. The Cerro Matoso Project will be instrumental in this by: (i) providing employment for up to 1,800 workers during implementation and about 720 during operations (para. 5.39), some of whom will come from the town of Montelibano and the rest from other parts of the country; (ii) providing upgraded social services in and around Montelibano, including new hospital facilities, improvements to sewage and power and resurfacing of the roads and airstrip (paras. 6.26 and 6.30); (iii) encouraging up and downstream industries, including quarrying (para. 6.20), road and river transportation (paras. 6.30 and 6.31), the local construction industry (para. 6.28), local manufacture of refractories and the domestic steel fabrication industry. On top of this, the Project will serve in some measure to rectify the imbalance of the economy, where development is critically dependent on coffee exports and in which mining presently contributes less than 0.9% of GDP. In the longer term, the training opportunities (paras. 5.39-5.44) for artisans and skilled workers will provide a substantial social infrastructure upon which can be built a better-balanced industrial sector and the management skills which will be passed on will be of critical importance in other natural resource industries, e.g., in petroleum and coal.

1/ For further detail, see Economic Position and Prospects of Colombia (Report No. 1548-CO), dated May 10, 1977.

XI. AGREEMENTS

11.01 The following major agreements and assurances have been obtained:

(a) from CMSA:

- (i) that CMSA will not change the conditions of the Billiton contract (or other scheduled documents) without the prior approval of the Bank (para. 3.50);
- (ii) that, as part of the overall information pertaining to the Project, it will provide the Bank with detailed information on pollution and that the Project will be carried out and operated with due regard to ecological and environmental factors, including, if necessary, reclamation of exhausted mining areas and waste dumps (para. 5.38);
- (iii) that it will provide adequate financing for the provision of housing (para. 6.28);
- (iv) that the Bank will participate equally in all securities including assignment of sales proceeds, which are enjoyed by the other lenders (paras. 8.11 and 9.16);
- (v) that the Company will adhere to certain definitions of and conditions for Project Completion (para. 8.16);
- (vi) that the Company will neither pay nor declare dividends if to do so would decrease the Company's current ratio below 1.3:1 or increase the Company's debt:equity ratio above 60:40 (paras. 9.11 and 9.15);
- (vii) that for a certain time the Company will not make annual capital investments of more than US\$10 million without Bank approval (para. 9.15); and
- (viii) that the Company will not incur long-term debt in addition to that already identified in the financing plan (paras. 8.09-8.13) prior to Project Completion; and that after the Completion Date the Company will incur debt only if after incurring such debt, the debt:equity ratio does also not exceed 60:40 (para. 9.15);

(b) from CMSA and ECONIQUEL/IFI, CONICOL/HANNA and BILLITON/SHELL:

- (i) on a training program, for which Hanna will provide technical assistance (para. 5.40);

- (ii) that financing will be provided to cover the basic Project cost, as detailed in para. 8.09;
- (iii) that, in addition to the financing plan for the basic Project cost, they will cause to be provided as required overrun financing of approximately US\$105 million (para. 8.13); and
- (iv) that a management agreement will be entered into with Hanna on terms and conditions satisfactory to the Bank (paras. 9.11 and 9.17).

(c) from the Government:

- (i) that it will cause SENA or some other agency acceptable to the Bank, to participate in the proposed training program for CMSA personnel (paras. 5.40 and 5.44);
- (ii) that it will take all actions required to ensure a timely supply of electricity to the Project and that the Bank will have ample opportunity to comment on any interim power solution which may be proposed and that any solution which may be adopted should be agreeable to the Bank (para. 6.07).

11.02 The following are conditions of loan effectiveness:

- (a) signature of the Sales Contract with Billiton (para. 3.50);
- (b) signature of power and gas contracts (paras. 6.10 and 6.12);
- (c) signature of engineering contracts with Bechtel which are acceptable to the Bank (para. 8.20); and
- (d) signature of co-financing agreements and all other scheduled documents as defined in Section 1.02 (b) of the Loan Agreement.

11.06 Given the preceding assurances and agreements, the Project is suitable for a Bank loan of US\$80 million to CMSA for 14 years, including 4 years of grace.

COLOMBIA
CERRO MATOSO NICKEL PROJECT
RESERVES OF SELECTED NON-FUEL MINERALS

	<u>Proven</u>	<u>Possible</u>	<u>Remarks</u>
	--(Million MT)---		

Metallic Minerals

Iron Ore	88	387	
Nickel Ores	25	41	- Proven reserves at Cerro Matoso only (metal content averaging 2.7%).
Bauxite	-	700	48% material.
Copper Ores	-	625	- Metal content averaging 1%.
Lead Ores	-	0.9	
Silver (fine troy oz. mn)	-	1.4	

Non Metallic Minerals

Limestone	11	-	- Paz del Rio only.
Phosphate	22	200	- Proven reserves at four sites only.
	(20%)		
Asbestos (short fiber)	0.3	-	- Las Brisas only.
Gypsum	10	40	
Talc	-	26	

Source: INGEOMINAS; U.S. Geological Service.

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COLOMBIA

CERRO MATOS) NICKEL PROJECT

MINERAL OUTPUT, 1965-77
(Metric Tons '000 Unless Specified Otherwise)

	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>(Estimate)^{1,2}</u> <u>1977</u>
<u>Metallic Minerals</u>													
Iron Ore (Mine output, metal content)	706	662	807	578	352	453	453	416	480	510	595	520	520
Lead (Metric tons Mine output, metal content)	460	597	603	740	409	293	205	294	153	126	114	-	-
Zinc (Metric tons Mine output, metal content)	48	300	506	650	164	156	112	85	146	37	18	-	-
Copper (Metric tons Mine output, metal content)	-	-	-	-	7	50	56	67	70	70	-	-	-
Chromite (Metric tons gross weight)	260	-	-	-	160	170	500	200	-	-	-	-	-
Manganese ore (Metric tons gross weight)	-	-	-	500	550	464	450	492	-	-	-	-	-
Mercury (76 lb. flasks)	46	89	210	362	334	215	213	153	144	79	-	-	-
<u>Precious Metals (Troy oz. '000)</u>													
Gold	319	281	258	240	219	202	190	188	216	265	309	298	263
Silver	116	107	110	100	77	76	68	70	75	75	83	106	100
Platinum - group metals	11	16	19	22	28	26	26	24	26	21	22	26	26
<u>Non-metallic Minerals</u>													
Phosphate rock	-	-	-	-	10.0	12.0	10.0	6.2	10.4	12.0	13.0	13	14
Limestone	3,890	3,231	3,351	4,287	4,258	5,007	5,342	6,591	7,000	7,620	7,800	8,000	8,540
Salt, marine & rock	331	382	469	505	678	561	826	1,025	1,313	1,545	1,536	1,600	n.a.
Cleav., fluorspar, feldspar	1,931	1,429	556	605	665	732	792	871	335	854	885	n.a.	n.a.
Gypsum	112	115	78	121	151	189	182	186	194	198	200	n.a.	n.a.
Sulfur (ore only)	18.4	21.0	24.0	28.8	26.9	29.9	30.5	32.5	27.8	30.6	30.0	n.a.	n.a.
<u>Precious & semiprecious Stones</u>													
Emerald (carats '000)	444	329	256	1,020	659	60	672	1,750	109	1	-	-	-

Source: Ministry of Mines and Energy; Bank of the Republic; U.S. Bureau of Mines.

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COLOMBIA
CERRO MATOSO NICKEL PROJECT
SIGNIFICANT NICKEL PRODUCERS

A. Industry Leaders

1. INCO (Canada): INCO was formed in 1902 and by 1920 it controlled almost 90% of the world's nickel output. Although its share had dropped to around 35% by 1976, it still mines the largest and richest copper-nickel orebody, the Frood-Stobie complex, near Sudbury, Ontario. In spite of its domination of Canadian sulphide mining, INCO is less well placed outside of Canada since it failed to obtain any significant interest in Australia.

Nevertheless, it has an 80% stake in the EXMIBAL project which has recently started up in Guatemala and also controls the PT International project in Indonesia. Among the major nickel companies, INCO is the only one which controls a significant captive market, with majority holdings in Huntington Alloys (US) and Henry Wiggin Ltd (UK) and minority shareholdings in Shimura Kako, Tokyo Nickel and Daido Special Alloys (Japan).

2. Falconbridge (Canada): Falconbridge was established in the 1920s and has managed to retain control of about 6-10% of world production, primarily through the phasing in of its Dominican subsidiary, FALCONDO. Like INCO, it is predominantly a sulphide producer based on the Sudbury basin although all nickel, copper and other by-products have been historically refined in Norway and marketing of finished nickel has been mostly in Europe. Although a Canadian corporation, ownership of Falconbridge has been in US hands since the 1960s.
3. Societe Le Nickel (France): from 1950 to 1976, SLN - which controls extensive reserves in the french colony of New Caledonia - had increased its share of the world market from 7% to about 9%. Notwithstanding this, it experienced severe financial problems in 1972-73 and 50% of the company is now owned by SNPA, a major French oil producer. The remaining 50% is owned by IMETAL, a Rothschild holding company in which AMAX (US) has a minority stake.

B. More Recent Entrants

1. AMAX (US): with mining interest in Botswana and New Caledonia and its own smelter in Louisiana, which also has a substantial stake in IMETAL (France);
2. Western Mining Co. (Australia): which is partially owned by Selection Trust (UK), which in turn is a major shareholder in AMAX, and which has now become the third largest free-market nickel producer;

3. Sherritt Gordon (Canada): whose domestic mining operations closed in 1976, but which owns 11% of Marinduque (Philippines) and 11% of the PT Pacific project in Indonesia;
4. Freeport Minerals (US): whose Cuban interests were nationalized but which now has a 50% stake in the Australian Greenvale project;
5. Anglo-American Corporation (South Africa): which is a partner with AMAX in Botswana, is investigating projects in Brazil and owns JCI (Rhodesia) and the Rustenburg Platinum Mines in South Africa; and
6. Hanna Mining Co. (US): which - in addition to its interest in Cerro Matoso - operates the only nickel mining and smelting operation in the US and which has a 20% interest in INCO's EXMIBAL project.

ANNEX 3-2

COLOMBIA
CERRO MATOSO NICKEL PROJECT

REFINED NICKEL PRODUCTION BY COUNTRY
(000 MT contained Nickel)

	1950	1961	1972	1973	1974	1975	1976	Average Annual Growth Rate	
								1961-1976	1972-1976
US	18.8	10.5	14.3	12.6	12.7	19.9	30.8	2.9%	20.0%
Canada	63.9	127.1	132.0	174.2	199.9	178.0	178.0	2.3%	7.8%
UK	21.2	38.0	31.9	36.8	35.7	37.3	33.1	(0.9%)	0.9%
Norway	10.0	32.2	43.3	42.7	43.2	37.1	32.7	-	(7.3%)
Japan	-	23.0	79.5	87.7	104.6	78.0	94.8	9.4%	4.5%
Philippines	-	-	-	-	-	9.4	14.3	-	-
South Africa	-	1.2	13.0	15.0	17.0	10.0	17.0	20%	6.6%
Dominican Rep.	-	-	17.4	30.1	30.5	26.9	24.4	-	10.0%
Australia	-	-	16.5	19.8	20.5	34.0	46.0	-	27.0%
New Caledonia	0.4	13.4	35.9	35.8	48.5	52.8	38.2	6.8%	1.6%
USSR	29.0	75.0	130.0	130.0	134.5	143.0	151.0	4.6%	3.7%
Cuba	-	18.1	17.6	17.0	14.6	18.0	18.0	-	0.1%
Other	4.5	21.0	52.1	54.5	55.2	55.5	64.9	7.8%	5.8%
World	147.8	359.5	583.5	656.2	717.2	699.9	743.2	4.9%	6.3%

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ANNEX 3-3

COLOMBIA
CERRO MATOSO NICKEL PROJECT

STAINLESS STEEL PRODUCERS AND SHARE OF NICKEL CONSUMPTION

	<u>Stainless</u>	<u>Nickel</u>
	-----%	-----
Japan	35	21
US	24	35
FR Germany	11	11
France	8	7
Sweden	7	6
Italy	6	4
UK	3	5
Others	<u>6</u>	<u>11</u>
	<u>100</u>	<u>100</u>

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ANNEX 3-4

COLOMBIA
CERRO MATOSO NICKEL PROJECT

Typical Composition of Commercially-Available Ferronickel

	<u>Ni</u>	<u>S</u>	<u>C</u>	<u>Si</u>	<u>P</u>	<u>Co</u> %	<u>Cr</u>	<u>Mn</u>	<u>Cu</u>	<u>Zn</u>	<u>Fe</u>
SLN FNI Ingots (20-40 kg)	24-28	0.03	0.03	0.03	0.02	0.8	-	-	-	-	Balance
SLN FN3 Ingots (20-25 kg)	21-27	0.04	1.65	2.4	0.025	0.7	1.5	-	-	-	"
SLN FN4 Ingots (20-25 kg)	21-27	0.3	1.65	3	0.03	0.7	1.5	-	-	-	"
Falconbridge Ferronickel Pigs (20 kg)	35	0.1	0.1	0.1	0.02	0.9	0.1	-	0.1	0.02	"
Nippon Yakin ONI A/ONI-3	18-23	0.04	3	0.8	0.04	-	0.1	0.5	0.1	-	"
Nippon Yakin ONI B/ONI-000	28-33	0.03	0.02	0.3	0.02	-	0.1	0.5	0.08	-	"
Hanna Ferro- nickel Ingots	50	0.008	0.02	-	0.22	-	0.02	-	-	-	"
Cerro Matoso Ferronickel	35-40	0.02	0.02	0.5	0.02	0.75	0.1	-	0.1	-	"

ANNEX 4

COLOMBIA
CERRO MATOSO NICKEL PROJECT

THE HANNA MINING CO.: PRINCIPAL OPERATIONS

Iron Ore (US)

- Groveland Mine (Michigan) 100%
- Butler Taconite (Minnesota) 37.5%
- Hanna Ore Mining (Minnesota) 15%
- National Steel Pellets (Minnesota) 15%
- Pilot Knob Pellets (Missouri) 50%

Iron Ore (Canada)

- Iron Ore Co. of Canada 27.14%
- Hollinger North Shore Exploration 40%

Iron Ore (Overseas)

- Labrador Mining and Exploration 22.3%
- St. John del Rey Mining (Brazil) 66.3%

Non-Ferrous (US)

- Hanna Nickel (Oregon) 100%
- Hanna Silicon and Ferrosilicon (Wash.) 100%

Coal (US)

- Colowyo Coal (Colorado) 50%
- H-G Coal (Colorado) 50%

Aluminum (Overseas)

- ALCOMINAS (Brazil) 31.97%

Nickel (Overseas)

- EXMIBAL (Guatemala) 20%

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ANNEX 5-1

CERRO MATOSO NICKEL PROJECT

ORE RESERVES BY ORE TYPE

		Dry Tons	Ni%	Co%	Total Fe%	Mg%	SiO2%	Al2O3%	L.O.I.%	⁺² Fe %	C%	S%
Stage I	Laterite	58,400	1.63	0.117	45.04	0.77	11.57	17.34	6.84	-	1,353	0.062
	Laterite boxwork	8,000	0.77	0.053	15.08	0.94	62.00	0.76	4.03	-	0.078	0.038
	Brown saprolite	414,100	3.73	0.108	18.46	11.71	41.86	2.92	8.90	0.8	0.098	0.021
	Brown saprolite boxwork	148,500	2.98	0.041	10.81	9.72	60.20	1.45	6.61	1.0	0.139	0.056
	Green saprolite	4,757,100	3.53	0.049	13.32	15.25	46.66	1.93	9.70	3.7	0.556	0.050
	Green saprolite boxwork	946,000	3.19	0.039	10.19	10.29	59.55	1.05	7.10	3.1	0.503	0.058
	Saprolitized peridotite	724,900	2.68	0.022	8.54	26.37	45.02	1.05	10.11	2.2	0.139	0.030
	Saprolitized peridotite boxwork	3,400	2.55	0.023	7.90	26.40	55.20	0.80	-	-	-	-
	Total before dilution	7,060,400	3.38	0.049	12.92	15.27	47.98	1.82	9.14	3.1	0.503	0.048
	Minable ore	6,144,600	3.38	0.049	12.92	15.27	47.98	1.82	9.14	3.1	0.503	0.048
	Hangingwall dilution	553,300	1.82	0.113	26.67	3.65	41.47	3.68	7.97	4.4	0.841	0.058
	Footwall dilution	362,500	2.20	0.031	9.12	23.59	47.76	1.26	9.49	2.3	0.202	0.030
	Total minable reserve	7,060,400	3.20	0.053	13.80	14.79	47.45	1.93	9.06	3.2	0.514	0.048
Stage II	Laterite	5,900	1.30	0.087	38.90	0.75	29.80	2.59	7.15	-	0.154	0.039
	Brown saprolite	1,165,600	3.64	0.054	13.37	15.80	46.07	2.01	9.17	0.9	0.109	0.076
	Brown saprolite boxwork	431,500	2.99	0.027	9.21	11.37	60.67	1.00	5.99	0.7	0.097	0.059
	Green saprolite	2,049,100	3.02	0.061	14.42	15.29	44.43	2.05	10.32	5.6	0.599	0.096
	Green saprolite boxwork	217,600	2.40	0.028	9.33	12.44	59.38	0.82	7.58	2.8	0.256	0.048
	Saprolitized peridotite	1,368,300	2.44	0.023	8.15	27.42	44.40	1.04	10.89	1.5	0.232	0.048
	Peridotite	14,400	1.16	0.009	6.47	35.15	40.28	0.64	-	-	-	-
	Total before dilution	5,252,400	2.97	0.045	11.92	18.17	46.75	1.66	9.68	3.1	0.382	0.077
	Minable ore	4,213,100	2.97	0.045	11.92	18.17	46.75	1.66	9.68	3.1	0.382	0.077
	Hangingwall dilution	627,900	1.72	0.102	25.27	6.33	40.05	3.42	8.60	4.9	0.451	0.058
	Footwall dilution	411,400	1.72	0.023	8.47	25.99	46.42	1.13	10.23	1.8	0.222	0.096
	Total minable reserve	5,252,400	2.72	0.050	13.24	17.36	45.93	1.82	9.60	3.2	0.377	0.076
Stage III	Laterite	370,100	1.33	0.182	37.33	1.00	19.72	4.97	7.18	11.5	0.752	0.058
	Laterite boxwork	11,100	0.96	0.139	19.99	0.62	55.13	1.14	5.91	-	0.076	0.134
	Brown saprolite	3,203,300	2.68	0.070	18.61	12.05	41.27	3.06	9.18	0.8	0.104	0.021
	Brown saprolite boxwork	696,900	2.09	0.051	12.62	8.43	61.18	1.41	6.20	0.7	0.091	0.017
	Green saprolite	5,952,000	2.72	0.066	17.68	12.58	42.02	2.71	10.29	4.8	0.640	0.034
	Green saprolite boxwork	412,900	2.48	0.048	11.44	9.41	58.00	1.68	7.60	2.8	0.064	0.026
	Saprolitized peridotite	2,003,600	2.53	0.028	9.03	27.06	43.22	1.19	10.63	1.3	0.082	0.016
	Saprolitized peridotite boxwork	5,000	2.11	0.014	6.30	19.90	59.90	-	-	-	-	-
	Peridotite	33,000	1.30	0.022	8.34	28.83	43.00	-	6.58	2.8	0.080	0.018
	Total before dilution	12,655,100	2.59	0.063	16.63	14.07	43.25	2.54	9.67	2.9	0.289	0.025
	Minable ore	8,059,000	2.59	0.063	16.63	14.07	43.25	2.54	9.67	2.9	0.289	0.025
	Hangingwall dilution	2,776,800	1.51	0.135	30.20	3.85	34.33	4.85	9.02	5.9	0.387	0.078
	Footwall dilution	1,819,300	1.63	0.033	11.25	21.53	45.69	1.90	10.02	2.2	0.214	0.025
	Total minable reserve	12,655,100	2.22	0.074	18.83	12.90	41.64	2.96	9.58	3.4	0.300	0.037
	Total All Reserves	24,967,900	2.60	0.063	16.23	14.37	44.19	2.43	9.44	3.3	0.377	0.048

Source: Hanna/Bechtel
 Industrial Projects Department
 August 1979

COLOMBIACERRO MATOSO NICKEL PROJECTMINE DEVELOPMENT PLAN AND PRODUCTION SCHEDULE
(Tons/Pounds In Thousands)

Operating Year	Tons Melted Per Hr (1)	KW's Per Ton	Stripping WMT(2)	Mining (3) DMT WMT(4)	Combined Stripping & Mining Total WMT	Dry Nickel Grade	% Nickel Recovery (7)	% Operating Time (6)	Nickel Production
-2			1,393	1,017 150(Stockpiled)	1,590	1,167	-		
1	95.1	520	2,456	1,793 605 460	3,061	2,253	-		
2	"	"	1,849	1,350 895 680	2,671	1,971	3.20	87.0	32,897
3	"	"	1,671	1,220 1,007 765	2,744	2,030	"	90.0	43,175
4	"	"	1,603	1,170 1,007 765	2,678	1,985	"	92.3	49,813
5	"	"	1,301	950 1,007 765	2,610	1,935	"	"	49,813
6	"	"	1,671	1,220 1,007 765	2,308	1,715	"	"	49,813
7	"	"	1,229	897 974 740	2,678	1,985	"	"	49,813
8	"	"	1,178	860 1,007 765	2,203	1,637	"	87	49,185
9	"	"	1,418	1,035 1,007 765	2,185	1,625	"	90	49,813
10	96.0	515	1,668	1,218 771 583	2,425	1,800	"	"	49,813
11	103.1	480	1,331	972 1,136 829	2,439	1,801	3.14	92.6	37,372
12	"	"	1,333	973 1,136 829	2,467	1,801	2.72	91.2	45,336
13	"	"	1,666	1,215 1,136 829	2,469	1,802	"	"	45,336
14	"	"	1,370	1,000 1,099 802	2,800	2,044	"	"	43,860
15	"	"	1,370	1,000 1,136 829	2,469	1,802	"	87	45,336
16	"	"	1,370	1,000 1,136 829	2,506	1,829	"	90	45,336
17	104.7	473	1,329	970 1,177 842	2,506	1,812	2.36	89.6	39,232
18	105.3	470	1,329	970 1,193 847	2,522	1,817	2.22	89.0	36,894
19	"	"	1,329	970 1,193 847	2,522	1,817	"	"	36,894
20	"	"	1,329	970 901 640	2,230	1,610	"	"	27,877
21	"	"	959	700 1,193 847	2,152	1,547	"	"	36,894
22	"	"	147	107 1,193 847	1,340	934	"	"	36,894
23	"	"	-	- 1,193 847	1,193	847	"	"	36,894
24	"	"	-	- 756 537*(310)	756	537	"	"	36,894
25	"	"	-	- 770 547*(300)	770	547	"	"	36,894
TOTAL			34,263	25,012 26,537 19,487	60,800	44,499			1,056,434

25 Year Average

779.5

2.71

90.7

86.5

42,257.4

- (1) 51,000 KVA X .97 power factor ÷ KW's consumed per ton.
 (2) Moisture assumed 27% H_2O .
 (3) Tons melted per hour X 365 X 24 X operating time + 98% (dust loss).
 (4) Moisture assumed Stage I - 24% H_2O ; Stage II - 27%; Stage III - 29%.
 (5) Assumed 2% plant dust loss.
 (6) Reline furnace in years 10 and 20. Kiln reline years 7, 14 and 20.
 (7) Recovery is based on average FeNi product at 37-1/2% Nickel.

*/ Stockpile drawdown.

Source: Hanna/Bechtel
 Industrial Projects Department
 August 1979

COLOMBIA
CERRO MATOSO NICKEL PROJECT

BRIEF DESCRIPTION OF THE PROCESSING PLANT 1/

1. Drying: Crude ore will be reclaimed from the blended stockpile by a front-end wheelloader and a variable speed apron feeder will discharge onto the dryer feed belt conveyor. The dryer will be designed to treat a maximum of 185 WMT per hour to reduce the moisture content from 35% to 7%. Provision will be made for an emergency stockpile to permit the dryer to be unloaded in case of process interruption or power failure. Dryer off-gas will be cleaned in cyclones and an electrostatic precipitator. The collected dust will be re-introduced into the process. The cleaned exhaust gases will be drawn by a fan through the dryer stack and discharged to the atmosphere.
2. Secondary Crushing and Screening: Due to the abrasive nature of the ore, the secondary crushing and screening circuit will consist of two independent lines. The dryer discharge conveyor will pass the stream of dried ore to one of two vibrating screens. The 10 mm screen undersize will go directly to the screen discharge belt, and the oversize will go to a Hazemag-type impact crusher. The screen discharge belt will feed the undersize, via a transfer belt, to one of three 4-hour capacity fine ore bins, or to a covered conical pile of 10,000 MT. Dust will be controlled at the screens, crushers and all transfer points and drawn to a baghouse where the dust-laden air will be cleaned and exhausted. Collected dust will be returned to the circuit.
3. Fine Ore and Coal Preparation: Each of the three ore bins, as well as the coal bin, will have a variable speed belt feeder at their draw points. The ore bins will be alternately filled, sampled and discharged, and the feeder belt will be equipped with a continuous weight scale. Dust collection equipment is included at all discharge and transfer points. Dust is recovered in a baghouse and returned to the circuit via a screw conveyor.
4. Approximately one month's coal supply will be stored in an open yard and will be reclaimed to an eight-hour bin, which discharges to a transfer conveyor fitted with a belt scale that will combine the required amounts of coal and ore on the balling plant feed conveyor. The balling plant feed conveyor will deliver to a twin paddle-type mixer, where water will be added in controlled proportions. The mixer will feed a 7.6 m variable speed balling disc, where the ore-coal mixture will be brought up to a final moisture content of approximately 22% and agglomerated. Provision has been made for a 6-hour emergency stockpile of green pellets.
5. Calcination: The kiln feed conveyor will transport the pellets to the 6.1x185 m kiln, which will be smoothly lined and fired in a controlled manner with a long flame and additional air injection through on board riding

1/ See flowsheet (page 35).

fans. The kiln will discharge the calcine through its refractory-lined hood surge hopper. Exhaust dust and gases will be collected and ducted to a multiple cyclone. Coarse particles in the cyclone underflow will be returned and the cyclone overflow will be scrubbed and exhausted through the 50 m kiln stack. The dust slurry from the scrubber underflow will go to a thickener with overflow water being recirculated. The thickener underflow will be pumped to a density control tank and reintroduced at the balling disc.

6. Smelting and Refining: The hot calcine will be drawn, via transfer containers supported on a shuttle car, to the furnace charge hoisting shaft and thence to one of nine furnace charging bins via an overhead crane. The 51 MVA, three electrode electric furnace is designed to operate on Soderberg electrode paste and will include hydraulic hoists and automatic slipping devices. The furnace cover will be of the suspended type. The furnace shell will be cylindrical and equipped with three tapholes for slag and two for metal. Dust and gases will go to a baghouse where the dust will be separated and returned. Carbon monoxide emissions will be closely monitored since its presence may indicate abnormal furnace conditions. If present, it will be flared either in the furnace stack or in the furnace itself by introducing excess air.

7. Slag will be tapped about 6 times a shift and run through refractory lined launders to one of two slag casting pits and, ultimately, to dump areas. Ferronickel will be tapped about five times a day. In order to reduce impurities, the metal will be poured into a 40 MT refining ladle and transferred to the refining station. The ladles will be heated with 5 MVA electrodes and stirred by electric induction. Sulfur will be removed by treating the metal with burned lime in the presence of silicon. To improve slag fluidity, fluor-spar will also be added. Phosphorus will be removed by oxidizing with iron ore and fluxing with lime.

8. From refining, the hot metal ladle will be moved to the 60 MT per hour pig casting machine which discharges the 20 kg pigs into a trommel, where they are cooled and cleaned. The pigs are then sorted and stacked manually and finally strapped in 2 MT lots onto pallets to be transported by fork lift truck to the shipping and storage area.

ANNEX 5-4

COLOMBIA
CERRO MATOSO NICKEL PROJECT

CERRO MATOSO IN-HOUSE TRAINING PROGRAM

	Implementation Period		
	<u>Year 1</u>	<u>Year 2</u>	<u>Year 3</u>
<u>Mine Foremen and Operators</u>			
General course & practical training		xxxxx	
<u>Operator Training</u>			
a) <u>Operating Labor</u>			xxx
General Course			
b) <u>Foremen & Key Operators</u>		xxx	
General Course			xxx
Operating Procedures			
Pilot Plant Training			xxx
<u>Maintenance Artisans</u>			
a) <u>Skilled</u>		xxx	
Basic Course (with SENA)			
Advanced Course (with SENA)			xxxxx
b) <u>Semi-Skilled</u>			xxx
Basic Course (with SENA)			

Industrial Projects Department
August 1979

ANNEX 6-1

COLOMBIA
CERRO MATOSO NICKEL PROJECT

Cerro Matoso: Process Energy Consumption, Stage I

Fuel	Ft ³ Million	MT	bbl	Energy Consumption Per Year Equivalent 1/ Gwh	Energy Input per lb of nickel 2/ kwh/lb
<u>Mining</u>					
Diesel Fuel		20,400		13.51	0.27
Sub-Total				<u>13.51</u>	<u>0.27</u>
<u>Drying and Calcining</u>					
Natural Gas	2,671.2			296.80	5.96
Coal		27,540		87.73	1.76
Sub-Total				<u>384.53</u>	<u>7.72</u>
<u>Smelting and Refining</u>					
Smelting Electrode paste		2,810		8.95	0.18
Electric Power (total plant)				541.67	10.88
Refining Electrodes		415		1.32	0.03
Sub-Total				<u>551.94</u>	<u>11.09</u>
Total				<u>949.98</u>	<u>19.08</u>

1/ Power demand assumed at 9000 BTU per kWh.

2/ Based on Stage I Nickel production (49.8 million lb/ annum).

COLOMBIA

ANNEX 6-2CERRO MATOSO NICKEL PROJECTANTICIPATED POWER REQUIREMENTS

<u>Operating Year</u>	<u>51,000 KVA X .97 L/Factor</u>	<u>Operating Time</u>	<u>Furnace KW's Required</u>	<u>Other</u>	<u>Refining</u>	<u>Townsitc</u>	<u>Total KW's</u>	<u>Operating Hrs/Year</u>	<u>Power Consumption GWh/a</u>
1	49,470	63%	31,166	10,798	5313	1200	48,477	8,760	424.66
2	"	80	39,576	"	"	"	56,887	"	498.33
3	"	90	44,523	"	"	"	61,834	"	541.67
4	"	"	"	"	"	"	"	"	"
5	"	"	"	"	"	"	"	"	"
6	"	"	"	"	"	"	"	"	"
7	"	87	43,039	"	"	"	60,350	"	528.67
8	"	90	44,523	"	"	"	61,834	"	541.67
9	"	"	"	"	"	"	"	"	"
10	"	"	44,523/0	10,798/1100	5313	"	61,834/2300	6,570/2190	411.29
11	"	"	44,523	10,798	5313	"	61,834	8,760	541.67
12	"	"	"	"	"	"	"	"	"
13	"	"	"	"	"	"	"	"	"
14	"	87	43,039	"	"	"	60,350	"	528.67
15	"	90	44,523	"	"	"	61,834	"	541.67
16	"	"	"	"	"	"	"	"	"
17	"	"	"	"	"	"	"	"	"
18	"	"	"	"	"	"	"	"	"
19	"	"	"	10,798/1100	5313/0	"	"	"	"
20	"	a/	44,523/0	10,798	5313	"	61,834/2300	6,570/2190	411.29
21	"	"	44,523	"	"	"	61,834	8,760	541.67
22	"	"	"	"	"	"	"	"	"
23	"	"	"	"	"	"	"	"	"
24	"	"	"	"	"	"	"	"	"
25	"	"	"	"	"	"	"	"	"

a/Operates at 90% for 9 months allowing 3 months for furnace reline at reduced demand and energy requirements.

<u>Energy Demand</u>		
Furnace	49,470	
Other	14,896	14,896
Refining	6,149	
Townsitc	3,200	3,200
	72,915	17,296

Source: Hanna/Bechtel
 Industrial Projects Department
 August 1979

COLOMBIA

CERRO MATOSO NICKEL PROJECT

POWER SUPPLY - KEY DATES

<u>Activity</u>	<u>Cerro Matoso Project</u>	<u>500 KV Trans- mission line</u>	<u>500 KV Substations</u>
Award of Contract 500 KV line	-	April 1978	-
Start of Construction 500 KV line	-	Jan. 1979	-
Award of Contract Substations	-	-	Feb. 1980
Start of Design and Manufacture, Substations	-	-	May 1980
Cerro Matoso Start of Construction	June 1979	-	-
500 KV line installed	-	April 1981	
Cerro Matoso needs power	Jan. 1982	-	
Cerro Matoso Construction Completed	April 1982	-	
Substation installed	-	-	May 1982

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COLOMBIA

CERRO MATOSO NICKEL PROJECT

ANNUAL NATURAL GAS REQUIREMENTS

DRYING								CALCINING							
Operating Year	% Moisture	% Moisture Eliminated	Wet MT'S	DMT's + 7% Moisture	Metric Tons H ₂ O	1000 Ft ³ /lb	Million Ft ³ Natural Gas per yr.	DMT	1000 Ft ³ Natural Gas per DMT	Million Ft ³ Natural Gas per year	Total Million Ft ³ Natural Gas per year				
1	24		17	705	576	129	4.59	592.20	536	2.40	1,285.20	1,877.40			
2	"		"	895	731	164	"	749.70	680	"	1,625.40	2,375.10			
3	"		"	1,007	823	184	"	837.90	765	"	1,833.30	2,671.20			
4	"		"	1,007	823	184	"	837.90	765	"	1,833.30	2,671.20			
5	"		"	1,007	823	184	"	837.90	765	"	1,833.30	2,671.20			
6	"		"	1,007	823	184	"	837.90	765	"	1,833.30	2,671.20			
7	"		"	974	796	178	"	812.70	740	"	1,770.30	2,583.00			
8	"		"	1,007	823	184	"	837.90	765	"	1,833.30	2,671.20			
9	"		"	1,007	823	184	"	837.90	765	"	1,833.30	2,671.20			
10	"		"	771	627	144	"	655.20	583	2.58	1,505.70	2,160.90			
11	27	20	1,136	891	245	"	1,121.40	829	"	"	2,142.00	3,263.40			
12	"	"	1,136	891	245	"	1,121.40	829	"	"	2,142.00	3,263.40			
13	"	"	1,136	891	245	"	1,121.40	829	"	"	2,142.00	3,263.40			
14	"	"	1,099	862	237	"	1,083.60	802	"	"	2,072.70	3,156.30			
15	"	"	1,136	891	245	"	1,121.40	829	"	"	2,142.00	3,263.40			
16	"	"	1,136	891	245	"	1,121.40	829	"	"	2,142.00	3,263.40			
17	29	22	1,177	905	272	"	1,241.10	842	2.65	"	2,142.00	3,263.40			
18	"	"	1,193	911	282	"	1,285.20	847	"	"	2,230.20	3,471.30			
19	"	"	1,193	911	282	"	1,285.20	847	"	"	2,242.80	3,528.00			
20	"	"	901	688	213	"	970.20	640	"	"	2,242.80	3,528.00			
21	"	"	1,193	911	282	"	1,285.20	847	"	"	2,242.80	3,528.00			
22	"	"	1,193	911	282	"	1,285.20	847	"	"	2,242.80	3,528.00			
23	"	"	1,193	911	282	"	1,285.20	847	"	"	2,242.80	3,528.00			
24	"	"	1,193	911	282	"	1,285.20	847	"	"	2,242.80	3,528.00			
25	29	22	1,193	911	282	"	1,285.20	847	3.63	"	2,242.80	3,528.00			
TOTAL			26,595	20,955	5,640	4.59	25,735.50	19,487			49,593.60	75,329.10			
25 Year Average								1,029.42				1,983.74	3,013.16		

/a Used 1000 BTU/ft³

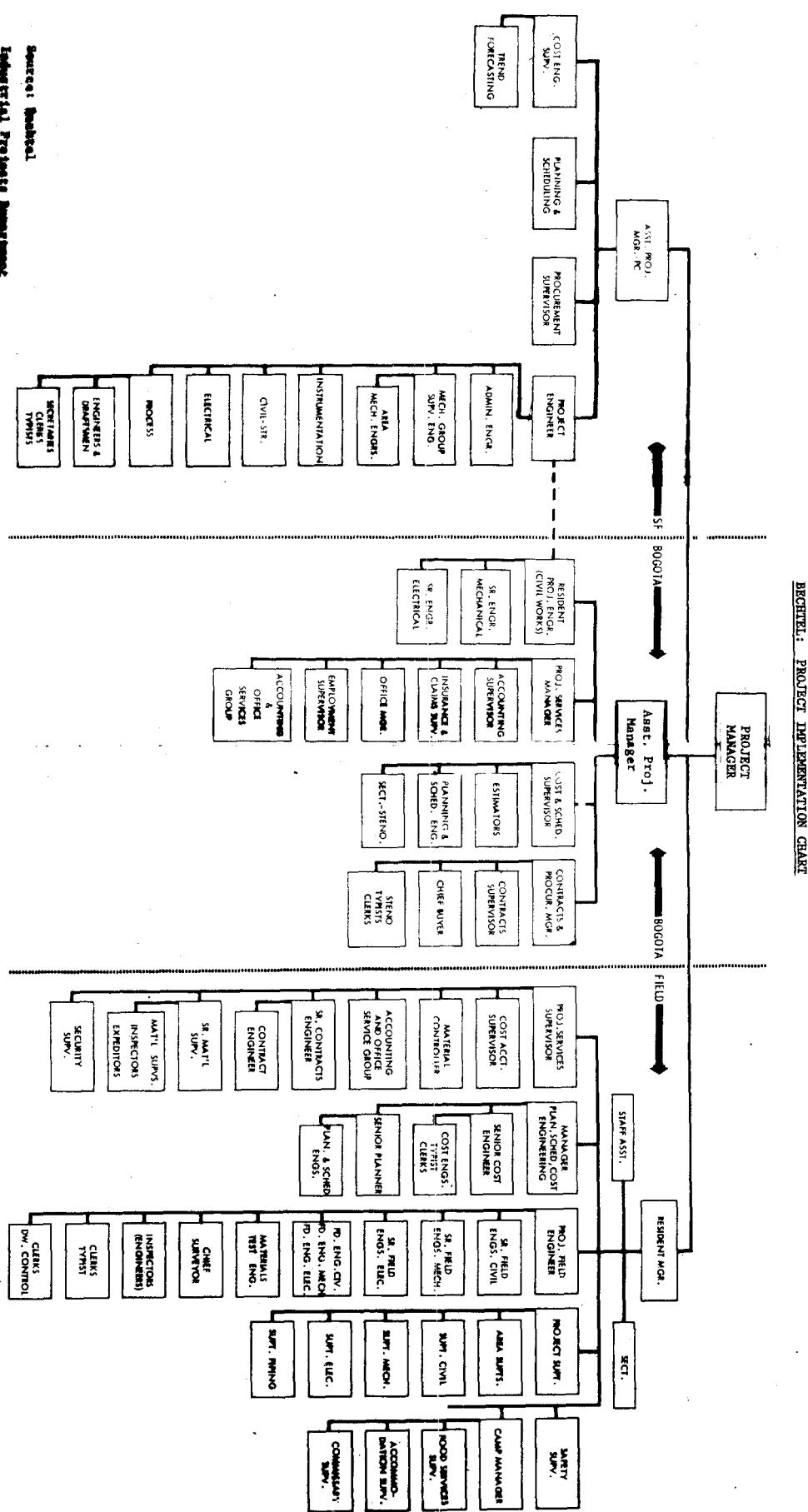
**Equivalent to 2,058 BTU per pound H₂O - 1975 Riddle experience
Pilot plant experience**

Source: Hanna/Bechtel

Industrial Projects Department
August 1979

COLOMBIA
CERRO MATOSO NICKEL PROJECT

BECHTEL: PROJECT IMPLEMENTATION CHART



COLOMBIA

CERRO MATOSO NICKEL PROJECT

PROJECTED WORKING CAPITAL REQUIREMENTS

(US\$ 000 - CURRENT TERMS)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
MINIMUM OPERATING CASH	675	1,007	980	1,018	1,080	1,141	1,166	1,216	1,287	1,352	1,423	1,494
ACCOUNTS RECEIVABLE	8,822	18,191	25,565	29,844	31,790	33,558	35,361	37,217	38,973	34,442	36,883	40,468
INVENTORIES												
RAW MATERIAL	626	906	953	986	961	1,090	1,058	1,065	1,202	1,285	1,351	1,427
WORK IN PROGRESS	2,176	3,491	4,081	4,386	4,601	4,907	5,083	5,407	5,790	5,155	6,215	6,962
NICKEL METAL	2,426	5,003	7,030	8,207	8,742	9,228	9,724	10,235	10,718	9,471	10,143	11,129
SPARES	7,142	8,006	8,648	9,819	10,671	11,781	13,473	15,096	15,879	17,412	18,573	19,918
TOTAL CURRENT ASSETS	21,867	36,604	47,257	54,260	57,845	61,705	65,865	70,236	73,849	69,117	74,588	81,398
ACCOUNTS PAYABLE	5,591	9,514	11,493	12,619	13,361	14,244	14,925	15,862	16,894	15,209	17,581	19,496
NET WORKING CAPITAL	16,276	27,090	35,764	41,641	44,484	47,461	50,940	54,374	56,955	53,908	57,007	61,902
CHANGE IN WORKING CAPITAL	16,276	10,814	8,674	5,877	2,843	2,977	3,479	3,434	2,581	(3,047)	3,099	4,895
	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====

INDUSTRIAL PROJECTS DEPARTMENT
REPORT PREPARED: AUGUST 1979

COLOMBIACERRO MATOSO NICKEL PROJECTESTIMATED DISBURSEMENT SCHEDULE FOR BANK LOAN

<u>Bank Fiscal Year and Quarter</u>	<u>Estimated Disbursements</u>	<u>Cumulative Estimated Disbursements</u>
----- (US\$000) -----		
<u>FY 1980</u>		
October-December 1979	4,200	4,200
January-March 1980	12,800	17,000
April-June	10,000	27,000
<u>FY 1981</u>		
July-September 1980	11,000	38,000
October-December 1980	10,400	48,400
January-March 1981	10,400	58,800
April-June	6,500	65,300
<u>FY 1982</u>		
July-September 1981	4,500	69,800
October-December 1981	3,800	73,600
January-March 1982	1,400	75,000
April-June 1982	-	75,000
<u>FY 1983</u>		
July-September 1982	-	75,000
October-December 1982	500	75,500
January-March 1983	2,000	77,500
April-June 1983	2,500	80,000

COLOMBIA
CERRO MATOBO NICKEL PROJECT
OPERATING COST SCHEDULE
(U\$* 000 - 1979 TERMS)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
A. MINE												
MINING AND STRIPPING												
POWER	10	14	16	16	16	16	16	16	16	13	15	16
LABOR	191	255	255	255	255	255	255	255	255	255	255	255
FUEL	674	919	910	888	807	874	791	744	801	818	817	822
CONSUMABLES AND SUPPLIES	946	1,290	1,278	1,247	1,133	1,228	1,111	1,044	1,124	1,149	1,146	1,153
SUB-TOTAL	1,821	2,478	2,459	2,406	2,211	2,373	2,173	2,059	2,196	2,235	2,233	2,246
CRUSHING, SCREENING AND STOCKPILING												
POWER	191	288	318	325	325	325	319	323	325	266	305	325
LABOR	61	81	81	81	81	81	81	81	81	81	81	81
FUEL	674	919	910	888	807	874	791	744	801	818	817	822
CONSUMABLES AND SUPPLIES	695	947	939	916	832	901	816	767	825	844	842	847
SUB-TOTAL	1,621	2,235	2,248	2,210	2,045	2,181	2,007	1,915	2,032	2,009	2,045	2,075
B. PLANT												
RECLAMATION, DRYING, CRUSHING												
POWER	382	576	637	650	650	650	638	646	650	533	611	650
LABOR	149	198	198	198	198	198	198	198	198	198	198	198
FUEL	1,139	1,825	2,109	2,168	2,168	2,168	2,149	2,163	2,168	1,766	2,146	2,350
CONSUMABLES AND SUPPLIES	396	618	714	734	734	734	728	732	734	598	727	796
SUB-TOTAL	2,056	3,217	3,658	3,750	3,750	3,750	3,713	3,739	3,750	3,095	3,682	3,994
COAL BLENDING, HAULING												
POWER	86	130	143	146	146	146	144	145	146	120	137	146
LABOR	101	134	134	134	134	134	134	134	134	134	134	134
CONSUMABLES AND SUPPLIES	72	116	134	138	138	138	136	137	138	112	136	149
OTHER (COAL)	289	464	536	551	551	551	546	549	551	449	545	597
SUB-TOTAL	548	844	947	969	969	969	960	965	969	815	952	1,026
CALCINATION												
POWER	478	720	796	813	813	813	798	808	813	666	764	813
LABOR	70	93	93	93	93	93	93	93	93	93	93	93
FUEL	2,188	3,504	4,049	4,163	4,163	4,163	4,125	4,152	4,163	3,390	4,119	4,511
CONSUMABLES AND SUPPLIES	32	52	60	61	61	61	61	61	61	50	61	66
SUB-TOTAL	2,768	4,369	4,998	5,130	5,130	5,130	5,077	5,114	5,130	4,199	5,037	5,483
SMELTING												
POWER	6,803	10,251	11,338	11,571	11,571	11,571	11,361	11,500	11,571	9,482	10,874	11,571
LABOR	359	479	479	479	479	479	479	479	479	479	479	479
CONSUMABLES	611	979	1,131	1,163	1,163	1,163	1,152	1,160	1,163	947	1,151	1,260
OTHER	50	80	92	95	95	95	94	95	95	77	94	103
SUB-TOTAL	7,823	11,789	13,040	13,308	13,308	13,308	13,086	13,234	13,308	10,985	12,598	13,413
REFINING												
POWER	784	1,101	1,306	1,333	1,333	1,333	1,308	1,324	1,333	1,092	1,252	1,333
LABOR	257	342	342	342	342	342	342	342	342	342	342	342
CONSUMABLES AND SUPPLIES	519	831	960	987	987	987	978	984	987	804	977	1,069
OTHER	1,584	2,537	2,931	3,014	3,014	3,014	2,987	3,006	3,014	2,455	2,983	3,266
SUB-TOTAL	3,144	4,891	5,539	5,676	5,676	5,676	5,615	5,656	5,676	4,693	5,554	6,010
OVERHEAD AND ADMINISTRATION												
POWER	382	576	637	650	650	650	638	646	650	533	611	650
LABOR	440	803	447	382	382	243	174	174	174	174	174	174
PLANT MOBILE	173	277	320	329	329	329	326	328	329	268	326	356
MAINTENANCE SUPPLIES	276	367	367	367	367	367	367	367	367	367	367	367
OTHER	427	569	569	569	569	569	569	569	569	569	569	569
SUB-TOTAL	1,698	2,592	2,340	2,297	2,297	2,297	2,143	2,084	2,089	1,911	2,047	2,116
TOWNSITE												
POWER	430	648	717	731	731	731	718	727	731	599	687	731
LABOR	127	169	169	169	169	169	169	169	169	169	169	169
MAINTENANCE	73	97	97	97	97	97	97	97	97	97	97	97
OTHER	642	856	856	856	856	856	856	856	856	856	856	856
SUB-TOTAL	1,272	1,770	1,839	1,853	1,853	1,853	1,840	1,849	1,853	1,721	1,809	1,853
C. OFFSITES												
INSURANCE	893	1,191	1,191	1,191	1,191	1,191	1,191	1,191	1,191	1,191	1,191	1,191
TECHNICAL COMMITTEE	363	484	484	484	484	484	484	484	484	484	484	484
HANNA TECH. ASSISTANCE	543	893	1,059	1,096	1,096	1,096	1,086	1,093	1,096	893	954	998
BOGOTÁ ADMINISTRATION	1,050	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400
SALES/FREIGHT COST	1,548	2,821	3,471	3,658	3,677	3,677	3,648	3,664	3,675	3,097	3,169	3,325
SUB-TOTAL	4,397	6,789	7,605	7,829	7,848	7,848	7,809	7,832	7,846	7,065	7,198	7,398
TOTAL OPERATING COSTS	27,148	40,974	44,673	45,428	45,087	45,385	44,423	44,447	44,849	38,728	43,155	45,614

COLOMBIA

CERRO MATOSO NICKEL PROJECT

PROJECTED INCOME STATEMENT

(US\$ 000 - CURRENT PRICES)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
PRODUCTION (000 LB.)	24,678	40,609	48,159	49,822	49,822	49,822	49,366	49,692	49,822	40,574	43,366	45,346
SALES (000 LB.)	20,976	38,220	47,026	49,573	49,822	49,822	49,434	49,643	49,803	41,961	42,947	45,049
PRICE FOB (US\$/LB.)	3.96	3.27	3.61	3.99	4.22	4.45	4.72	4.94	5.15	5.40	5.65	5.91
GROSS SALES REVENUE	62,089	124,979	169,764	197,796	210,249	221,708	233,328	245,236	256,485	236,589	242,651	266,240
SALES DISCOUNT	3,850	7,536	9,982	11,274	11,564	11,972	12,320	12,630	12,901	11,329	12,133	13,312
QUALITY DISCOUNT	3,104	3,749	-	-	-	-	-	-	-	-	-	-
NET SALES REVENUE	55,135	113,694	159,782	186,522	198,685	209,736	221,008	232,606	243,584	215,260	230,518	252,928
PRODUCTION COSTS												
MINING & STRIPPING	2,276	3,296	3,467	3,585	3,493	3,963	3,846	3,871	4,370	4,671	4,913	5,188
CRUSHING, SCREENING												
AND STOCKPILING	2,026	2,973	3,170	3,293	3,231	3,642	3,552	3,600	4,044	4,199	4,499	4,793
RECLAMATION, DRYING												
AND CRUSHING	2,570	4,279	5,158	5,588	5,925	6,263	6,572	7,029	7,463	6,469	8,100	9,226
COAL BLENDING	685	1,123	1,335	1,444	1,531	1,618	1,699	1,814	1,928	1,703	2,094	2,370
CALCINATION	3,460	5,811	7,047	7,644	8,105	8,567	8,986	9,614	10,209	8,776	11,081	12,666
Smelting	9,779	15,679	18,386	19,829	21,027	22,224	23,162	24,880	26,483	22,959	27,716	30,984
REFINING	3,930	6,505	7,810	8,457	8,968	9,479	9,939	10,633	11,295	9,808	12,219	13,883
SUB-TOTAL	24,726	39,666	46,373	49,840	52,280	55,756	57,756	61,441	65,792	58,585	70,622	79,110
COST OF GOODS SOLD	21,017	37,425	45,367	49,320	51,914	55,235	57,456	60,888	65,139	59,666	68,817	77,837
INVENTORY ADJUSTMENT	3,709	2,241	1,006	520	366	521	300	553	653	(1,081)	1,805	1,273
GROSS MARGIN	34,118	76,269	114,415	132,202	146,771	154,501	163,552	171,718	178,445	155,594	161,701	175,091
OPERATING EXPENSES												
OVERHEAD AND ADMIN.	2,123	3,447	3,299	3,423	3,629	3,836	3,793	3,918	4,157	3,994	4,503	4,888
TOWNSITE	1,590	2,354	2,593	2,761	2,928	3,095	3,257	3,476	3,687	3,597	3,980	4,280
INSURANCE	893	1,191	1,191	1,191	1,191	1,191	1,191	1,191	1,191	1,191	1,191	1,191
TECHNICAL COMMITTEE	454	644	682	721	765	808	857	910	963	1,012	1,045	1,118
HANNA TECH. ASSIST.	679	1,116	1,324	1,370	1,370	1,370	1,799	1,810	1,815	1,479	1,581	1,654
BOGOTA ADMIN.	1,313	1,862	1,974	2,086	2,212	2,338	2,478	2,632	2,786	2,926	3,080	3,234
SALARIES/FREIGHT COST	1,935	3,752	4,894	5,450	5,810	6,141	6,457	6,888	7,313	6,473	6,972	7,681
LOCAL TAXES	351	412	371	339	308	282	263	245	223	218	201	189
GOVERNMENT ROYALTY	-	1,520	4,903	7,048	8,101	8,971	9,942	10,792	11,451	9,987	10,220	11,340
SUB-TOTAL	9,338	16,298	21,231	24,389	26,314	28,032	30,037	31,862	33,586	30,877	32,793	35,575
OPERATING PROFIT	24,780	59,971	93,184	112,813	120,457	126,469	133,515	139,856	144,859	124,717	128,908	139,516
DEPRECIATION	19,506	22,761	20,521	18,691	16,989	15,314	14,000	12,864	11,542	10,789	9,736	8,698
AMORTIZATION	9,207	9,207	9,207	9,207	9,207	9,207	9,207	9,207	9,207	9,207	9,207	9,207
PRE-PROD. DEPLETION	-	-	2,707	3,385	251	-	-	-	-	-	-	-
FINANCIAL CHARGES												
IBRD	5,700	7,840	7,400	6,600	5,800	5,000	4,200	3,400	2,600	1,800	1,000	200
SUPPLIERS CREDITS	1,520	2,220	1,960	1,730	1,490	1,250	1,010	770	540	300	60	-
COMMERCIAL LOANS	6,330	10,110	8,870	7,150	5,470	3,790	2,110	430	-	-	-	-
SUB-TOTAL	13,550	20,170	18,230	15,480	12,760	10,040	7,320	4,600	3,140	2,100	1,060	200
PROFIT BEFORE TAX	(17,483)	7,833	42,519	66,050	81,250	101,115	112,195	122,392	130,177	111,028	118,112	130,618
INCOME TAX	-	-	11,975	24,532	28,874	36,320	40,305	43,992	46,803	40,137	42,544	47,031
NET PROFIT AFTER TAX	(17,483)	7,833	30,544	41,518	52,376	64,795	71,890	78,400	83,374	71,691	75,568	83,587

COLOMBIA

CERRO MATOSO NICKEL PROJECT

PROJECTED SOURCES AND APPLICATIONS OF FUNDS
(US\$ 000 - CURRENT TERMS)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	
SOURCES OF FUNDS																
PROFIT BEFORE INTEREST AND TAX	-	-	-	(3,933)	28,003	60,749	81,530	94,010	111,155	119,515	126,992	133,317	113,928	119,172	130,818	
DEPRECIATION	-	-	-	19,506	22,761	20,521	18,691	16,989	15,314	14,000	12,864	11,542	10,789	9,736	8,698	
AMORTIZATION	-	-	-	9,207	9,207	9,207	9,207	9,207	-	-	-	-	-	-	-	
FRE-PRODUCTION DEPLETION	-	-	-	-	-	2,707	3,385	251	-	-	-	-	-	-	-	
INTERNAL CASH GENERATION	-	-	-	24,780	59,971	93,184	112,813	120,457	126,469	133,515	139,856	144,859	124,717	128,908	139,516	
LONG-TERM DEBT																
IBRD	4,200	44,200	25,200	1,900	4,500	-	-	-	-	-	-	-	-	-	-	
SUPPLIERS CREDIT	2,000	10,000	12,000	1,600	-	-	-	-	-	-	-	-	-	-	-	
COMMERCIAL LOAN	5,800	12,800	82,300	-	-	-	-	-	-	-	-	-	-	-	-	
EQUITY	25,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
NEW EQUITY	10,000	40,000	-	34,500	4,500	-	-	-	-	-	-	-	-	-	-	
TOTAL SOURCES	47,000	107,000	119,500	62,780	68,971	93,184	112,813	120,457	126,469	133,515	139,856	144,859	124,717	128,908	139,516	
APPLICATIONS OF FUNDS																
FIXED ASSETS	20,757	101,898	106,116	14,508	8,547	-	-	-	-	-	-	-	-	-	-	
PRE-PRODUCTION EXPENSES	25,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
INTEREST DURING CONSTRUCTION	1,240	5,000	13,330	7,810	-	-	-	-	-	-	-	-	-	-	-	
REPLACEMENTS	-	-	-	544	532	451	2,686	1,381	2,136	4,427	3,052	426	4,121	1,525	2,414	
RELINING	-	-	-	-	-	-	-	-	-	168	-	-	4,096	-	-	
INCREASE IN WORKING CAPITAL	-	-	-	16,276	10,814	8,674	5,877	2,843	2,977	3,479	3,434	2,581	(3,047)	3,099	4,895	
INTEREST CHARGES	-	-	-	13,550	20,170	18,230	15,480	12,760	10,040	7,320	4,600	3,140	2,100	1,060	200	
DEBT REPAYMENT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
IBRD	-	-	-	-	4,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	4,000	
SUPPLIERS CREDITS	-	-	-	1,280	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	1,280	-	
COMMERCIAL LOAN	-	-	-	-	8,408	16,817	16,817	16,817	16,817	16,817	16,817	16,817	16,817	-	-	
INCOME TAX PAID	-	-	-	-	-	-	11,975	24,532	28,874	36,320	40,305	43,992	46,803	40,137	42,544	
REMITTANCE TAX	-	-	-	-	-	-	4,110	5,185	6,415	7,117	7,762	8,254	7,097	7,569	9,195	
DIVIDENDS TO ECONIQUEL	-	-	-	-	-	-	7,676	16,815	21,212	26,242	29,116	31,752	33,767	29,035	30,965	37,614
REMITTANCE ABROAD	-	-	-	-	-	-	7,505	16,441	20,741	25,658	28,468	31,046	33,016	28,390	30,276	36,778
TOTAL APPLICATIONS	46,997	106,898	119,446	53,968	55,031	71,789	100,761	116,031	129,719	143,792	141,710	135,736	129,155	123,911	137,640	
ANNUAL SURPLUS	3	102	54	8,812	13,940	21,395	12,052	4,426	(3,250)	(10,277)	(1,862)	9,123	(4,438)	4,997	1,876	

INDUSTRIAL PROJECTS DEPARTMENT
REPORT PREPARED AUGUST 1979

COLOMBIA
CENTRO MATABO NICKEL PROJECT
PROJECTED BALANCE SHEET
(U\$M 000 - CURRENT TERMS)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
ASSETS												
CASH (OPERATING)	675	1,007	980	1,018	1,080	1,141	1,166	1,216	1,287	1,352	1,423	1,494
ACCOUNTS RECEIVABLE	8,822	18,191	25,565	29,844	31,790	33,358	35,361	37,217	38,973	34,442	36,883	40,468
INVENTORY	5,228	9,400	12,064	13,579	14,304	15,225	15,865	16,707	17,710	15,911	17,709	19,518
SUPPLIES AND SPARES	7,142	8,006	8,648	9,819	10,671	11,781	13,473	15,096	15,879	17,412	18,573	19,918
SUB-TOTAL	21,867	36,604	47,257	54,260	57,045	61,705	65,865	70,236	73,849	69,117	74,588	81,398
CASH (SURPLUS)	8,971	22,911	44,306	56,358	60,784	57,534	47,257	45,395	54,518	50,080	55,077	56,953
TOTAL CURRENT ASSETS	30,838	59,515	91,563	110,618	118,629	119,239	113,122	115,631	128,367	119,197	129,665	138,351
GROSS FIXED ASSETS	296,203	305,282	305,733	308,419	309,800	311,936	316,531	320,383	320,809	329,026	330,551	332,965
ACCUMULATED DEPREC.	19,506	42,267	62,788	81,479	98,468	113,782	127,782	140,646	152,188	162,977	172,713	181,411
ACCUMULATED AMORT.	9,207	18,414	27,621	36,828	46,035	46,035	46,035	46,035	46,035	46,035	46,035	46,035
ACCUMULATED DEPLET.	-	-	2,707	6,092	6,343	6,343	6,343	6,343	6,343	6,343	6,343	6,343
NET FIXED ASSETS	267,490	244,601	212,617	184,020	158,954	145,776	136,371	127,359	116,243	113,671	105,460	99,176
TOTAL ASSETS	298,328	304,116	304,180	294,638	277,583	265,015	249,493	242,990	244,610	232,868	235,125	237,527
LIABILITIES												
ACCOUNTS PAYABLE	5,591	9,514	11,493	12,619	13,361	14,244	14,925	15,862	16,894	15,209	17,581	19,496
TAXES PAYABLE	-	-	11,975	24,532	28,874	36,320	40,305	43,992	46,803	40,137	42,544	47,031
CURRENT DEBT	14,968	27,377	27,377	27,377	27,377	27,377	18,967	10,560	9,280	4,000	-	-
TOTAL CURRENT LIAB.	20,559	36,891	50,845	64,528	69,612	77,941	74,197	70,414	74,257	64,626	64,125	66,527
LONG-TERM DEBT												
IBRD	71,500	68,000	60,000	52,000	44,000	36,000	28,000	20,000	12,000	4,000	-	-
SUPPLIERS CREDIT	21,760	19,200	16,640	14,080	11,520	8,960	6,400	3,840	1,280	-	-	-
COMMERCIAL LOANS	92,492	75,675	58,858	42,041	25,224	B,407	-	-	-	-	-	-
TOTAL	185,752	162,875	135,498	108,121	80,744	53,367	34,400	23,840	13,280	4,000	-	-
ACCUM. LEGAL RESERVES	-	783	3,837	7,989	13,227	19,707	26,896	34,736	43,073	50,242	57,000	57,000
PAID IN EQUITY	109,500	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000
RETAINED EARNINGS	(17,483)	(10,433)	-	-	-	-	-	-	-	-	-	-
TOTAL EQUITY	92,017	103,567	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000
TOTAL LIABILITIES AND EQUITY	298,328	304,116	304,180	294,638	277,583	265,015	249,493	242,990	244,610	232,868	235,125	237,527

INDUSTRIAL PROJECTS DEPARTMENT
REPORT PREPARED: AUGUST 1979

COLOMBIA
CERRO MATOSO NICKEL PROJECT
SELECTED FINANCIAL INDICATORS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
ACTIVITY												
PRODUCTION	24,678	40,609	48,159	49,822	49,822	49,822	49,366	49,692	49,822	40,574	43,366	45,346
% OF ANNUAL CAPACITY	50	82	97	100	100	100	99	100	100	81	87	91
SALES (\$000)	55,135	113,694	159,782	186,522	198,685	209,736	221,008	232,606	243,584	215,260	230,518	252,928
GROSS PROFIT	34,118	76,269	114,415	137,202	146,771	154,501	163,552	171,718	178,445	155,594	161,701	175,091
OPERATING PROFIT	24,780	59,971	93,184	112,813	120,457	126,469	133,515	139,856	144,859	124,717	128,900	139,516
INTEREST CHARGES	13,550	20,170	18,230	15,480	12,740	10,040	7,320	4,600	3,140	2,100	1,060	200
CASH GENERATION	24,780	59,971	96,116	117,533	129,522	136,785	144,948	152,267	158,028	136,202	140,661	152,557
PROFITABILITY												
NET PROFIT AFTER TAX	(17,483)	7,833	30,544	41,518	52,376	64,795	71,890	78,400	83,374	71,691	75,568	83,587
INCOME TAX	-	-	11,975	24,532	28,874	36,320	40,305	43,992	46,803	40,137	42,544	47,031
NET PROF. BEF. TAX	-	7	27	35	41	48	51	53	53	52	51	52
AS % OF SALES	-	7	19	22	26	31	33	34	34	33	33	33
NET PROF. AFT. TAX	-	7	19	22	26	31	33	34	34	33	33	33
AS % OF SALES	-	3	10	14	19	24	29	32	34	31	32	35
AS % OF ASSETS	-	3	10	14	19	24	29	32	34	31	32	35
LIQUIDITY												
CURRENT RATIO	1.50	1.61	1.80	1.71	1.70	1.53	1.52	1.64	1.73	1.84	2.02	2.08
QUICK RATIO	0.90	1.14	1.39	1.35	1.35	1.18	1.13	1.19	1.28	1.33	1.46	1.49
DEBT AS % OF EQUITY	0.67	0.61	0.54	0.49	0.41	0.32	0.23	0.17	0.10	0.03	-	-
DEBT SERVICE COVERAGE	1.67	1.71	2.04	2.35	2.39	2.61	2.80	4.22	7.36	6.15	8.59	23.09
PROFIT BREAK-EVEN												
CAPACITY UTILIZATION	1.85	0.94	0.64	0.52	0.46	0.35	0.32	0.29	0.27	0.28	0.27	0.25
PRICE	1.40	0.97	0.77	0.68	0.65	0.58	0.55	0.54	0.53	0.54	0.56	0.55
CASH BREAK-EVEN												
CAPACITY UTILIZATION	1.15	0.82	0.70	0.59	0.54	0.44	0.41	0.33	0.26	0.28	0.27	0.22
PRICE	1.43	1.10	0.94	0.83	0.79	0.71	0.68	0.62	0.57	0.59	0.60	0.57

INDUSTRIAL PROJECTS DEPARTMENT
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COLOMBIA
CERRO MATOSQ NICKEL PROJECT

ANNEX 10

ESTIMATED FOREIGN EXCHANGE INFLOW GENERATED BY THE PROJECT
 (US \$ Million - 1979 Terms)

Year	Foreign Exchange Outflow						Foreign Exchange Inflow					
	Capital Costs	Working Capital	Operat-ing Costs	Loans on Foreign Loans	Repayment of Foreign Loans	Dividends to Private Sponsors	Sub-Total	Foreign Loans	Equity Inflow from Private Sponsors	Exports	Sub-Total	Net Flow
1979	9.4	-	-	1.2	-	-	10.6	11.2	8.3	-	19.5	8.9
1980	45.9	-	-	4.5	-	-	50.4	60.4	15.7	-	76.1	25.7
1981	47.8	-	-	11.3	-	-	59.1	101.3	-	-	101.3	42.2
1982	6.7	12.0	6.5	17.0	1.0	-	43.2	2.8	10.6	44.1	57.5	14.3
1983	4.1	7.5	9.8	15.2	11.3	-	47.9	3.4	6.2	85.5	95.1	47.2
1984	.3	5.7	10.7	12.9	19.4	5.3	54.3	-	-	113.3	113.3	59.0
1985	1.8	3.7	10.9	10.4	18.4	11.0	56.2	-	-	125.2	125.2	69.0
1986	.9	1.7	10.8	8.1	17.3	13.1	51.9	-	-	125.8	125.8	73.9
1987	1.3	1.7	10.9	6.0	16.4	15.4	51.7	-	-	125.6	125.6	73.9
1988	2.5	1.8	10.7	4.1	15.5	16.1	50.7	-	-	124.9	124.9	74.2
1989	2.1	1.8	10.7	2.4	10.1	16.5	38.0	-	-	123.7	123.7	85.7
1990	.2	1.2	10.6	1.6	5.3	16.6	35.5	-	-	122.4	122.4	86.9
1991	3.9	(1.4)	9.3	1.0	5.1	13.6	31.5	-	-	103.0	103.0	71.5
1992	.7	2.2	10.4	.1	4.4	13.8	31.6	-	-	104.8	104.8	73.2
1993	1.0	3.0	10.9	-	1.7	15.9	32.5	-	-	109.5	109.5	77.0
1994	4.3	-	10.9	-	-	15.9	31.1	-	-	109.5	109.5	78.4
1995	1.1	-	10.9	-	-	15.9	27.9	-	-	109.5	109.5	81.6
1996	.1	-	10.9	-	-	15.9	26.9	-	-	109.5	109.5	82.6
1997	.1	-	10.9	-	-	15.9	26.9	-	-	109.5	109.5	82.6
1998	.3	-	10.9	-	-	15.9	27.2	-	-	109.5	109.5	82.3
1999	.1	-	10.9	-	-	15.9	26.9	-	-	109.5	109.5	82.6
2000	.5	-	10.9	-	-	15.9	27.3	-	-	109.5	109.5	82.2
2001	.0	-	10.9	-	-	15.9	26.8	-	-	109.5	109.5	82.7
2002	.0	-	10.9	-	-	15.9	26.8	-	-	109.5	109.5	82.7
2003	.0	-	10.9	-	-	15.9	26.8	-	-	109.5	109.5	82.7

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