

C A R A J A S

IRON ORE PROJECT

CVRD CARES:

The essential

- human

- environmental

- social

work undertaken

by CVRD

1984 EDITION

BRAZIL'S CARAJAS IRON ORE PROJECT

- ENVIRONMENTAL ASPECTS -

- SOCIAL COMPONENT -

INFORMATION

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PART A : ENVIRONMENTAL ASPECTS

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COMPANHIA VALE DO RIO DOCE

April 6, 1984

BRAZIL'S CARAJAS IRON ORE PROJECT
- ENVIRONMENTAL ASPECTS -

Presented at the
Commission of the European Communities
Brussels and Luxembourg
February 21, 1983

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Preface and Acknowledgements

This paper summarizes the environmental management activities of the Companhia Vale do Rio Doce of Brazil, with particular emphasis on the Carajas Iron Ore Project currently being implemented in the Amazon Region.

The authors wish to acknowledge the collaboration of colleagues who provided detailed information on their areas of specialization. In sequence of material presented in the paper, thanks are given to:

- 1 - CVRD Southern System Pollution Control: Roosevelt Fernandes da Silva, SUPEL, CVRD; Eustaquio Mendes, SUMIN, CVRD.
- 2 - Brazilian Environmental Progress: Paulo Nogueira Neto, SEMA.
- 3 - FRD: Forest Reserve of Linhares, Espirito Santo: Renato Moraes de Jesus, FRD.
- 4 - FUNAI: Amerindian Sub Project: Iara Ferraz, Anthropologist.
- 5 - Carajas Mine Pollution Control: Mozart Kraemer Litwinski, SUNOR, CVRD.

Acknowledgements also to Robert Goodland, Office of Environmental Affairs of the World Bank; Eduardo Rocha Porto and Luis Fernandes Braga Neto, CVRD Ecologists for detailed information on the Environmental Management Program Activities; Katia Serejo Genes, Carlos Manoel China, and particularly for Eliana Mendes for secretarial services.

The work describes the evolution of the Company's ecological consciousness, first, in response to severe environmental problems faced in iron ore mining, transport and shipping operations in densely populated Southern Brazil and second, in response to the challenge of constructing and operating a large-scale mining project in the fragile and little known Amazon Region.

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Acronyms

ABA	Associação Brasileira de Antropologia (Brazilian Association of Anthropology)
BNDES	Banco Nacional de Desenvolvimento Econômico e Social (National Bank for Economic and Social Development)
CETESB	Companhia de Tecnologia de Saneamento Ambiental (Environmental Sanitation Technology Company of São Paulo)
CIMA	Comissão Interna de Meio Ambiente (Internal Environmental Commission of CVRD)
CIPA	Comissão Interna de Prevenção de Acidentes (Internal Accident Prevention Commission of CVRD related to the Ministry of Labor)
CNPq	Conselho Nacional de Desenvolvimento Científico e Tecnológico (National Council for Scientific and Technological Development)
CVRD	Companhia Vale do Rio Doce
DEURK	Departamento de Projeto de Núcleos Urbanos (Townsites Design Department)
DOCEGEO	Rio Doce Geologia (CVRD Geological Research Subsidiary)
EEC	European Economic Community
EMBRAPA	Empresa Brasileira de Pesquisas Agropecuárias (Brazilian Agency for Agricultural Research, Ministry of Agriculture)
FADESP	Fundação de Aniparo e Desenvolvimento da Pesquisa (Foundation for Research Support and Development)
FBCN	Fundação Brasileira para Conservação da Natureza (Brazilian Nature Conservation Foundation)
FUNAI	Fundação Nacional do Índio (National Foundation for Indigenous Populations, Ministry of the Interior)
FUNDACAO SESP	Fundação de Serviços de Saúde Pública (Public Health Services Foundation, Ministry of Health)
GEAMAM	Grupo de Estudos e Assessoramento sobre Meio Ambiente (Environmental Studies and Advisory Group of CVRD)

GETAT	Grupo Executivo das Terras do Araguaia-Tocantins (Executive Group for the Araguaia-Tocantins Area)
IBDF	Instituto Brasileiro de Desenvolvimento Florestal (Brazilian Institute for Forest Development, Ministry of Agriculture)
IBGE	Instituto Brasileiro de Geografia e Estatística (Brazilian Institute of Geography and Statistics)
INCRA	Instituto Nacional de Colonização e Reforma Agrária (National Institute for Colonization and Agrarian Reform)
INPA	Instituto Nacional de Pesquisa da Amazonia, CNPq (National Institute for Amazon Research)
INPE	Instituto Nacional de Pesquisas Espaciais, CNPq (National Institute for Space Research)
IPHAN	Instituto do Patrimônio Histórico e Artístico Nacional (National Institute of Historic and Artistic Patrimony, Ministry of Education)
IRI	Instituto de Pesquisa Hortícola (Agricultural Research Institute)
KfW	Kreditanstalt für Wiederaufbau (West German Reconstruction Bank)
SEMA	Secretaria Especial do Meio Ambiente (Special Secretary of Environment, Ministry of the Interior)
SEPLAN	Secretaria de Planejamento (Secretary of Planning, Ministry of Planning)
SERNAT	Secretaria de Recursos Naturais, Tecnologia e Meio Ambiente (Secretary of Natural Resources, Technology and Environment - Representative of SEMA in Maranhão)
SNT	Serra Norte The mine site of the Carajas Iron Ore Project
SOPREN	Sociedade de Preservação de Recursos Naturais e Culturais da Amazonia (Society for the Preservation of Amazon Natural and Cultural Resources)
SPU	Serviço Patrimônio da União (Federal Patrimony Service)
SUCAM	Superintendência de Campanhas (da Saúde) (Superintendency of Health Campaigns, Ministry of Health)

- SUDAM **Superintendência do Desenvolvimento da Amazonia
(Superintendency for Amazon Development, Ministry of the Interior)**
- SUCAR **Superintendencia de Implantacao do Projeto Carajas
(Carajas Iron Ore Project Implementation Superintendency of CVRD)**
- SUMIN **Superintendencia da Mina
(Mines Superintendency of CVRD)**
- SUPEL **Superintendencia de Pelotizacao
(Pelotizing Superintendency of CVRD)**
- SUNOR **Superintendencia de Pre-Operacao do Projeto Ferro Carajas
(Carajas Iron Ore Project Preoperation Superintendency of CVRD)**
- UNICEF **United Nations Children's Fund**
- UFMA **Universidade Federal do Maranhao
(Federal University of Maranhao)**
- UFPA **Universidade Federal do Para
(Federal University of Para)**

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1. ABSTRACT

The Environmental Management Program of the Companhia Vale do Rio Doce - CVRD - for the Carajas Iron Ore Project in Brazilian Amazonia is presented.

CVRD - a state and privately owned corporation operating under the jurisdiction of the Ministry of Mines and Energy, is the one of the world's leading producers and exporters of iron ore. Created in 1942, CVRD has focused on the mines in the southern, more developed state of Minas Gerais as the source of virtually all production to date. In 1967, a concentrated mineral province with rich deposits of iron ore, estimated 18 billion tons, 66.68% Fe, manganese, nickel, tin, copper, gold, and bauxite was discovered in the northern remote, less developed state of Para in Amazonia, in the Sierra dos Carajas, near the municipality of Maraba.

An intensive survey program from 1969 to 1972 initiated feasibility studies for a major component of regional development - the Carajas Iron Ore Project - an integrated complex consisting of open pit mine, railway system and deep water port, with two townsites and eight housing divisions.

This major development project in the region raises sensitive questions about the potential ecological impact in the peculiar but relatively unknown Amazon region. Through its experience in the south of Brazil, CVRD has become sensitized to the ecological issues of mining projects and has developed expertise in environmental assessment and management practices. Study of the Carajas Iron Ore Project began as early as 1972 with the completion of more than twelve environmental and related studies, mostly by consultants under the supervision of CVRD staff responsible for environmental management.

In 1980, CVRD created an independent advisory work group - GEAMAM - responsible for advising on all environmental aspects of Company activities and for preparation of an environmental management manual. At all project sites, CVRD created internal environmental commissions - CIMAs - which enforce, monitor and control the environmental aspects of project implementation and operation. Two Internal Environmental Commissions were created at the mine and port sites of the Carajas Iron Ore Project, coordinated by ecologists, Field Environmental Officers, who divide responsibility for the environmental management of the railway.

With the formal designation of an Environmental Coordinator (May 1982) and the contracting of fulltime technical assistance, the Environmental Management Program has become structured and strengthened; budget requirements and timetables of activity implementation are being prepared.

The Program includes:

- Analysis of Environmental Conditions
- Research, Planning and Establishment of Management Strategies
- Monitoring and Control of Impacts: Prevention and Mitigation
- Environmental Education
- Monitoring and Control of Basic Services for Area Inhabitants
- - Coordination with Governmental, Environmental, Financial and Research Institutions.

The agreement signed with FUNAI, the National Foundation for Indigenous populations, to provide assistance to the 14 Indian reserves within the Project area is described. Details of the Program's progress to date and activities scheduled for future implementation are presented.

An intensive survey program from 1987 to 1991 has been conducted for a major component of regional development - the Caracas Iron Ore Project - an integrated complex consisting of open pit mine, railway system and deep water port, with two countries and eight housing divisions.

This major development project in the region raises sensitive questions about the potential ecological impact on the relatively unknown Amazon region. Although the experience in the south of Brazil, CNU has become acquainted to the ecological issues of mining projects and has developed expertise in environmental assessment and management practices. Study of the Caracas Iron Ore Project began early as 1982 with the completion of a baseline environmental and related studies, mostly by contract, and the supervision of environmental monitoring for environmental management.

In 1983, CNU entered an agreement with the Caracas Iron Ore Project - responsible for advising on all environmental aspects of company activities and for preparation of an environmental management plan. All project sites, CNU created internal environmental committees - which enforce, monitor and control the environmental aspects of project implementation and operation. Two Internal Environmental Committees were created at the mine and port sites of the Caracas Iron Ore Project, coordinated by ecologists. This Environmental Management Plan was developed by ecologists for the environmental management of the project.

With the formal designation of an Environmental Management Plan (EMMP) and the contracting of FUNAI to assist in the implementation of the Environmental Management Program, CNU has become a permanent and active partner in the project requirements and timetable of activities.

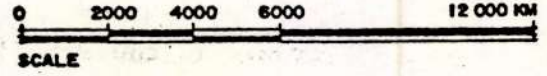
2. BRAZIL AND THE COMPANHIA VALE DO RIO DOCE

Brazil is the second largest iron ore producer in the world; in 1980 it produced 87.4 million metric tons of iron ore - 10.4% of total world production. Its iron ore reserves, estimated at 34.2 billion tons, are mainly located in two states - Minas Gerais in the Southern more developed part of the country (42%), and Para in the Northern remote and less developed Amazon region (55%).

The principal producer of Brazilian iron ore is the Companhia Vale do Rio Doce (CVRD) - a state and privately owned corporation founded in 1942, under the jurisdiction of the Brazilian Ministry of Mines and Energy. 1/ Today one of the world's leading producers and exporters of iron ore, the Company also operates bauxite, gold, manganese and titanium mines. Through its subsidiaries and associated companies it is also involved in geological prospecting and research, beneficiation in joint ventures with foreign associates to produce and sell iron ore pellets, metallurgy of alumina and aluminum, marketing, shipping, reforestation and cellulose production 2/. (Figure 1).

1/ 78% of its shares are Federal and 22% are held by the private sector.

2/ Gazzola, Eduardo Almeida, "Pollution Problems in the Mining Industry in Brazil - The Performance of the Cia. Vale do Rio Doce", April 1982.

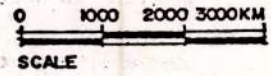
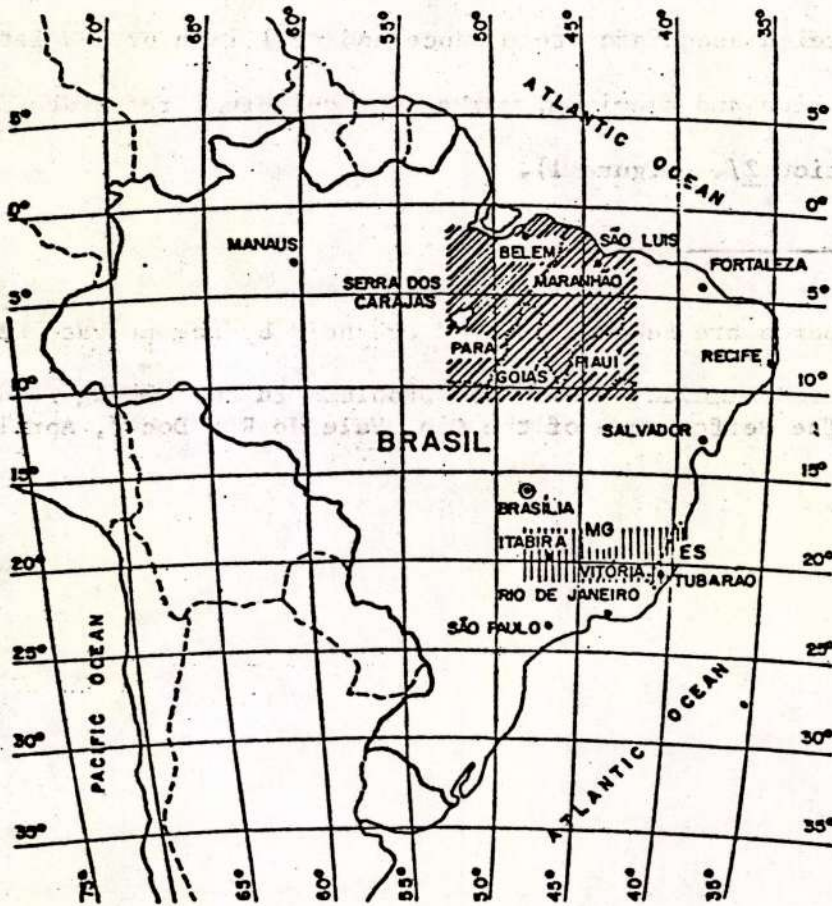


LEGEND

- CITY
- INTERNATIONAL BOUNDARY
- ◻ MINING SITES

LOCATION OF CVRD IRON ORE MINING SITES

Figure 1



LEGEND

- CAPITAL
- CITY
- INTERNATIONAL BOUNDARY
- - - STATE BOUNDARY
- ▨ NORTHERN SYSTEM
- ▤ SOUTHERN SYSTEM

LOCATION OF NORTHERN AND SOUTHERN SYSTEMS

Figure 2

3. CVRD's SOUTHERN SYSTEM ENVIRONMENTAL MANAGEMENT

3.1 Environmental Problems

Virtually all iron ore production to date by CVRD has been from the Southern Minas Gerais mines with advantages of infrastructure, location and proximity to urban and industrial centers. Owned and operated by CVRD since 1942, the Southern System is a complex of iron ore mines in Itabira, Minas Gerais, a 550-Km-long railway and the port of Tubarao in Vitoria, Espirito Santo (Figure 2). From 1942 to 1966, when the port of Tubarao was inaugurated, environmental problems were manageable, given the relatively small scale of production and the predominantly granulated characteristic of the ore. However, with production changes, both in terms of a greater scale and increased proportion of much finer ore, environmental management became more difficult because of problems caused by dust, noise and gas, and liquid and solid waste pollution during the mining, processing, handling, loading and transporting of the fine, ultrafine and blue dust iron ore in densely populated areas.

The problems faced were:

1. In the state of Minas Gerais, the juxtaposition of a complex of open pit, strip mining iron ore operations and the unplanned growth of a human settlement, Itabira, where population increased from 5000 in 1942, to more than 80,000 in 1982.
2. Along the railway, the loss of iron ore dust to wind erosion, which in a train of 160 wagons would lose the ore weight equivalent of full ore wagon per trip, with an average of five to ten such trains per day.

3. In the state of Espirito Santo, problems caused by the dominant winds blowing towards the existing city of Vitoria from the port and the huge earth moving operations during port construction which required great effort and expenditure for site reclamation and landscaping.

With heightening community protest in the decade of the 1970's and increased awareness that "prevention costs less than cure", CVRD became increasingly more sensitized to the advantages of environmental prudence, and initiated the necessary measures to control pollution at its source.

3.2 Brazilian Environmental Progress

It is during this period, soon after the United Nations Environmental Conference held in Stockholm in 1972 in which Brazil participated, that the Government accelerated efforts to improve environmental management. Eight years ago, only 600,000 hectares of Brazilian land were set aside for conservation under the management of IBDF - the Brazilian Forestry Development Institute. Less than three years ago, the total area preserved for ecological purposes amounted to about 2.4 million hectares, equivalent to 0.28% of the total area of Brazil. However, under the auspices of SEMA (Special Secretary of the Environment - Ministry of the Interior, established October 30, 1973) and that of DPN (IBDF's Department of National Parks), Brazil expanded these areas almost fivefold. By the year end of 1981, Brazil had officially set aside 11 million hectares for ecological conservation and research, equivalent to 1.3% of its territory, including 23 National Parks, 11

Biological Reserves and 11 Ecological Stations 1/. As of September 1982, IBDF is responsible for about 12 million hectares, and SEMA for 1.6 million, which is due to be increased to 2.5 million with the inclusion of a 900,000 hectare reserve presently being created in the Amazon 2/.

In 1982, the Getty Prize - the world's foremost recognition of environmental achievement - was awarded to the Brazilian Government's leading environmentalists: Dr. Maria Tereza Jorge Padua of IBDF and Dr. Paulo Nogueira Neto of SEMA, not only for being instrumental in the establishment of National Parks, intensification of conservation of fauna and flora and establishment of Ecological Stations, but also in the passing of Law No. 6.938 of August 31, 1981 establishing the comprehensive National Environment Policy of Brazil.

3.3 Environmental Solutions Implemented

In its Southern System, the Companhia Vale do Rio Doce initiated the following measures to improve environmental management:

1. At the Itabira Mines, the construction of retention dams (presently 5, with more scheduled for construction) and tailings ponds and the controlled stockpiling of mining wastes;

1/ Ecological Stations, established by Law No. 6902 in April 1981, are representative areas of Brazilian ecosystems preserved for purposes of ecological research and conservation education. Ninety percent of the area of each ecological station is maintained as an integral biotic preserve, where only research which would not impact or alter the natural ecosystem is permitted; the remaining ten percent, maintained as a partial preserve, can be utilized for more interactive research, such as studies which evaluate the impacts of numerous activities on the ecosystem. Brazil presently maintains 11 Ecological Stations. Perfil - Edicao Especial, SEMA - Ministerio do Interior, IBDF - Ministerio da Agricultura.

2/ As stated by Dr. Paulo Nogueira Neto, Special Secretary of SEMA in an interview on October 5, 1982 in Rio de Janeiro.

2. To control dust pollution at the mine, port and pelletizing

plants, the installation of water sprays on belt conveyors, reclaimers, stockers and storage piles, and specifically at the mine, the aspiration of water by six 45,000-liter-tanks adapted to roadgraders to diminish the dust caused by the traffic of heavy machinery. An erosion control program of planting grasses and ground cover also has been initiated.

3. At the pelletizing plants, monitoring of dust and noise pollution

with the measurement of dust indices (in suspension and sedimentation), presence of gases, the sulfur dioxide content in the air (due to the burning of fuel oils), Fe_2O_3 in the dust, noise, radiation, vibration and temperature indices with the technical support of CETESB since November 1980 1/. Milk of lime or water is used as an agglomeration agent 2/ to control wind erosion. To illustrate the magnitude of the problem of dust in the pelletization plants, there are 16 stopckpiles of superfine ore, each containing 90,000 tons of ore, in addition to the processed product stockpiles. The Company is presently installing dust-bag filters for the belt conveyers, electrostatic dust precipitators in the plant chimneys, and applying milk of lime to other types of fines.

1/ da Silva Fernandes, Roosevelt, "Qualidade do Ar de Vitoria/ES - Monitoramento Ambiental da Area de Influencia do Terminal Maritimo da Companhia Vale do Rio Doce". Mining in the Southern Hemisphere Congress, Federal University of Rio de Janeiro, December 1982.

2/ da Silva Fernandes, Roosevelt, "Contencao eolica em pilhas de estocagem de minerio fino e operacoes com pelotas". Internal report, Operational Technical Services, Department of the Operation Division of the Cia. Vale do Rio Doce, Vitoria, Espirito Santo, 1976.

Itabira!

4. Along the railway and at critical points of wind erosion, the monitoring of dust pollution, the use of enclosed car dumpers and the use of chemical agglomerants - glucose, dextrin or hydrated lime - which have since been patented by the Company. 1/.
5. At the port, the development and implementation of an extensive environmental master plan with monitoring of environmental impacts both in the industrial and urban sectors, with the technical assistance of the Nippon Steel Corporation of Japan since 1980. This master plan also includes a broad program of site reclamation and landscaping.
6. At the Itabira mines, the collaboration of the Foundation for Research Development - FUNDEP - and the Department of Biology of the Federal University of Minas Gerais since 1974 to monitor and control disease vectors (flies, and mollusk hosts of schistosomiasis), undertake limnological studies, develop pisciculture, study the influence of chemical flocculants used in ore processing, and train personnel.
7. For all company operations, the development of a comprehensive program of worker health and safety engineering with the construction of modern hospitals, equipped at levels superior to

1/ da Silva Fernandes, Roosevelt "Arrasto eolico no transporte e estocagem de minerio de ferro, Analise tecno-economica de alternativas de contencao - 1 e 2 MINERACAO METALURGIA - Ano XLI - n 389 e 390, Aug. and Sept. 1977, and da Silva Fernandes, Roosevelt "Efeito da abrasao causada pela poeira de minerio de ferro nas locomotivas da EFVM" - Internal Report - Operational Technical Services Department of the Operations Division of the Cia. Vale do Rio Doce, Vitoria; Espirito Santo.

those required by law 1/, periodic monitoring of employee health, accident prevention and safety control, and routine monitoring of basic sanitation, industrial and domestic solid waste, sewage, draining of the water retention basin and water impounding, treatment and supply.

CVRD maintains Internal Accident Prevention Commissions - CIPAs, as stipulated by the Ministry of Labor, whose members are employees of the CVRD operational areas, and operate under the coordination of the Sector of Industrial Safety Engineering. These CIPA's alert staff to potential occupational safety problems, arrange preventive measures, monitor accident statistics and promote accident prevention goals.

3.4 CVRD Reforestation and Forestry Research

In addition to its reforestation programs, CVRD's subsidiary - Floresta Rio Doce - FRD - is actively involved in botanical research, forest exploration, agriculture, apiculture and cattle raising. FRD administers an area of about 350,000 ha in the states of Minas Gerais, Espirito Santo and Maranhao. Up to 1981, FRD had reforested about 125,000 ha with the following species: Eucalyptus spp 98,000 ha; Pinus spp 24,000 ha; Native species 3,000 ha. Of the 17,000 ha owned by CVRD in the Itabira district which totals 130,000 ha, the land use is as follows:

Reforested area 10,000 ha; water and tailings ponds 1,500 ha; industrial area 5,500 ha.

1/ By Brazilian law, for the 5000 CVRD mining employees, a staff of 3 physicians, 1 nurse and 1 nursing assistant is mandated. CVRD maintains a staff of 10 physicians, 2 nurses and 4 nursing assistants in its three field clinics at the port of Tubarao. Gazzola, Eduardo Almeida, "Pollution Problems in the mining Industry in Brazil: The Performance of Vale do Rio Doce", 1982.

Along the Vitoria-Minas Railway, FRD is implementing a green belt project to conserve and protect the railroad and the surrounding landscape. Twenty-seven thousand seedlings of native species have already been planted. At the port of Tubarao, another green belt is being implemented. In the 2 1/2 year period since initiation, more than 80,000 seedlings have been planted.

The FRD Forest Reserve in Linhares, Espirito Santo is an especially noteworthy example of CVRD's environmental concern. This 20,000 ha tract of land, purchased between 1955 and 1960, is one of the last remains of the Atlantic Forest in Brazil. Originally purchased for railway sleeper(ties) production, the tract is now solely managed for research in recognition of the value of the forest, and in 1981 was declared a permanent federal reserve. Today it is one of Brazil's principal centers of native species research.

Among the many areas of study are the following: Ecology - forest management, sustained yield production, introduction of species for reforestation, production of phytogeographic maps characterizing the diverse forest types of the reserve and their management potential.

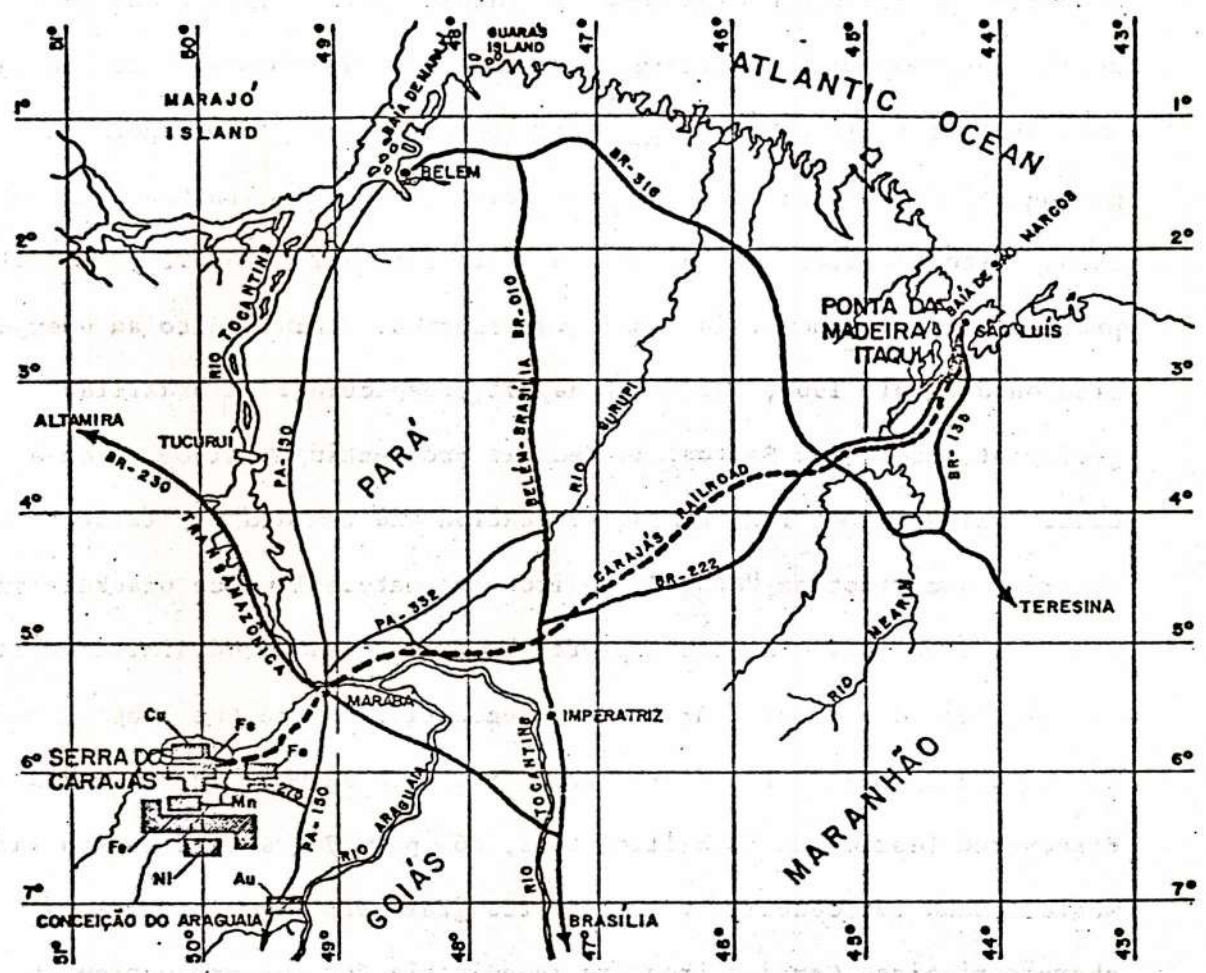
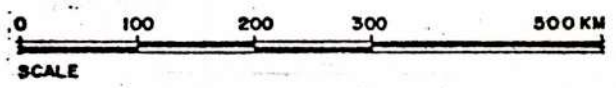
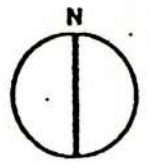
1/ See Moraes de Jesus, Renato et al.

- a) "Ensaio de Producao Sustentada". Brazilian Forestry Congress - Belo Horizonte, Minas Gerais, May 1982.
- b) "Estudo das Feno fases em Essencias Florestais Nativas"
- c) "Enriquecimento em matos degradados e em formacao de menor potencial" - Forest Reserve of Linhares, Floresta Rio Doce, Cia Vale do Rio Doce. Congress on Native Species in 1982.
- d) "Floracao, Frutificacao e Denominacao Comum de Leguminosas Arboreas das Florestas no Norte do Espirito Santo. I Faboideae", Boletim Tecnico No. 2. Universidade Federal de Vicosa, Vicosa, Minas Gerais.






Botany - organization of an internationally registered herbarium of all forest materials 1/, production of seeds 2/, greenhouse operation and study of forest fauna, bioclimatology and forest sociology.

1/ The herbarium is registered with the New York Botanical Garden, Cary Arboretum.

2/ More than 5 tons of seeds were produced in 1981.



LEGEND

-  CARAJÁS MINERAL PROVINCE
-  CITY
-  FEDERAL HIGHWAY
-  STATE HIGHWAY
-  CARAJÁS RAILROAD

CARAJÁS: MINERAL DEPOSITS AND ACCESS ROADS.

Figure 3

4. THE CARAJAS IRON ORE PROJECT

4.1 Project Description

The discovery of the rich Carajas mineral province in 1967 gave CVRD the opportunity to implement a mining, rail transport and human settlement component of a large scale regional development plan in the Amazonian tropical rainforest. Until the mid 1960's only sporadic geological surveys were done in the Serra dos Carajas in the state of Para. With the discovery of manganese in the region in 1966, mineral prospecting on a commercial basis was spurred. This led to an unexpected find on July 31, 1967, the first day of prospecting: A Brazilian geologist, Breno dos Santos, landed his prospecting helicopter on a natural clearing of low, sparse vegetation and immediately identified the material underfoot as "canga", an iron ore material which blankets surface iron ore deposits. Intense exploration soon revealed 60 similar clearings in the area, devoid of dense forest vegetation due to the canga. Thus, inadvertently, the largest high grade iron ore deposit in the world was discovered (estimated 18 billion tons, 66% pure Fe) sufficient to satisfy world demand for centuries. Due to its grain-size and chemical characteristics, Carajas iron ore is suitable for the production of sinter-feed, in great demand in the world market. Further prospecting by CVRD's prospecting subsidiary DOCEGEO, led to the discovery of rich deposits of manganese, nickel, copper, bauxite, tin and gold, justifying the designation of the Carajas Mineral Province.

The Carajas Mineral Province (approximately 6° south latitude and 50° west longitude) is located in the Municipalities of Maraba and Sao Felix do Xingu, in the state of Para, about 550 Km south of Belem, the state capital, and 780 Km from Sao Luis, capital of the state of Maranhao, at an average altitude of about 650 meters above sea level (Figure 3).

The nearest town is Maraba (population 70,000) located 130 Km northeast of Carajas. Population density in the region is extremely low.

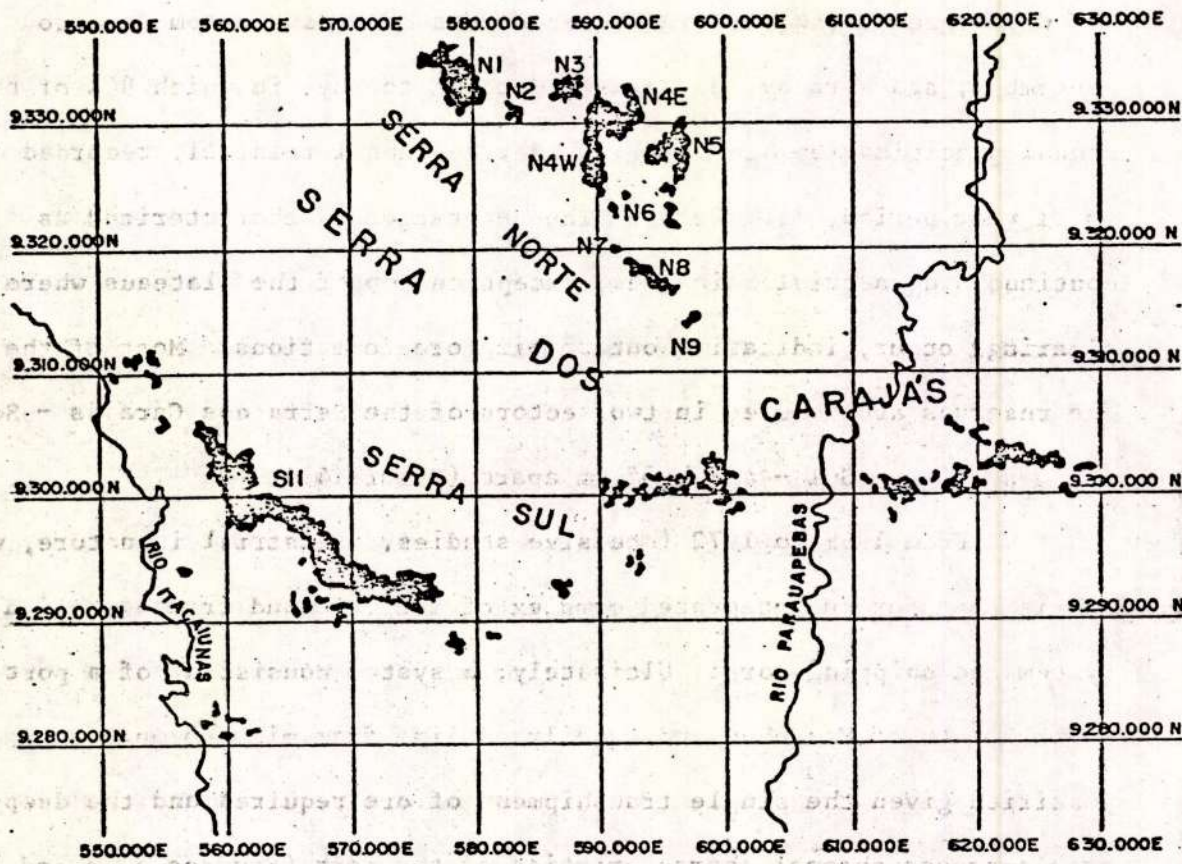
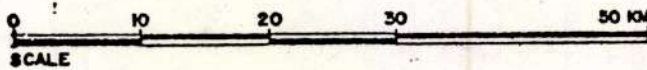
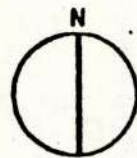
The climate is tropical with the annual temperature averaging 24° C. There are two distinct seasons: a dry season from June to September, and a rainy season from October to May, in which 90% of the annual precipitation occurs. The average annual rainfall, recorded over an 11 year period, is 2,236mm. The vegetation is characterized as continuous equatorial rainforest except on top of the plateaus where clearings occur, indicating outcropping ore formations. Most of the iron ore reserves are located in two sectors of the Serra dos Carajas - Serra Norte and Serra Sul - about 35 Km apart (Figure 4).

From 1969 to 1972 intensive studies, industrial in nature, were carried out for an integrated complex of mine, inland transportation system and shipping port. Ultimately, a system consisting of a port site in the state of Maranhao and a railroad line from mine to port was justified given the single transshipment of ore required and the deep-water stable-access channel characteristics of the port (Figures 5, 6 and 7).

Porta da Madeira, about 10 km from Sao Luis, the state capital, was selected for the deepwater port site as it is geomorphologically suitable to accommodate very large bulk carriers of up to 280,000 deadweight tons without dredging. The 890 km, single track Carajas railway will link the mine site to the shipping port. Mining operations are scheduled to start in 1985 with an initial export production of 15 million tons per year (tpy), attaining 35 million tpy in 1987.

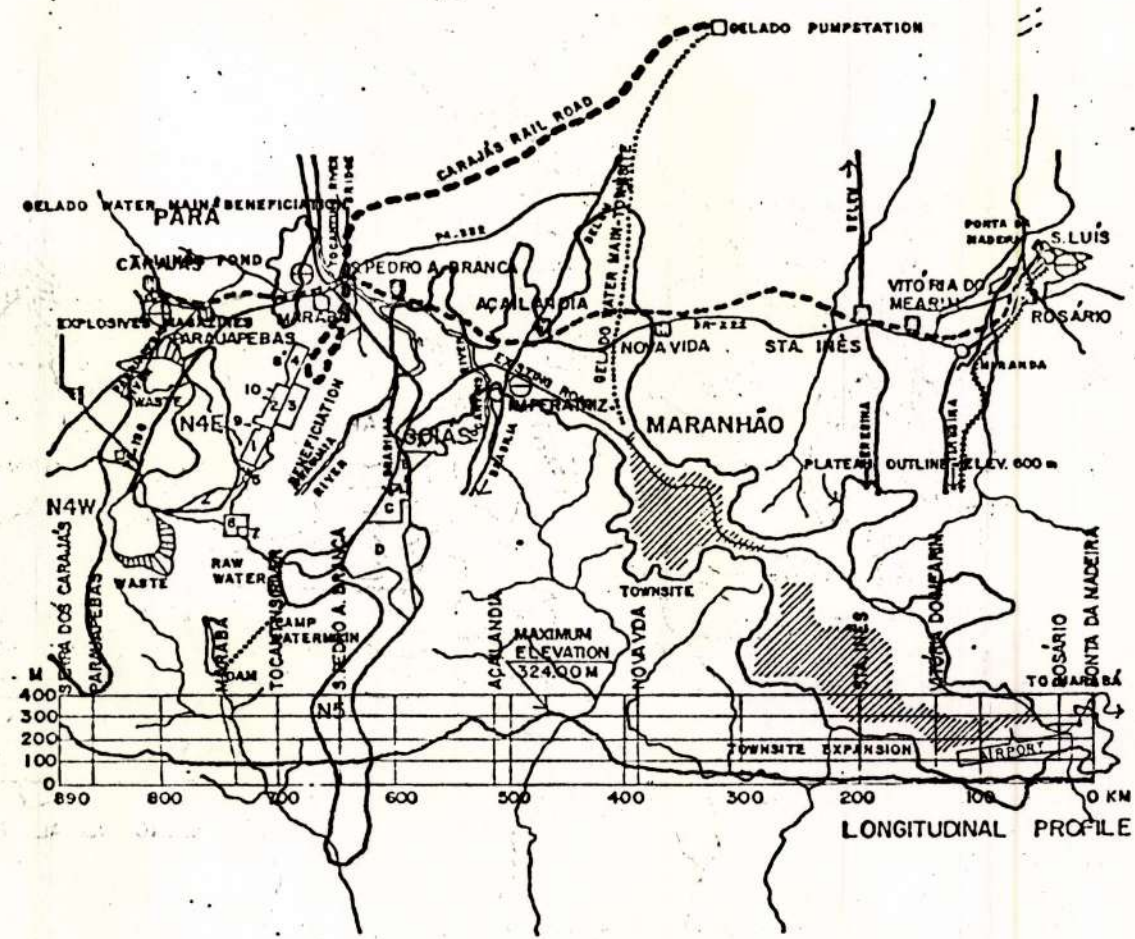
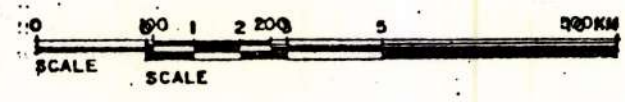
As the project will create employment in this sparsely inhabited region, 1/ two townsites and eight housing divisions will be built to

1/ The total labor force requirement for the project is 4,539 for 15 million tpy, 5,260 for 25 million tpy, and 5,683 for 35 million tpy.



LOCATION OF MAIN IRON ORE CLEARINGS.

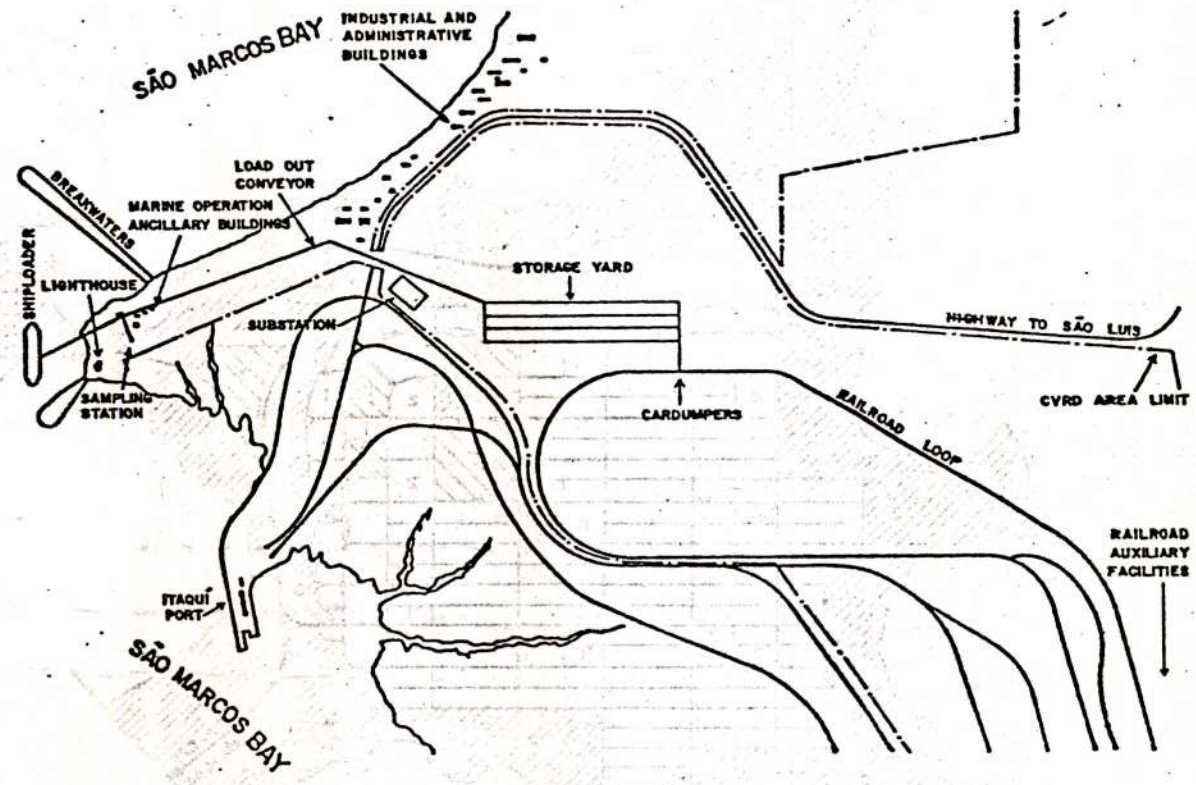
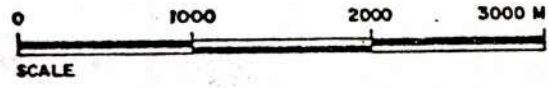
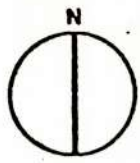
Figure 4



- LEGEND**
- CARAJÁS RAILROAD
 - CONTRACTORS HOUSES
 - S. LUIS - TERESINA RAILROAD
 - CVRD OFFICES & SINGLES LODGINGS
 - CONTRACTORS SUBSITES & LODGINGS
 - CONTRACTORS
 - RIVERS
 - 1- PRIMARY AND SECONDARY CRUSHING
 - 2- SCREEN & TERT. CRUSHING
 - 3- SOLIDS RECOVERY
 - 4- STORAGE & LOADOUT
 - 5- PILOT PLANT/LABS
 - 6- SUPPORT FACILITIES
 - 7- ADMINISTRATION
 - 8- MAIN SUBSTATION
 - 9- WATER TANK
 - D- RECOVERED WATER TANKS

MINE LAYOUT
CARAJÁS IRON ORE PROJECT RAILROAD COMPONENT.

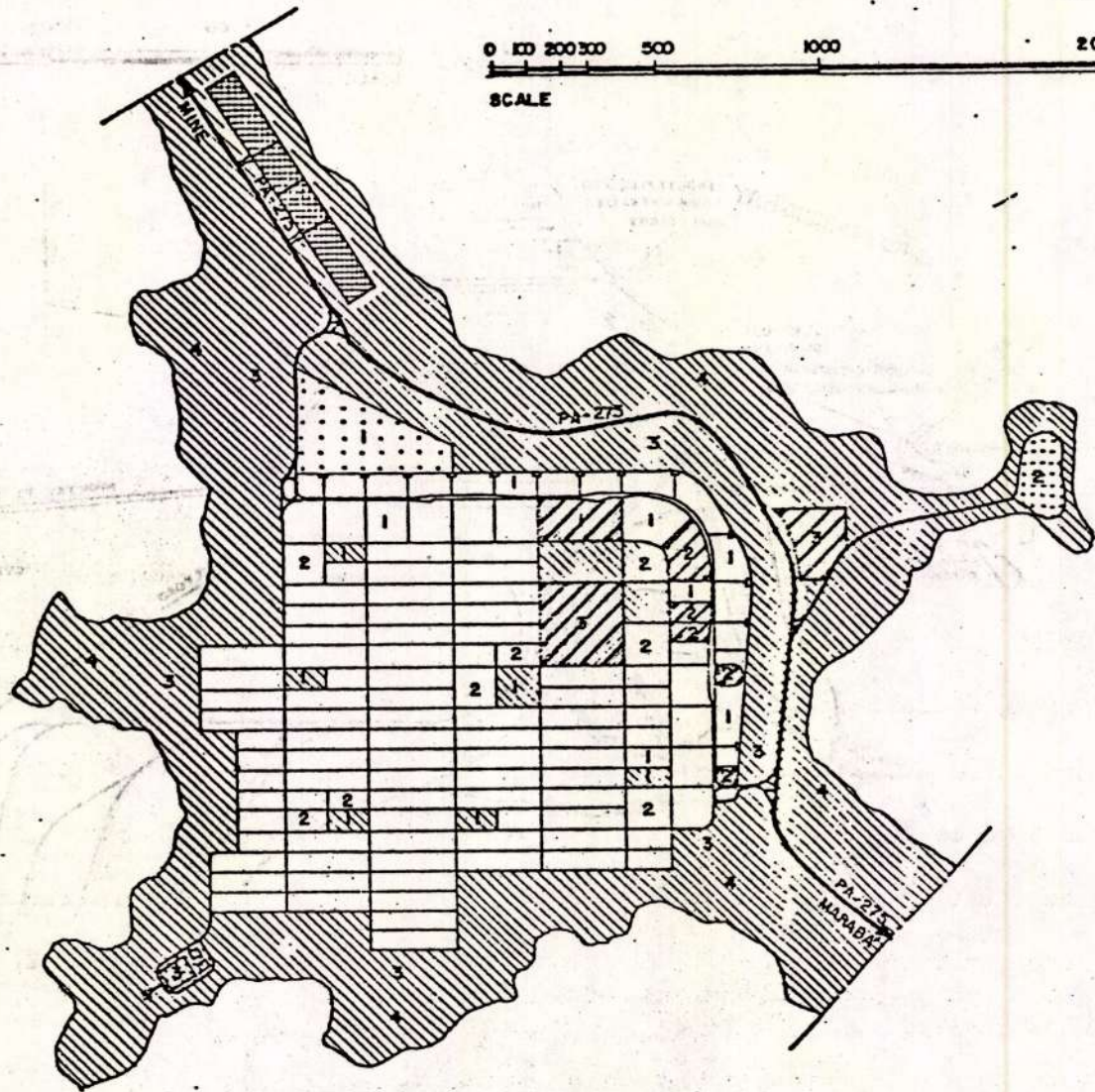
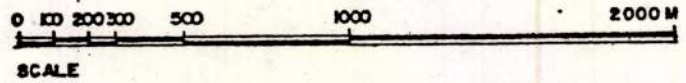
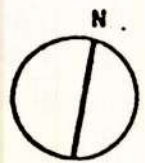
Figure 6
Figure 5



Symbol	Description	Symbol	Description	Symbol	Description
[Symbol]	INDUSTRIAL AND ADMINISTRATIVE BUILDINGS	[Symbol]	RAILROAD TRACKS	[Symbol]	RAILROAD AUXILIARY FACILITIES
[Symbol]	LOAD OUT CONVEYOR	[Symbol]	STORAGE YARD	[Symbol]	CARDUMPERS
[Symbol]	MARINE OPERATION ANCILLARY BUILDINGS	[Symbol]	SUBSTATION	[Symbol]	HIGHWAY TO SÃO LUÍS
[Symbol]	SHIPLOADER	[Symbol]	SAMPLING STATION	[Symbol]	ITÁQUI PORT
[Symbol]	BREAKWATERS	[Symbol]	LIGHTHOUSE	[Symbol]	CVRD AREA LIMIT
[Symbol]	INDUSTRIAL AND ADMINISTRATIVE BUILDINGS	[Symbol]	RAILROAD TRACKS	[Symbol]	RAILROAD AUXILIARY FACILITIES
[Symbol]	LOAD OUT CONVEYOR	[Symbol]	STORAGE YARD	[Symbol]	CARDUMPERS
[Symbol]	MARINE OPERATION ANCILLARY BUILDINGS	[Symbol]	SUBSTATION	[Symbol]	HIGHWAY TO SÃO LUÍS
[Symbol]	SHIPLOADER	[Symbol]	SAMPLING STATION	[Symbol]	ITÁQUI PORT
[Symbol]	BREAKWATERS	[Symbol]	LIGHTHOUSE	[Symbol]	CVRD AREA LIMIT

CARAJÁS IRON ORE PROJECT PORT COMPONENT

Figure 7



LEGEND

- | | | |
|--|--|--|
|  CENTRAL AREAS |  GREEN AREAS |  SPECIAL AREAS |
| 1- ADMINISTRATION | 1- NEIGHBORHOOD CENTERS | 1- HEALTH CENTER |
| 2- COMMUNITY SERVICES | 2- CENTRAL PARK | 2- GUESTHOUSE |
| 3- LEISURE | 3- PRESERVATION AREA | 3- SEWAGE TREATMENT PLANT |
|  RESIDENTIAL AREAS | 4- EXISTING VEGETATION | |
| 1- LOCAL COMMERCE, APARTMENTS AND SINGLES LOGGINGS |  INDUSTRIAL AREA | |
| 2- SCHOOLS | | |
| 3- ONE FAMILY DWELLINGS | | |

CARAJÁS TOWNSITE FROM ONE PROJECT REPORT

CARAJÁS TOWNSITE

Figure 6

provide for the basic needs of project personnel and dependents and the migrant population attracted to this new development pole, including housing, basic sanitation services, and facilities for health care, education, leisure and recreation at the mine and port sites and along the railroad.

The two townsites - Carajas and Parauapebas - are new settlements whose population will range from 10,000 to 20,000 inhabitants, and eight housing divisions will be integrated with existing towns with population increases ranging from two to five thousand inhabitants (Figure 8).

The total cost of the Carajas Iron Ore Project is estimated at US\$4,527 million (July 1982) including the financing required. Including allowances for physical contingencies, US\$680 million (19.5%) is for the mine, US\$1872 million (53%) for the railroad, US\$251 million (7%) for the port, US\$206 million (6%) for the townsites in Carajas and Parauapebas, US\$481 million (14%) for project management, inspection services, engineering and insurance and US\$14 million (0.5%) for the Amerindian program for a total of US\$3,50 billion. As of September 30, 1982, CVRD had invested US\$1,047,863.

The management of the Carajas project is the responsibility of two directors: the Development Director during the construction phase and the Production Director after the start of operation. After the merging of AMZA with CVRD in 1981, the Carajas Project Implementation Superintendency (SUCAR) was established to assume AMZA's function. The Preoperation Superintendency (SUNOR) was organized to manage the preoperation phase and to constitute the nucleus of the staff which will operate the Project after 1985.

Wms
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3

The Carajas Iron Ore Project is viewed by the Government as a vital means for stimulating development of a region encompassing the states of Goias, Para and Maranhao north of 8° south latitude, and between the Amazon, Xingu and Parnaiba rivers, an area about 1000 Km x 800 Km. Recognizing the abundant mineral deposits as well as the possible agricultural opportunities, the Government has decreed an Interministerial Council - Programa Grande Carajas - to oversee and manage all potential development programs in the Grande Carajas region. The Carajas iron ore project will undoubtedly have a major impact on opening the area to future development through the establishment of a basic transport system and implementation of the 10 serviced townsites and housing divisions. 1/ It therefore carries a heavy responsibility for ensuring adequate environmental management and raises a series of sensitive questions about the balance which must be sought between development of rich natural resources and the conservation of nature.

4.2 Environmental Implications of Large Scale Projects in Amazonia

Brazil has witnessed a number of large scale projects attempting to develop the natural resources of Amazonia, with many suffering severe financial losses and causing irreparable environmental damage, due to inadequate analysis, long range planning and governmental control.

Schubart 2/ indicates that the environmental consequences of indiscriminate, uncontrolled large scale development of Amazonia could

→ 1/ On September 21, 1982, CVRD was authorized to mine the manganese deposits at Carajas - the second development project of the Mineral Province.

→ 2/ Schubart, Herbert Otto Roger. "Ecologia e Desenvolvimento na Area de Influencia do Programa Grande Carajas" National Institute of Amazon Research (INPA/CNP_q) National Council of Research and Development CNP₂, Manaus, Amazonas, November 1981, pages 1-6.

bring the following consequences: a) destruction of genetic stocks 1/; b) radical modification of soil structure; c) alteration of climate and hydrological cycles and d) introduction of pests and disease.

→ The question of Amazonian soil fertility is particularly illustrative. The long held popular notion that the luxurious green vegetation of the Amazon forest is indicative of high soil fertility is denied by research 2/. It has been found that most of the nutrients in tropical rain forest are stored in the vegetation, rather than in the soil. Of the nutrients stored in the soil under rain forest, most is found in the top 30 centimeters. Thus, this ecosystem is far more susceptible to disruption. Indiscriminate forest clearing and removal of the nutrient-rich biomass in a climate with over 2000 mm annually of warm leaching rains can cause irreparable damage.

Goodland notes that after about three harvests, practically all non-tree forest replacement crops on all but the most fertile soils fail without continual use of chemical inputs such as fertilizers and biocides, an option too expensive for most people in this region so distant from urbanized centers. After crops fail, the whole area becomes ruinate cattle pasture or is abandoned, at the cost of the loss of a non-renewable and quickly disappearing resource — the virgin Amazonian forest. Thus, this resource is being exploited as capital, rather than the interest on this capital being managed on a sustainable basis 3/.

1/ Chaotic forest clearing threatens the extinction of thousands of species plants and animals, many of which may not even be known to man. See Schubart, 1981, Moran, 1982 and Goodland, 1975.

→ 2/ Moran, Emilio F. "Ecological, Anthropological and Agronomic Research in the Amazon Basin", Latin American Research Review 1982, pages 6-9.

3/ Goodland, R.J.A. "Brazil's Environmental Progress in Amazonian Development" Invited paper presented at the Change in the Amazon Basin Symposium of the Royal Geographical Society. Manchester, England, September 1982.

4.3 CVRD's Environmental Special Studies

Sensitized by the environmental issues which arose in Itabira, Minas Gerais and Vitoria, Espirito Santo in the south of Brazil, and in view of the poorly understood environment of the Carajas Iron Ore Project area, a series of studies complementary to industrial operations were contracted from 1972 to 1981 to consultants under the supervision of the CVRD staff responsible for townsite design and implementation and environmental management. These studies have helped form the basis of the Project's environmental planning and urban design 1/.

1/ The special studies already completed are:

- *AMZA, 1980. The Carajas Townsite. Rio, CVRD (DEPEK) 59 p.
- *AMZA, 1980-81. Projeto Ferro Carajas: Normas ... de higiene, medicina, seguranca de trabalho ... para preservacao de fauna e flora. Rio, CVRD, DEPEK:v.p.
- *AMBIENTAL S/C Ltda, 1979. Analise das Condicoes climaticas e Recomendacoes applicaveis as edificacoes para a regio atravessada pela ferrovia Carajas-Sao Luis. S. Paulo.
- *AMBIENTAL S/C Ltda, 1979. Projeto Carajas: Conforto termico-diretrizes para ocupacao urbana e edificacoes - S. Paulo.
- *Barbosa Tomassini, H.C. 1976. Health study. Carajas Rio, AMZA contract 36.
- *Clima Paisagismo Ltda, 1981. Projeto Carajas: Levantamentos do meio fisico-biologico: solos, vegetacao, flora e fauna. Rio.
- *CVRD, 1981. Tratamento do efluente do laboratorio de Carajas: premissas basicas. Rio, CVRD, Departamento de Mineracao.
- *EDAP - Projeto Carajas: Educational Study. Educacao, Assessoria e Planejamento.
- *Guedes, Joaquim e Assoc. 1973. Carajas: Nucleos Urbanos - infraestrutura, equipamentos estudos/fase A viabilidade. S. Paulo, Arq. Joaquim Guedes.
- *Hidrobrasileira, 1977. Projeto Carajas - Food Supply Study, Rio. (Continued next page).

Physical analyses included climatology, ecology, botany, environmental comfort and appropriate construction technologies. Social analyses included education, health and supply of foodstuffs.

Institutional analyses included the study of administrative and legal mechanisms for the implementation of the townsites and housing divisions. The methodology of these studies included a diagnosis of the project area, analysis of data and proposals - physical, social and institutional - for the 890 km along the railway right-of-way. Studies were also undertaken of the area's infrastructure: water, energy, transportation, settlements, and sources of materials to be used in the project.

The physical analyses contributed towards a better understanding of environmental conditions. For example, after one year of climatological research in situ, it was possible to identify within this equatorial region, the four "climatological zones" present: the oceanic at the port site, the suboceanic at Santa Ines, the equatorial continental in the region of Imperatriz and Maraba half way along the railway, and the mountainous at Carajas. The elements analyzed in this climatological study

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- *Knowles, O.H. 1981. *Assessoramento Ecologico ao Projeto Carajas, Rio, CVRD/DEPEK 9p.
 - *Kliass, Rosa Grena, Correa Lima e Mayerhofer, 1979. "Nucleo Habitacional da Serra dos Carajas - Diretrizes de Paisagismo", Rio.
 - *Mayerhofer, Marcos R. Ordem Institucional, Rio CVRD.
 - *Murca Pires J., 1973. Aspectos da flora da regioao Serra dos Carajas e Itacaiunas 13p. in Guedes J. (q.v.).
 - *Serra Freire E.M., 1979. Estudo Ecologico para Implantacao do Nucleo Habitacional de Carajas, Rio de Janeiro.
 - *Tarifa, Jose Roberto., 1980. Bases climaticas para edificacoes e nucleos urbanos - Ferrovia Sao Luis-Carajas, Rio de Janeiro.
 - *Tarifa, Jose Roberto, 1980. Caracterizacao Climatica de SLZ/Imperatriz e Maraba: preliminary report.
 - *Tarifa, Jose Roberto, 1980. O Clima da Serra dos Carajas - Final Report.

were: winds, rainfall, insolation and temperature, and their relationship with the region's vegetation and topography.

Parameters for the urban and architectural design of the townsites and housing divisions were derived from the environmental comfort recommendations for each climatic zone identified and were applied in the process of choosing appropriate construction materials, dimensioning space, siting and layout.

The biotic study involved a preliminary inventory of flora and fauna of the Carajas Region, to provide support for the urban design to be implemented as well as to indicate areas requiring more detailed study. Others aspects such as health and the collection, treatment and disposal of solid waste, sewage and storm water were studied by the ecologists at this period.

The social analyses indicated that the area is based on incipient economy, strongly characterized by primary activities by a population with unmet needs in the health and education sectors.

The regional population demonstrates the nosology characteristics of a low income population, marked by malnutrition, malaria, cutaneous leishmaniasis, schistosomiasis, yellow fever, tuberculosis and other diseases. The supply of educational and health services is very low, both in quantity and quality. For the provision of foodstuffs, the region has a weak internal system of distribution and is totally dependent on production from the south of Brazil.

The two alternative policies for administering the townsite were studied - "company town" versus "open city" - and the latter was preferred with the administration of urban and public services, commerce etc., in the hands of the local government and the private sector.

4.4 CVRD's Environmental Manual for the Carajas Iron Ore Project

In order to be effective, the environmental management for such a large scale project presupposes not only the analysis of existing conditions, but also the monitoring of project implementation and the correct operation of the definitive system.

To monitor the environmentally adequate implementation of the project by the dozens of contractors involved, a manual 1/ was prepared, establishing environmental norms to protect the regional biota and to ensure basic health protection for the workers.

These norms are included in all project job contracts. They outline company policy as regards forest clearing, topsoil stockpiling, erosion control, vegetation regeneration, no hunt/no capture of fauna, and basic sanitation. They have proven effective not only in heightening ecological awareness, but also in preventing pathology, particularly of diseases caused by vectors, contaminated drinking water, inadequate sewage and solid waste disposal and inadequate diet.

4.5 GEAMAM: The Environmental Study and Advisory Group

In December 1980, CVRD created an independent environmental group - GEAMAM - Environmental Study and Advisory Group - to advise on all environmental aspects of the Company activities and particularly to oversee activities at Carajas. The group is composed of nine senior scientists/Amazon experts, chaired by an executive secretary who is technical adviser to the President of CVRD 2/.

1/ Concremat, "Normas para Preservacao da Fauna e da Flora", 1981.

2/ GEAMAM members of 1982 are: Angelo Camargo (Climatology), Aziz Ab'Saber (Geomorphology), Paulo Alvim (Agronomy), Italo Falesi (Soils), Frazao Medeiros de Lima (Development), Joao Murca Pires (Botany), Jose Candido de Carvalho (Conservation), Warwick Kerr (Biology) and Agripino Abranches Viana (Chairman, Special Adviser to the CVRD Presidency).

Together with CVRD staff responsible for environmental management, GEAMAM prepared an environmental manual, with mandatory guidelines for all aspects of contractors activities as they affect wildlife, forest clearing, fire prevention, erosion, stream crossing, etc.

GEAMAM will carry out site inspection of the Carajas mine, railway and port sites at least twice every year through 1985 when the Project is scheduled to initiate operations and at least once annually through 1997. After each visit, a report will be submitted for review with comments by CVRD on each recommendation and a description of any action to be taken as a consequence of GEAMAM findings.

4.6 CIMA - Internal Environmental Commission

In June 1981, CVRD created a permanent on-site Internal Environmental Commission (CIMA) at the Carajas mine, composed of CVRD employees and contractors, coordinated by an ecologist/full time environmental officer, to monitor and control project implementation and operations with respect to Government and CVRD environmental guidelines and to implement the Carajas Environmental Management Program at the field level 1/. With the engaging of another ecologist/full time environmental officer in July 1982, a second CIMA was established at the port site 2/.

1/ The Ecologist/Field Environmental Officer at the Serra Norte Mine Site is geologist Eduardo Rocha Porto.

2/ The Ecologist/Field Environmental Officer at the Sao Luis Port Site is forestry engineer Luis Fernando Braga Neto.

Responsibility for the environmental management of the railway is divided between the two CIMAs. The mine CIMA is responsible for the 150 km between Serra Norte Carajas to Maraba (an area of dense tropical forest, sparsely inhabited, but more likely receive greater development impacts). The port CIMA is responsible for the 740 km between Maraba and Sao Luis (an area characterized by secondary vegetation and longstanding human occupation).

In May 1982, to strengthen the environmental management organization, SUCAR formally designated the Townsites Design Department Manager who had been tacitly responsible for the environmental, architectural and urban design sectors of the project since 1972 as overall Environmental Coordinator.^{1/} With the contracting of full time technical assistance ^{2/}, the core environmental staff was engaged and the Carajas environmental management program structured (see Figure 9).

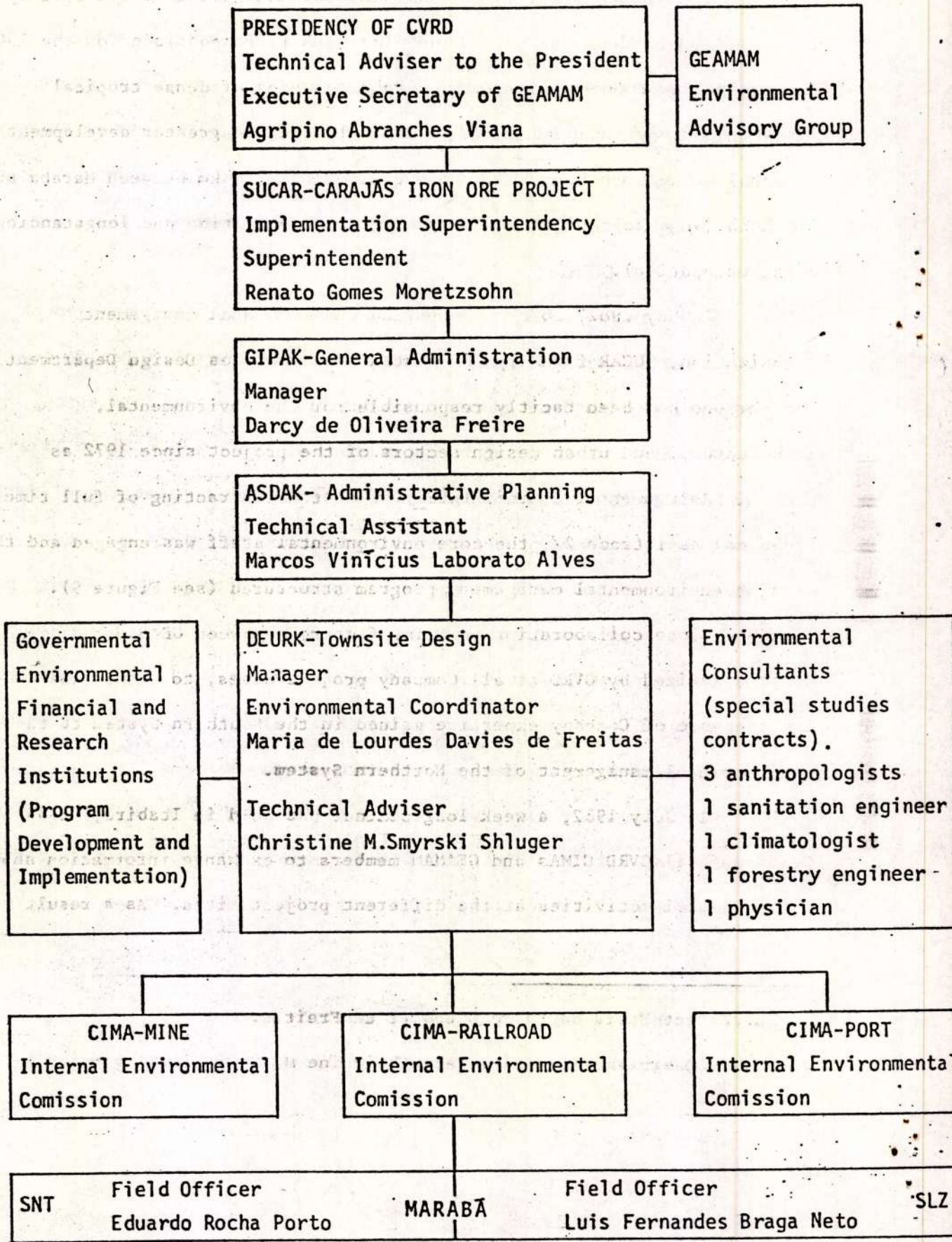
Close collaboration is being fostered between GEAMAM and the CIMAs organized by CVRD at all Company project sites, to ensure the transference of Company expertise gained in the Southern System to the environmental management of the Northern System.

In July 1982, a week long seminar was held in Itabira, Minas Gerais of all CVRD CIMAs and GEAMAM members to exchange information about environmental activities at the different project sites. As a result

^{1/} Architect Maria de Lourdes Davies de Freitas.

^{2/} Geographer-Landscape Architect Christine M. Smyrski-Shluger.

CARAJÁS IRON ORE PROJECT
ENVIRONMENTAL PROGRAM ORGANIZATION



Figure

of this meeting, the first inspection visit of the Carajas mine, railroad and port by a group of CIMA technicians of the Southern System, accompanied by the staff of the Carajas Environmental Management Program - SUCAR and SUNOR - to evaluate present and potential environmental impacts and to develop guidelines and recommendations for their prevention and control. 1/ 2/. Follow up studies on specific issues observed and additional meetings are programmed for the interim period before the next field visit. In March 1983, another meeting of the CIMA technicians from both Northern and Southern Systems together with GEAMAM members, is programmed to be held in Vitoria, Espirito Santo.

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- 1/ CIMA SUCAR Companhia Vale do Rio Doce - "Relatorio de Viagem ao Projeto Ferro Carajas" - Equipe CIMAs de SUNOR, SUMIN, SUEST, SUPOT, SUPEL and SUCAR, July 26-31 1982.
 - 2/ CIMA SUCAR Companhia Vale do Rio Doce - "Relatorio de Programa de Meio Ambiente", April/June 1982. Rio de Janeiro.

5. CARAJAS IRON ORE PROJECT ENVIRONMENTAL MANAGEMENT PROGRAM

5.1 General Presentation

The Environmental Management Program of the Carajas Iron Ore Project includes the following activities:

I STUDY AND ANALYSIS OF ENVIRONMENTAL CONDITIONS

1. Ecological zonation of the region.
2. Selection of areas for environmental conservation.

II RESEARCH, PLANNING AND ESTABLISHMENT OF MANAGEMENT STRATEGIES

(Agreements signed with external agencies)

1. CNP_q - National Council for Scientific and Technical Research, and FAPESP - Foundation for Research Support and Development, through the Emilio Goeldi Museum in Belem, Para.

Establishment of a physical base for research in the Sierra dos Carajas and inventory of flora, fauna and archaeological sites.

2. FUNAI - National Indian Foundation

Provide socio-economic support to 14 Amerindian communities within the project sphere of influence.

III MONITORING AND CONTROL OF ENVIRONMENTAL IMPACTS - PREVENTION AND SOLUTIONS

1. Flora: landscaping, nurseries, control of fires and forest clearing, utilization of cut timber, topsoil stockpiling, vegetation regeneration and erosion control planting.
2. Fauna: protection of wildlife and control of domestic animals.
3. Climate: meteorological station.
4. Soils, air, water: engineering pollution control at mine, railway and port sites.
5. Historical, archaeological and scenic sites.

IV ENVIRONMENTAL EDUCATION

1. Environmental education program.
2. Cultural and leisure activities.
3. Commemorations related to environment.
4. Publicity.

V MONITORING AND CONTROL OF BASIC SERVICES FOR AREA INHABITANTS

1. Health.
2. Basic Sanitation.
3. Security.

VI COORDINATION WITH GOVERNMENTAL, ENVIRONMENTAL, FINANCIAL AND RESEARCH INSTITUTIONS

The Field Environmental Offices are staffed with additional personnel to fulfill the activities of the above program. As need arises, additional technical support is provided through sector consultants who are contracted on a special studies basis. Currently on contract are three anthropologists and a physician to assist in the Amerindian component of the program, as well as a sanitation engineer, a climatologist and one forest engineer specialized in forest fire prevention and control. The following outlines the program components:

5.2 Analysis of Environmental Conditions

5.2.1 Environmental Zonation.

For the purpose of a comprehensive overview of the existing environmental, socio-economic and institutional conditions of the project's region of influence, the SUCAR Environmental Unit has prepared a series of maps at 1:1,000,000 which are being used for the development of

environmental zonation and management guidelines for optimal resource utilization. The region under study is composed of a strip forty kilometers wide of both sides of the railroad (890 km long), from the mine to the port site. The maps analyze the following data:

Physical Inventory: topography, climate, geomorphology, vegetation, geology and mineral resources, soils, hydrology, potential land use, biotic endemic areas and areas of potential scenic value.

Social-Economic and Institutional Inventory:

Political and administrative divisions, Amerindian populations, population density by municipality, existing land use, ownership, health, CVRD townsites and housing divisions and economic development projects.

With the analysis and overlay of these maps, it will be possible to evaluate the regional resource capacity, degree of vulnerability to impacts caused by intensive use activities (such as industry, mining, transport) and/or attractiveness for other uses (such as areas for environmental conservation, agriculture), as well as the potential of areas for conflict (invasion of Amerindian lands, illegal prospecting, squatters).

Members of GEAMAM are directly involved in the data analysis; Dr. Aziz Ab'Saber has already commented on the relative degrees of fragility of the geomorphological, geological and hydrological components of the inventory. Dr. Joao Murca Pires and Dr. Italo Falesi are consulting on the vegetation and soils components respectively.

5.2.2 Ecological Stations and Conservation Tracts

Contact has been established with the appropriate governmental agencies - SEMA, IBDF, GETAT, INCRA and others - to determine procedures and strategies for the implementation of land use guidelines derived from the Environmental Zonation, and to obtain technical assistance in diverse environmental activities such as biotic inventory, selection of conservation tracts, program development and other environmental activities.

SEMA, the Special Environmental Secretary (Secretaria Especial do Meio Ambiente) coordinates and oversees the environmental aspects of all major projects in Brazil. Upon CVRDs request, SEMA has nominated an agency representative to act as liaison in all CVRD/SEMA collaborative efforts. An environmental impact assessment report is currently being prepared by CVRD for presentation to SEMA for approval in 1983. SEMA is also providing assistance in the selection of areas to be preserved as ecological stations 1/ and in the development of an ecologically oriented educational program for the Carajas Community.

IBDF - The Brazilian Forestry Development Institute is responsible for all aspects related to forestry (forest clearing, protected tracts, rare and endangered species, national parks). Also upon CVRD request, IBDF has nominated an agency representative for liaison. IBDF is providing assistance by training the Carajas Project forest rangers and establishing permanent control posts at strategic locations. IBDF is also helping to identify habitats of endangered species which should be protected as National Parks or Biological Reserves.

1/ For a description of Brazilian Ecological Stations, see footnote No. 2 on page 7 of this paper.

CVRD is purchasing tracts of virgin forest to be maintained for the purposes of experimentation, research and conservation of native species. The purchase of 10,000 hectares at Buriticupu on the upper Pindare River is currently being negotiated, where forest ecology research will be conducted there with the assistance of EMBRAPA and CNPq.

5.3 Research, Planning and Establishment of Management Strategies

5.31 Inventory of Flora, Fauna and Archaeological Sites.

An agreement was signed in June 1982 with CNPq - the National Council of Scientific and Technological Development - to formalize technical-scientific exchange and establish a physical base for activities at Serra Norte which would facilitate systematic research projects. Such research would be of particular value in contributing to the general knowledge of this relatively unknown region and would be applied in the decision making process for the use and management of existing regional resources, not only mineral, but also flora, fauna and rational land use. Under the terms of the agreement, CVRD has access to all research findings and the right to solicit specific research of its own interest, within the capacity of the research teams in the field.

Terms are presently being negotiated with FADESP - Foundation for Research Support and Development and with the Museu Paraense Emilio Goeldi of Belem for the initiation a five year research project on the botany, land vertebrates, forest and medicinal entomology, ichthyology and archaeological sites at the mine and port sites and along the railroad. This research, programmed over a five year period at an operating cost of Cr\$30 million (US\$160,000 in 1982) for 1983, will be utilized for the ecological zoning, selection of conservation areas and ecological stations and to develop further management strategies. It is

FADESP
M. Goeldi
CVRD

believed that in the Serra dos Carajas, in particular, numerous plant and animal species, either rare, threatened by extinction or new to science will be found.

5.3.2 Socio-Economic Support for Amerindians.

One of the most important elements of the Carajas Iron Ore Project Environmental Management Program is the socio-economic support for the Amerindian populations of the region. An estimated 4,535 Amerindians live in the area of influence of the project, defined as a radius of 100 km from the mine and along the railway 1/ (Figures 10 and 11).

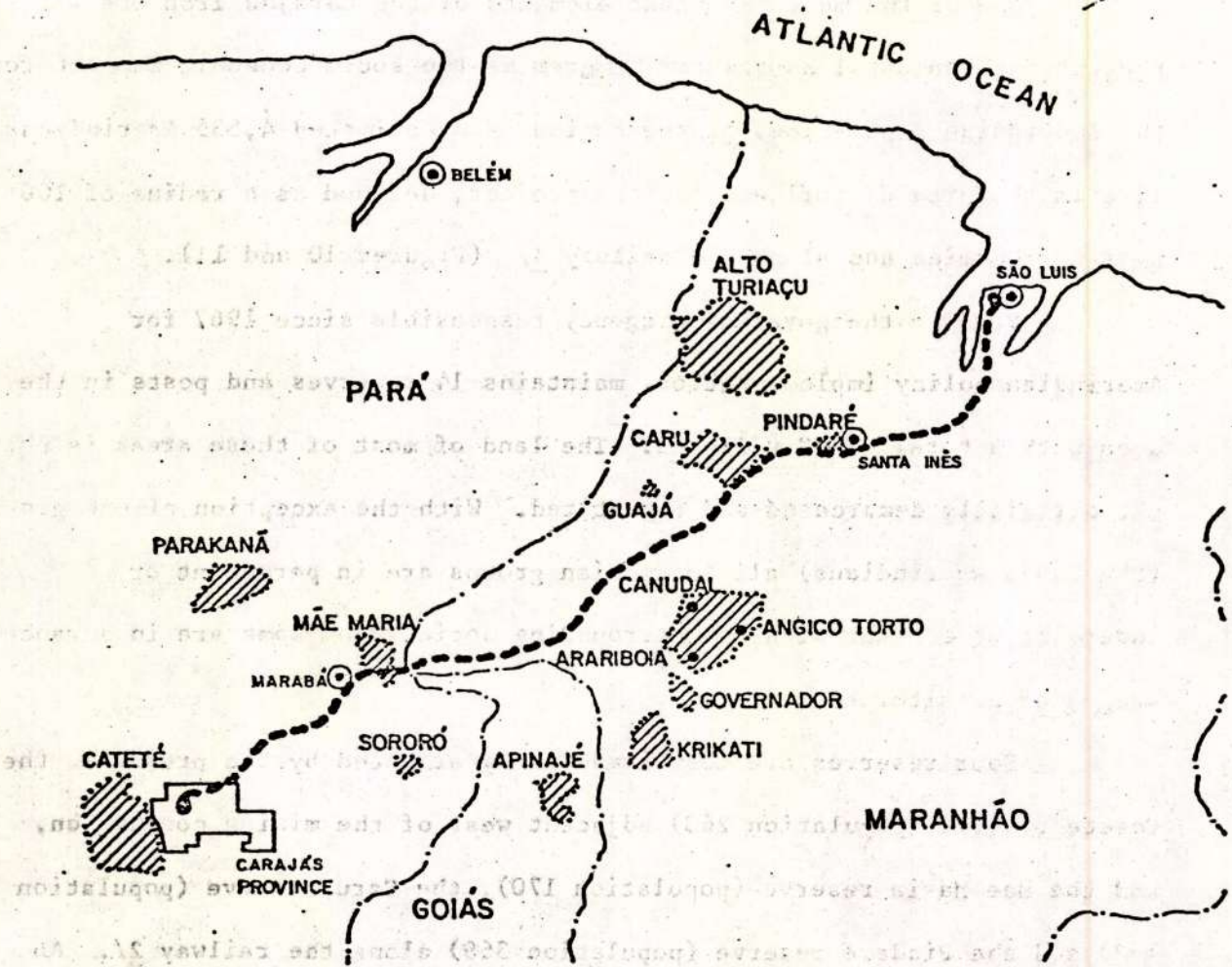
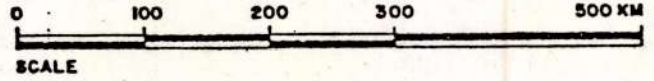
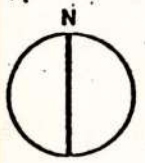
FUNAI - the government agency responsible since 1967 for Amerindian policy implementation, maintains 14 reserves and posts in the area with a total of 38 villages. The land of most of these areas is not yet officially demarcated and registered. With the exception of one group (the Guaja Amerindians) all Amerindian groups are in permanent or intermittent contact with the surrounding society and some are in advanced stages of acculturation.

Four reserves are most immediately affected by the project: the Catete reserve (population 263) adjacent west of the mining concession, and the Mae Maria reserve (population 170), the Caru reserve (population 162) and the Pindare reserve (population 369) along the railway 2/. An

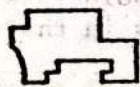




→ 1/ Current research by the Brazilian Association of Anthropologists^{?!} indicates the possibility of more than 8,000 Amerindians in this area.

2/ The population statistics are taken from the reports of the four anthropologists based on field work with the Amerindian communities during July to September 1982. See their reports, footnote on page 42 of this report.

NAO
PARAKMA



LEGEND

-  CARAJÁS CONCESSION AREA
-  INDIAN RESERVATIONS
-  CARAJÁS RAILROAD
-  CITY
-  STATE BOUNDARY

INDIAN RESERVATIONS WITHIN PROJECT AREA OF INFLUENCE

Figure 10

Figure 11: Amerindian Reserves in the Area of Influence of the Carajas Iron Ore Project

Reserve	State	Amerindian Group	Population	Area Size (ha)	Area Status ^{a/}	Municipality	Number of Villages
Catete	Para (2a)	Xikria/ Kayapo	263	439,150	Pending/ Edital	Maraba	1
Mae Maria	Para (2a)	Gaviao	170	62,000	Decree	Maraba	2
Parakana	Para (2a)	Parakana	123	270,000	Decree + Portaria	Tucuruí	2
Sororo	Para (2a)	Surui	89	26,257	Decree + Portaria	Maraba	1
Alto Turiacu	Maranhao (6a)	Urubu- Kaspor	312	530,524	Decree + Portaria	Moncao	5
Angico Torto	Maranhao (6a)	Guaajajara (Tenetehara)	1,084	413,589	Decree + Portaria	Amarante	8
Arariboia	Maranhao (6a)	Guaajajara	569	? b/	— c/	Amarante	4
Canudal	Maranhao (6a)	Guaajajara	434	? b/	— c/	Amarante	2
Caru	Maranhao (6a)	Guaajajara and Guaja	162	170,000	Decree + Edital	Boa Jardim	5
Guaja	Maranhao	Guaja	29				1
Governador	Maranhao (6a)	Gaviao	208	41,643	Decree + Portaria	Carutapera & Moncao	1
Krikati	Maranhao (6a)	Krikati	297	136,000	Decree + Portaria	Montes Altos	1
Rio Pindare	Maranhao (6a)	Guaajajara	369	13,425	Decree + Edital	Moncao & Boa Jardim	2
Apinaje	Goiás (7a)	Apinaje	447	101,000	Decree + Portaria	Tocantinopolis	2
Total			4,535	2,203,588			37

Source: FUNAI

All areas lack register with the "Serviço do Patrimônio da União".

Unknown.

Possibly included in Angico Torto Decree; data being verified.

Population figures for the reserves nº 1,2,9 and 13 are derived from the recent CVRD contracted field work in these communities on ABA anthropologists.

additional approximately 155 Guaja Amerindians live in the vicinity of the Carajas railway, close to and within the Caru reserve.

X
Of these four reserves, the latter three are located east of the mining complex and have become acculturated. One, the Cavioes, is integrated with the monetary economy. The economies of these three reserves are based on the harvesting and marketing of Brazil nuts and subsistence agriculture. The Catete reserve belonging to the Xicrin-Kayapo, west of the mine site, is virtually untouched and isolated. This group is of particular concern due to vulnerability to disease.

The Mae Maria reserve has already been impacted by a large scale economic development project. In 1980, the power line of the Tucurui hydro-electric project traversed the reserve requiring the relocation of the village. The Community was indemnified by the power company for the transmission line right-of-way. The funds were used by the community in part to build brick houses which still lack basic sanitation services.

X
→
No resettlement of Amerindians will be required as a result of the Carajas Iron Ore Project, though the railway traverses a corner of the Mae Maria Reserve for which the community received indemnification by CVRD. Nevertheless, protection of Amerindian lands from illegal invasion within the project region remains a critical issue.

X
To minimize the impacts of accelerated economic development as a result of the Carajas Iron Ore Project, FUNAI proposed a Carajas Amerindian subproject to CVRD to upgrade services in the area over a five year period from 1982 to 1986 (FUNAI: "Projeto Ferro Carajas: Apoio as Comunidades Indigenas. Janeiro de 1982).

X On June 25, 1982 CVRD signed an agreement with FUNAI to fund and execute the subproject (total cost of US\$13,595,400 Dec. 1981 rate of exchange) whose objective is to take adequate preventive measures and to create more viable conditions within the reserves, by 1) protecting Amerindian lands, 2) improving health care, 3) upgrading FUNAI staff, communications and transport at the Amerindian posts, 4) providing technical assistance, equipment and funding for economic development projects and 5) improving educational services.

The restructuring and strengthening of the FUNAI Delegation in Maranhao and its regional units is necessary in order to improve the quality of services provided by FUNAI to the numerous Amerindian reserves throughout the State, many of which suffer severe problems of illegal land invasion. Measures are also proposed to strengthen the outreach operations of FUNAI's Regional Delegations in Maraba, Para and Sao Luis, Maranhao.

In the first year, the subproject will concentrate on the four reserves immediately affected - Catete, Mae Maria, Caru and Pindare. On September 1, 1982 the first disbursement of US\$1,396,000 was made, about 10% of total funds. The equipment required for the first year subproject implementation is already being procured by CVRD.

→ With particular respect to the protection of Amerindian lands - a critical issue, the subproject includes measures such as 1) eviction of squatters and illegal trespassers from Amerindian lands; 2) safeguards against trespass, i.e. field level demarcation, clear marking of reserve borders and regular surveillance; 3) the redefinition, decree and demarcation of Guaja and Parakana Amerindian lands; 4) the settlement of cases under litigation of contested reserve borders and of pending lawsuits, and 5) the formal register of all reserves with the Servico do Patrimonio da Uniao.

The CVRD-SUCAR Environmental Management Program contracted three eminent anthropologists and one physician, specialized in these Amerindian groups and recommended by the Brazilian Association of Anthropology to provide advocacy planning support to the Amerindian groups, and to ensure that all elements of the subproject serve their best interests 1/. After the subproject was signed, they visited the reserves, analyzed the adequacy of the measures proposed by FUNAI, submitted written reports to CVRD and FUNAI, and are monitoring modifications of the subproject components and their implementation.

5.4 Monitoring and Control of Environmental Impacts

Field personnel routinely inspect the following items to control and prevent environmental impacts and to implement corrective measures.

5.4.1 Flora

5.4.1.1 Green Belt - Buffer Zones

GEAMAM strongly recommended the creation of buffer zones to minimize any negative impact of the project on adjacent areas. As iron ore deposits

1/ The Anthropologists are: Lux Vidal for the Catete, Iara Ferraz for the Gavioes, Mercio Gomes for the Caru and Pindare and Dr. Joao Paulo Botelho Vieira Filho for the health component of all four reserves. The reports which they submitted are:

1. Botelho Vieira Filho, Dr. Joao Paulo "Retrospectiva e Atualidade da Saude dos Indios Xicrins e Gaviao. Necessidades presentes e futuras frente ao Projeto Carajas". Department of Medicina, Paulista School of Medicine, Sao Paulo, SP, July 1982.
2. Ferraz, Iara "Os Indios Gavioes: Observacoes sobre uma situacao critica". Department of Anthropology, University of Sao Paulo. (Rio de Janeiro, RJ, July 1982)
3. Pereira Gomes, Mercio, "A Problematica Indigena do Maranhao, especificamente nas areas de influencia imediata da Ferrovia Carajas: Reserva Turiacu, Reserva Caru e Reserva Pindare". Campinas, Sao Paulo, SP, September 1982.
4. Vidal, Lux, "Levantamento da situacao atual dos indios Xicrin do PI Catete - Recomendacoes iniciais frente ao Projeto Carajas". Department of Anthropology, University of Sao Paulo, SP, July 1982.

→ extend to the perimeter of the 429,000 hectare mining concession, CVRD has requested expansion of the concession area to allow for the establishment of a buffer zone around the mining area. Similar buffer zones will be established along the railway and at the port.

At the mine site, a planting scheme is being designed for the protection of the forest edge cleared for the Carajas townsite, airport and access highway; a grading plan and a replanting schedule will be developed for the reclamation of the mining sites after strip mining.

5.4.1.2 Nursery

A nursery has been constructed at Serra Norte and another is scheduled for construction in Sao Luis as principal support facilities providing plant materials - trees, shrubs, ornamentals, flowers, ground cover - for landscaping the existing campsites and offices and for implementing the landscape design developed by CVRD's consultant landscape architects for the mine and port sites. The Serra Norte nursery located adjacent to the Airport has been operating since October 1982 complete with a greenhouse, seed beds, shade frames, propagating benches, sheds for the preparation and mixture of soil and fertilizers, offices, maintenance shops, and garage for trucks and equipment. Native species seeds are being locally collected, germinated and propagated. Seeds and seedlings are also being provided by CVRD's own Forestry Division and by governmental agencies such as EMBRAPA - Brazilian Agency of Agricultural Research of the Ministry of Agriculture.

5.4.1.3 Research on Vegetation Regeneration

Under a two year contract signed in March 1982, the Agricultural Research Institute - IRI - will study and recommend optimum planting techniques for the mine, railroad and port sites to control erosion and

rehabilitate earth worked areas. Pilot experiments have been started at Serra Norte with the planting of diverse species of grasses, legumes and ground cover.

5.4.1.4 Erosion control planting

Access roads, rail cuttings and embankments of all project sites are being graded and stabilized with topsoil that is replacement seeded to grass and monitored by environmental staff.

5.4.1.5 Control of Forest Clearing

Forest clearing at the mine site is being closely supervised on a routine basis by the environmental staff to ensure that undesired or inadvertent clearing by the contractors employees is kept to a minimum. The company established a policy to pay the cost of clearing only the areas specified by the job contract; any additional areas cleared would be at contractors cost (or rather, loss).

As of May, 1982, 90% of the area required for construction in Carajas had already been cleared - the equivalent of approximately 2,000 hectares, less than 1% of the 429,000 hectare concession.

5.4.1.6 Topsoil Stockpiling

Some contractors are required to scrape the top 15 cm of topsoil from the areas cleared for construction, and to transport and stockpile this topsoil to be used for site reclamation and replanting.

5.4.1.7 Prevention and Control of Forest Fires

A forest engineer of the Federal University of Parana was contracted in April 1982 as a consultant to develop a program and educational campaign at the Carajas mine site to prevent, control and

fight forest fires 1/ Two lookout towers are being built, necessary equipment is being procured and the forest rangers have already been trained by IBDF 2/.

5.4.1.8 Landscaping

Landscape architects have been contracted to develop landscape designs for the mine and port sites, both to ameliorate the living conditions of the community residents and to reclaim the areas affected by construction earthworks and to landscape townsites now under construction.

5.4.1.9 Utilization of Timber

The bulk timber at Serra Norte available, already cut, after forest clearing for construction was inventoried by a technical team from I.P.T., the Institute of Technological Research of the State of Sao Paulo. The volume and quality of the timber at the airport and along the transmission line which could be utilized for construction at Serra Norte or for other purposes, was estimated. A preliminary estimate indicated a volume of 19,500 m³: 6000 m³ stockpiled at the existing saw mill, 10,000 m³ at the airport, townsite, transmission line and borrow pits, with an additional 3500 m³ still to be cut for the construction of the Esteril Norte retention dam and for the townsite expansion.

5.4.2 Fauna

The regional fauna is very rich in number of species, but comprising relatively few individuals. The Company policy of no hunt/no capture of wild animals in the Carajas area is being enforced according to

1/ Soares, Ronaldo Viana. "Plano de Implantacao de um Sistema de Prevencao e Controle de Incendios Florestais para a Serra dos Carajas" CVRD - Curitiba 1982.

2/ See page 35 of this report.

Article No. 1 of the Federal Law No. 5197 of January 3, 1967, which prohibits the utilization, pursuit, destruction, hunt or capture of wild animals. Domestic animals at the mine site are also prohibited.

5.4.3 Climate

A climatologist, professor of the University of Sao Paulo who had done the climatological research on the project region, supervised the assembling of the meteorological station at Serra Norte 1/ Environmental staff take readings three times a day of rainfall, direction and velocity of winds, relative humidity of the air, temperature, rate of flow and water level of the Gelado River. Similar stations will be assembled along the railroad and at the port site. Meteorological data from existing sources are utilized for a comparative analysis of the regional microclimates.

5.4.4 Soil, Air and Water

CVRD environmental experience acquired in the Southern System operation of the Tubarao port, Itabira mines and 550 km of connecting railroad is being directly applied to planning pollution control for the Carajas Project. In general, pollution problems are expected to be less severe in the north than in the south for several reasons: (i) Carajas ore is sinter feed, and less dusty than the fines, ultra fines and blue dust in the south; (ii) Carajas sinter feed will be more humid (shipped wetter) than Itabira products; and (iii) the prevailing winds at Sao Luis are from port to sea, unlike Tubarao where winds blow from the ore port towards the city.

In September 1982, CVRD contracted the Promon Engineering Company to design and implement the Ponta da Madeira port terminal and to

1/ See Tarifa, Jose Roberto, reference footnote on page 25.

undertake a 12-month comprehensive port study to develop an optimum pollution prevention system. 1/ The program includes: a) preparation of a pollution control master plan, b) design and implementation of an environmental monitoring system, c) identification and implementation of the priority project norms and operational procedures, and d) a landscape architecture design subcontract.

The preliminary report after a site visit by Promon technicians presents observations about the conditions of storm water runoff, erosion control on the site embankments, solid waste disposal, protection of mangrove swamps and existing vegetated tracts, and issues related to the low income settlements adjacent to the Port Terminal site.

1/ Promon Engineering, "Terminal da Ponta da Madeira - Estudos e Projetos para Controle Ambiental na Area do Terminal" August 1982. (also) "Relatorio de viagem ao terminal de Ponta da Madeira da CVRD: Engenharia Ambiental." November 1982.

At the mine all overburden dump sites and tailings will have carefully designed retention dams and settling ponds 1/. Currently, there exist two provisional retention dams, one, Gabiao for the retention of mining fines carried by rains, and the other, for the retention of industrial wastes from the pilot beneficiation plant. The permanent dam - Esteril Sul - which will be utilized for the retention of fines from the mine's south overburden dumpsite, is presently being used as a source of drinking water. Two additional dams will be constructed, one, Rejeito Norte, for the retention of the wastes from the definitive beneficiation plant and as a source of industrial process water, and the other, Esteril Norte, for the retention of fines from the mine's north overburden dumpsite.

Mining process water will be discharged into settling ponds filtered through specially permeable dams and recycled back to the plant 1/. Another dam and settling pond - Rejeito Norte - is under construction; the possible need for additional dams is being studied. The mine site is irrigated during the dry season to reduce dust, for the benefit of the both humans and machinery. The behavior of the moist ore during the journey of 890 km from mine to port will be monitored.

1/ The following information was confirmed by Mozart Litwinski, SUNOR Mine Superintendency, Assistant for Operations Coordination: The water recycling system of the pilot plant currently uses a special classifier which removes the heavier fraction, before the water flows into a thickening tank - with the addition of flocculant polymer "Super floc A-120" - which effectively flocculates the colloids. About 95% of the water is recycled back into the wet screening system. The fines thickening tank is emptied by a front loader to a dam about once a week.

5.4.5 Historic, Archaeological and Scenic Sites

IPHAN - the National Institute of Historic and Artistic Patrimony - is being contracted through the Museu Goeldi-CVRD Agreement to carry out an archaeological search and salvage inventory of valuable sites within the project region. A museum at Serra Norte will be established to document and safeguard the history of this project's development and to house specimens of typical flora, fauna and archaeological artifacts.

Belvederes are being constructed at strategic points of panoramic views. One has been established at the guest house, with the construction of a gazebo and an elevated platform at the plateau edge, connected by an interpretive trail winding through the forest. An additional two sites along the access highway PA-275 have been selected.

5.5 Environmental Education

A program of Environmental Education is being developed with the technical assistance of SEMA - The Special Secretary of the Environment, whose objective is to foster a dynamic, continuous process of educating the Serra Norte community about the equilibrium of nature and the role of people in maintaining or re-establishing that equilibrium. The program includes training of teachers, preparation and utilization of ecologically oriented materials, and the diffusion of this information at all levels of the community.

The educational and administrative staff of the community school already is closely collaborating with the Environmental Staff by incorporating ecology in all school projects, lessons, and activities possible. Appropriate materials are being solicited and provided by Brazilian environmental agencies. Cultural and leisure activities are being encouraged, such as the creation of scout clubs, camps out, garden clubs with contests and classes, etc.

Environmentally relevant events, such as the International Day of the Environment, and the National Week of the Tree, have been commemorated with week-long programs of special film presentations, lectures by invited guest speakers from GEAMAM and Universities, contests, exhibits of art by school children, distribution of T-shirts and information pamphlets, with great success and community participation.

Throughout the urban and industrial sectors of the mine, environmental signs are posted to remind the resident worker community of their responsibility for environmentally sound behavior. Educational campaigns are being elaborated by the Field Environmental Officer, the Public Health Physician and the Occupational Safety Engineer which focus on issues such as nature conservation, pollution control, hunt and capture of wild animals, fire prevention and control, health, hygiene, worker safety, etc.

5.6 Basic Services Delivery

The delivery of basic services for the Serra Norte Community are being monitored on a routine basis by the four inspectors of the CIMA Mine staff accompanied by the technicians of Occupational Safety Engineering, Social Assistance, Public Health and Sanitation.

5.6.1 Health

An agreement was signed in April 1982 with Fundacao SESP - Public Health Services Foundation of the Ministry of Health, to provide technical assistance in research for 12 months, through the Evandro Chagas Institute of Belem on the tropical diseases which could affect the region's population. The research aims to control and or eradicate leishmaniasis, arboviral diseases, leptospirosis, Chagas disease, hepatitis and bacterio-enteritic infections.

At present, the possible collaboration of Fundacao SESP in delivery of basic health services for the regional population through its existing health units and those being constructed by CVRD (two hospitals at the Carajas and Parauapebas townsites and two health units at the Acailandia and Nova Vida housing divisions) is being studied.

UNICEF - The United Nations Children's Fund also has been contacted to examine possible interface in the areas of primary health care, nutrition monitoring, basic sanitation, income generation and education for the regional population.

5.6.2 Basic Sanitation

A sanitation engineer was contracted as consultant in August 1982 to develop, during a 9-month period, a comprehensive, phased program of basic sanitation services for Serra Norte, which includes recommendations for an improved system of domestic solid waste collection, transport and disposal 1/ and organization of operational norms as well as a community education component.

5.6.3 Security

The total 429,000 hectare area of the CVRD mining concession at Serra Norte is presently being surveyed and aerophotogrammetrically documented at a scale of 1:20,000 for the purpose of more accurate area delimitation, facilitating border protection and control of illegal trespass.

In October 1982, a two year agreement was signed with GETAT - the Executive Group for the Araguaia - Tocantins area for the purpose of fostering mutual collaboration in the analysis of and policy recommendations for the resolution of land conflicts in the Carajas Iron Ore Project area of influence.

1/ Costa Leite, Luis Edmundo H.B. "Sistema de Limpeza Urbana Acampamento N5 - Serra Norte" Rio de Janeiro, October 1982.

A corps of ten forest rangers and inspectors have been trained by IBDF - the Brazilian Forestry Development Institute to enforce federal and company policies on the protection of flora and fauna, illegal invasion and mineral prospecting and fire surveillance. Close collaboration is maintained with appropriate federal and local security agents.

5.7 Coordination with Governmental, Environmental and Financial and Research Institutions

Contact is maintained with the following institutions for the development and implementation of program activities:

Research Centers:

CNPq	Conselho Nacional de Desenvolvimento Cientifico e Tecnologico
INPA	Instituto Nacional de Pesquisa da Amazonia
INPE	Instituto Nacional de Pesquisa Espacial
IPHAN	Instituto do Patrimonio Historico e Artistico Nacional
	Museu Paraenze Emilio Goeldi
IBGE	Instituto Brasileiro de Geografia e Estatistica
ABA	Associacao Brasileira de Antropologia
UFMA	Universidade Federal do Maranhao
UFPA	Universidade Federal do Para

Environmental Agencies, Public and Private:

SEMA	Secretaria Especial do Meio Ambiente
IBDF	Instituto Brasileiro de Desenvolvimento Florestal
FBCN	Fundacao Brasileira de Conservacao da Natureza
SERNAT	Secretaria de Recursos Naturais, Tecnologia e Meio Ambiente
SOPREN	Sociedade de Preservacao de Recursos Naturais da Amazonia

Governmental Institutions:

FUNAI Fundacao Nacional do Indio
GETAT Grupo Executivo das Terras do Araguaia-Tocantins
INCRA Instituto Nacional de Colonizacao e Reforma Agraria
EMBRAPA Empresa Brasileira de Pesquisas Agropecuarias
SUCAM Superintendencia de Campanhas de Saude
SUDAM Superintendencia de Desenvolvimento da Amazonia
SEPLAN Secretaria de Planejamento
Secretaria De Saude, Belem do Para
Secretaria De Agricultura, Belem do Para
Fundacao De Servicos De Saude Publica

Financial Agencies:

→ EEC European Economic Community
→ World Bank
→ BNDES Banco Nacional de Desenvolvimento Social
→ KfW Kreditanstalt fur Wiederaufbau

6. Challenge for the Future

The decade of the 1970's witnessed heightened worldwide interest in conserving and managing environmental resources. From 1970 to 1980 about twice as many new projected areas were created as had been established in the preceding 100 years: there are now 2,611 conservation areas in 124 countries on the United Nations List of National Parks and Equivalent Reserves. Altogether, the conservation areas on the U.N. list total almost 4 million square kilometers 1/. At the beginning of the last decade, conservation programs were regarded as an impediment to economic development, especially in the developing countries; now it is widely recognized that the failure to conserve natural resources makes sustained economic growth impossible.

Together with this change, has come another shift in viewpoint, from the old notion that conservation means the fencing in of nature and leaving it alone, to a more active view (as expressed in the International Union for the Conservation of Nature's 1980 World Conservation Strategy) that conservation is "the management of the human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the demands and aspirations of future generations".

This is the challenge faced by the Environmental Management Program for the Carajas Iron Ore Project - the implementation and operation of iron ore strip mining and industrial activities, rail transport, deep water shipping and housing component of a large scale regional development plan in the virgin Amazonian forest.

1/ Royal Swedish Academy of Science, "AMBIO - A Journal of the Human Environment" Volume XI, Number 5 Pergamon Press, NY. 1982.