

## Introduction

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This Environmental Impact Report (Relatório de Impacto Ambiental - RIMA) presents the results from **Araguaia Project's** Environmental Impact Study (Estudo de Impacto Ambiental - EIA).

The RIMA aims to present the main characteristics of this mining project, as well as the environment in which it is inserted, in a clear and direct manner and using an accessible language.

Thus, this report will consider a long-term mining project (at least 25 years of life of mine), inserted in a region with propensity to mining (Araguaia Belt context), whose product (ferronickel alloy) is essential for stainless steel production and, consequently, for the industrial development of the country.

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The environmental studies related to Araguaia Project licensing process were prepared by a team composed of several specialists from different fields of expertise, under the technical responsibility of Walm Engenharia e Tecnologia Ambiental LTDA.

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## **1. The Project**

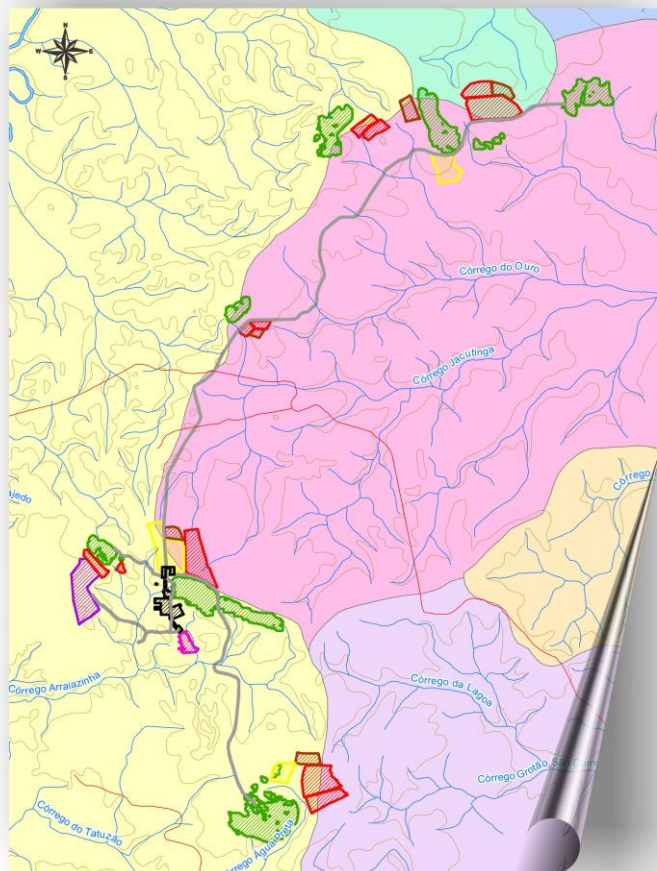
The project presented here is the **Araguaia Project**, which consists of the exploration of 07 nickel laterite deposits located in the municipality of Conceição do Araguaia-PA.

The following items present a description of the project in order to show its activities, processes and tasks during the implementation, operation and closure phases.

## **2. The Project Location**






The Araguaia Project is located 40 km north of the urban area of Conceição do Araguaia municipality, in the southeastern portion of Pará State, near the border with Tocantins State (25 km west of the Araguaia river). The PA-449 road, connecting the municipalities of Conceição do Araguaia and Floresta do Araguaia, cuts through the Project area. **Figure 2-1** illustrates the Project location.

The project is located approximately 200 km from BR-153, a federal highway that provides access to the Port of Itaqui, in São Luís do Maranhão. Road transport along the route shown in Figure 2-2 (approximately 1,150 km from the Araguaia Project to the Port of Itaqui) will be the main transport channel to receive inputs and export the Ferronickel Alloy.



## Legend

Directly Affected Area (Área Diretamente Afetada - ADA) of the Physical and Biotic factors

-  Pits
-  Waste Pile
-  Metallurgical Plant
-  Roads
-  Slag Pile
-  Industrial Plant Cooling Reservoir



## Regional Location

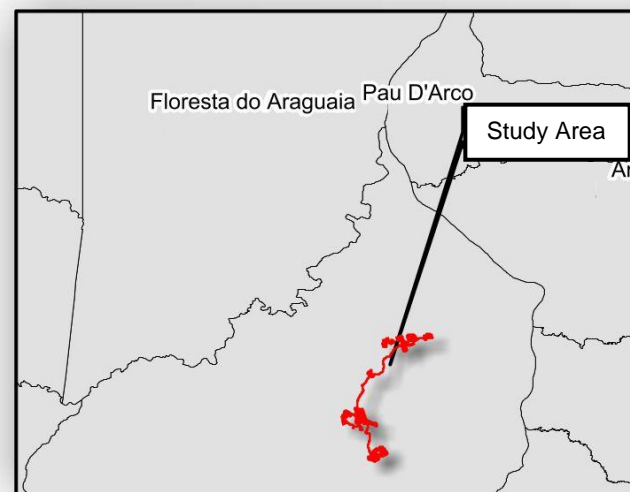


Figure 2-1 – Araguaia Project Location

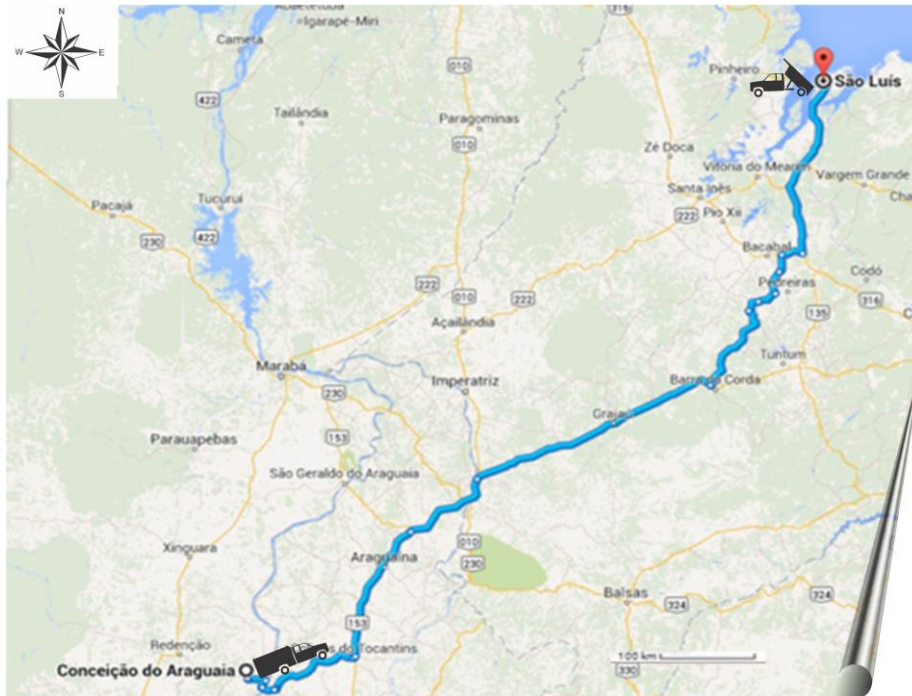


Figure 2-2 – Road transport route from the project to the Port of Itaquí.

### 3. Rationale and Objectives of the Araguaia Project

Brazil is one of the world's leading producers of iron ore, niobium, manganese, aluminium, kaolin and tin. Considering the recent development of large-scale projects, the country also has great potential to become one of the world's largest nickel producers.

Nickel is an essential metal for manufacturing stainless steel, which is an indispensable alloy for the food, chemical and oil industries. Stainless steel is also used in the manufacture of household appliances, vehicles and in construction.

Historically, nickel production came from nickel sulphide deposits, but these deposits are being depleted and nickel laterite deposits are gaining space in the mining sector. It is worth noting that the Araguaia Project deposits are **nickel laterite** deposits.

**Nickel laterite:** nickel found in soils modified by rainfall with high concentrations of iron and aluminium

The main objectives of the project are:

- To produce ferronickel alloy in a region with propensity to mining, with basic infrastructure, logistics infrastructure and available labour force;
- Anticipate future demand for nickel to ensure that the supply of this metal is maintained in the market;
- To develop mining and metallurgical activities in the southeast of Pará State, being committed to a balance between financial, environmental and social issues.

**Figures 3-1 and 3-2** show examples of nickel and stainless steel applications.



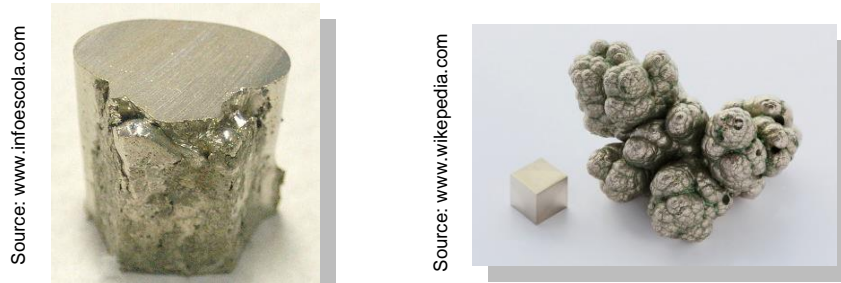


Figure 3-1 – Nickel



Figure 3-2 – Stainless steel

It is also worth noting that this is a world-class nickel project both in terms of production capacity and ore grade, which combined, provide minimum production cost, proven process route and optimal infrastructure. The Araguaia Project is set to start production at a crucial time for the nickel market, when demand will exceed supply.

## 4. Project Characteristics

The “Araguaia” mining project consists of exploring seven nickel laterite deposits located in the municipality of Conceição do Araguaia. Considering the physical characteristics of the deposits and their proximity to the surface, it is expected that the extraction of the ore is feasible through open-pit mining, operated by backhoe loaders and ore transport trucks. The estimated life of mine of the project is 25 years, with an average annual production of 900,000 tons.

A **mineral deposit** is a local concentration of one or more useful substances with economic value

After extraction, the ore will be transported to the metallurgical process where the ferronickel metal alloy will be produced. The metallurgical process is based on a rotary electric furnace, known by the acronym RKEF (Rotary Kiln Electric Furnace).

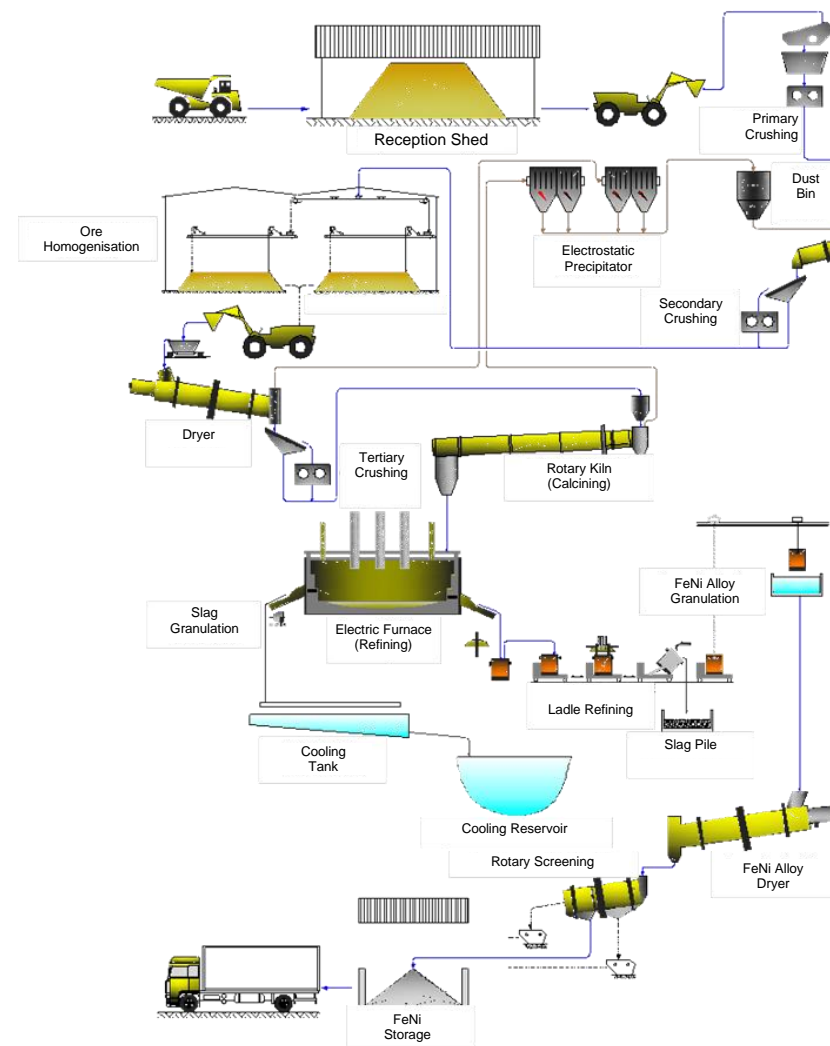
RKEF has been used for nickel laterite for over 60 years. There are currently 18 plants using this process worldwide, including in China.

The most recent plants to use RKEF are Barro Alto (Anglo American) and Onça Puma (Vale), both in Brazil, as well as a POSCO plant in South Korea.

**Figure 4-2** illustrates the main stages of the RKEF metallurgical process.



**Figure 4-1 – Locations (deposits)  
where nickel will be mined**



**Figure 4-2 – Process Stages**

## Water Consumption

The water required to operate the project will be collected from the Arraías river and transported to the project through a pipeline (to be built) approximately 10 km long.

The estimated water consumption values are presented in **Table 4.1-1**, considering the average processing of 900 thousand tons of ore per year.

**Table 4-1 – Estimated use of water at the operation**

Type of water	Average	Minimum	Maximum
	Required flow rate in m <sup>3</sup> /hour		
Raw water	130.97	123.96	137.97
Pre-treated	42.52	38.44	46.59
Demineralised	12.84	12.84	12.84
Potable	33.33	33.33	33.33
Total	219.66	208.58	230.74

The three main sources of water consumption are:

- ✓ Metallurgical plant;
- ✓ Road humidification and dust reduction at construction sites;
- ✓ Drinking water for employees' consumption.

In addition to the intake from the Arraías river, three water intake alternative sources are envisaged:

- ✓ Use of the underground water pumped from the mining pits;
- ✓ Rainwater collection system;
- ✓ Capture of the effluent water from the **slag** pile.

## Slag

Waste generated by the transformation of metallic minerals at high temperature.

## Energy Consumption

The estimated electricity consumption to operate the project is 72.48 MW nominal, 73.49 MW at peak. To meet this demand, it is planned to capture and transport energy from Colinas Electrical Substation, located in the municipality of Colinas do Tocantins-TO.

In order to enable energy collection and transmission, two new substations and a transmission line will be required. The first substation will be 500/230 kV and will be located near Colinas Electrical Substation. The second substation will be 230/13.8 kV and will be in the area where the project is located. The transmission line between Colinas do Tocantins and the Project will be 230 kV and 110 km long.

## Main Environmental Controls

### Solid Waste

The municipalities of Conceição do Araguaia and Floresta do Araguaia do not have an environmentally appropriate solution for final disposal of solid waste, either at the city centre or in the urban agglomerations of these municipalities.

Based on this scenario, the **solid waste** will be disposed of according to the system proposed for the Araguaia Project (See **Figure 4-3**) which is based on the selective collection of solid waste.

Selective collection will be implemented during the construction and operation phases of the project. Solid waste collectors, properly identified by the colours

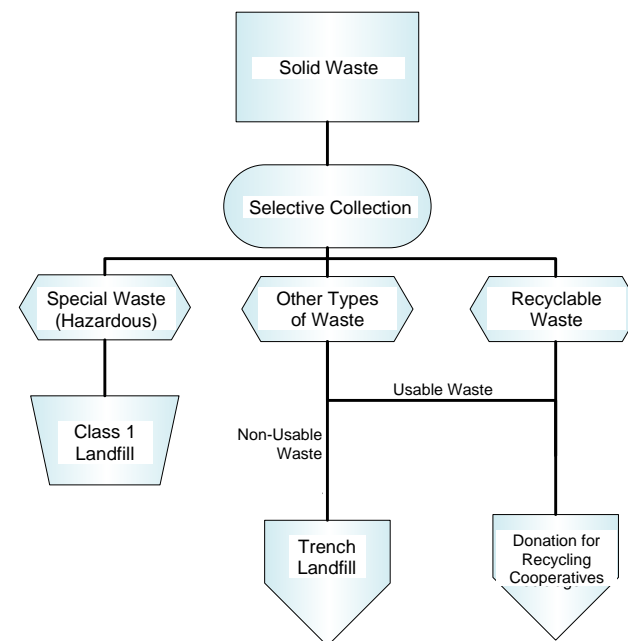
established by the applicable legislation (Conama Resolution 275/2001), will be distributed near the points where waste is generated. The construction and operation teams will be trained for the correct separation of the solid waste. The waste, duly separated and conditioned, will be periodically transported to cooperatives.

Special waste, such as batteries, fluorescent lamps, petroleum waste, paint packaging and other compounds related to the maintenance of mechanical, electrical and electronic devices, will be stored in containers at a solid waste centre, to be periodically sent to appropriate landfill sites.

**Solid Waste** is what is generically called rubbish, i.e.: solid materials considered useless, superfluous or hazardous, generated by human activity, and which must be discarded or eliminated.

Organic waste with no potential for reuse or recycling will be sent to trench landfill sites, built around the project.

The slag from the metallurgical process will be transported by trucks to the slag pile. In the future, this slag may also be used in civil works for soil correction and aggregate composition. The total volume of slag produced during the 25 years of operation is estimated at 9.93 million m<sup>3</sup>. The proposed slag pile has a surface area of approximately 78.7 hectares, four 15-metre high benches and a maximum total capacity of 25.80 million m<sup>3</sup>. **Figures 4-4** and **4-5** show the location of the slag pile.



**Figure 4-3 – Solid waste disposal system**



**Figure 4-4 – Slag Pile Location**



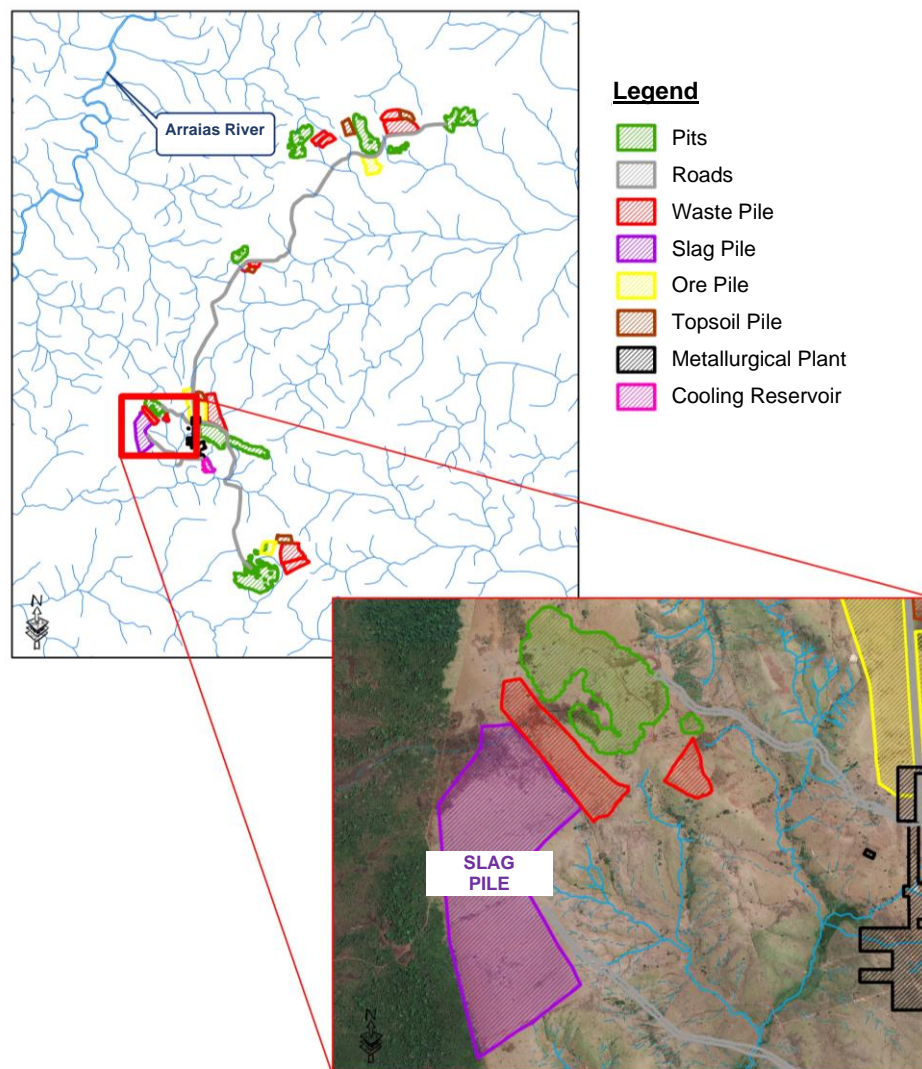


Figure 4-5 – Schematic Location of the Slag Pile

## Liquid Effluents

As presented in the water consumption item, the ferronickel smeltery processes consume a considerable volume of water (219.66 m<sup>3</sup> per hour on average).

In order to minimise the pressure on the rivers and streams, water reuse is planned in the project's highest consumption activities. The main water consumption activities are presented in **Table 4-2**.

Table 4-2 – Main water consumption activities

Nº	Description	Water Type	Circuit
01	Smeltery cooling	Pre-treated	Closed
02	Slag granulation	Raw	Closed
03	FeNi granulation cooling	Raw	Closed
04	Refinery cooling	Pre-treated	Closed
05	Cooling the smeltery electrode	Demineralised	Closed
06	Canteen/cafeteria	Potable	Open
07	Drying and rotary kiln cooling	Pre-treated	Closed
08	Dust control	Pre-treated	Open
09	Mixed dust	Raw	Open

## Project Labour and Timetable

The project implementation phase will take 24 months from the environmental licence authorising to start the works.

During this period, the Araguaia Project will create several jobs, including operators, labourers, engineers, carpenters, physicians and foremen. At the construction peak, it is estimated that 1,092 workers will be hired.

During the project operation phase, which will last for 25 years, it is expected that 456 new jobs will be created.

## 5. The Environmental Assessment

CONAMA Resolutions 01/86 and 237/97, which regulate the requirement for environmental impact studies in Brazil, determine that the areas of influence should be subdivided into three levels of coverage, to represent the limits of the geographical areas that may be directly or indirectly affected by the impacts: **physical factor, biotic factor and socioeconomic factor**.

Thus, the objective of this chapter is to present the main aspects related to the physical, biotic and socioeconomic factors, which are likely to be modified by the implementation and operation of the Araguaia Project.

### Definition of Areas of Influence

The area of influence corresponds to a territory in which it is possible to identify the action of the impacts of a project. Different impacts can occur in different areas, justifying the delimitation of at least three areas of influence.

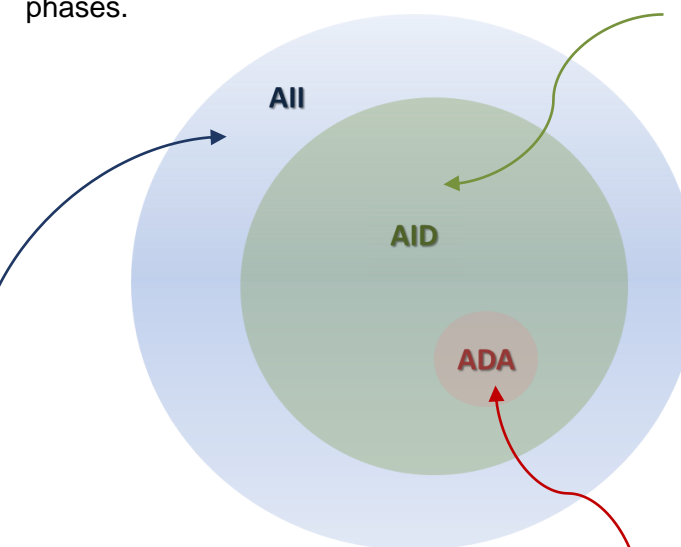
**Figures 5-1 and 5-2**, shown in the next pages, illustrate Araguaia Project areas of influence.

### Area of Indirect Influence

**(Área de Influência Indireta, AII)** - has a regional aspect and is associated with the areas where the impacts of the project may occur in an indirect and diffuse manner.

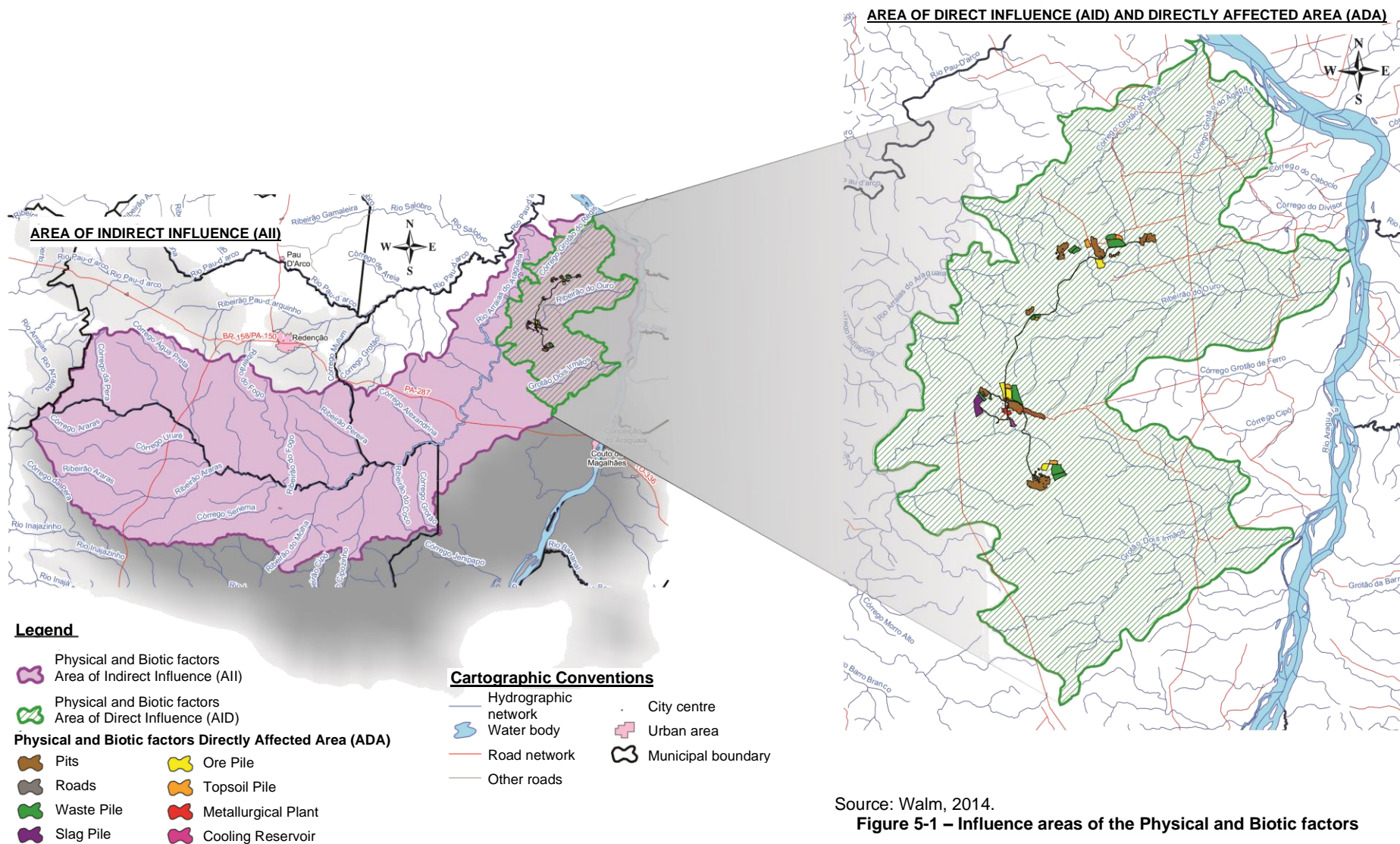
### Area of Direct Influence

**(Área de Influência Direta, AID)** - corresponds to the area where the impacts caused by the project directly influence the environment, whether during the planning, implementation and/or operation phases.

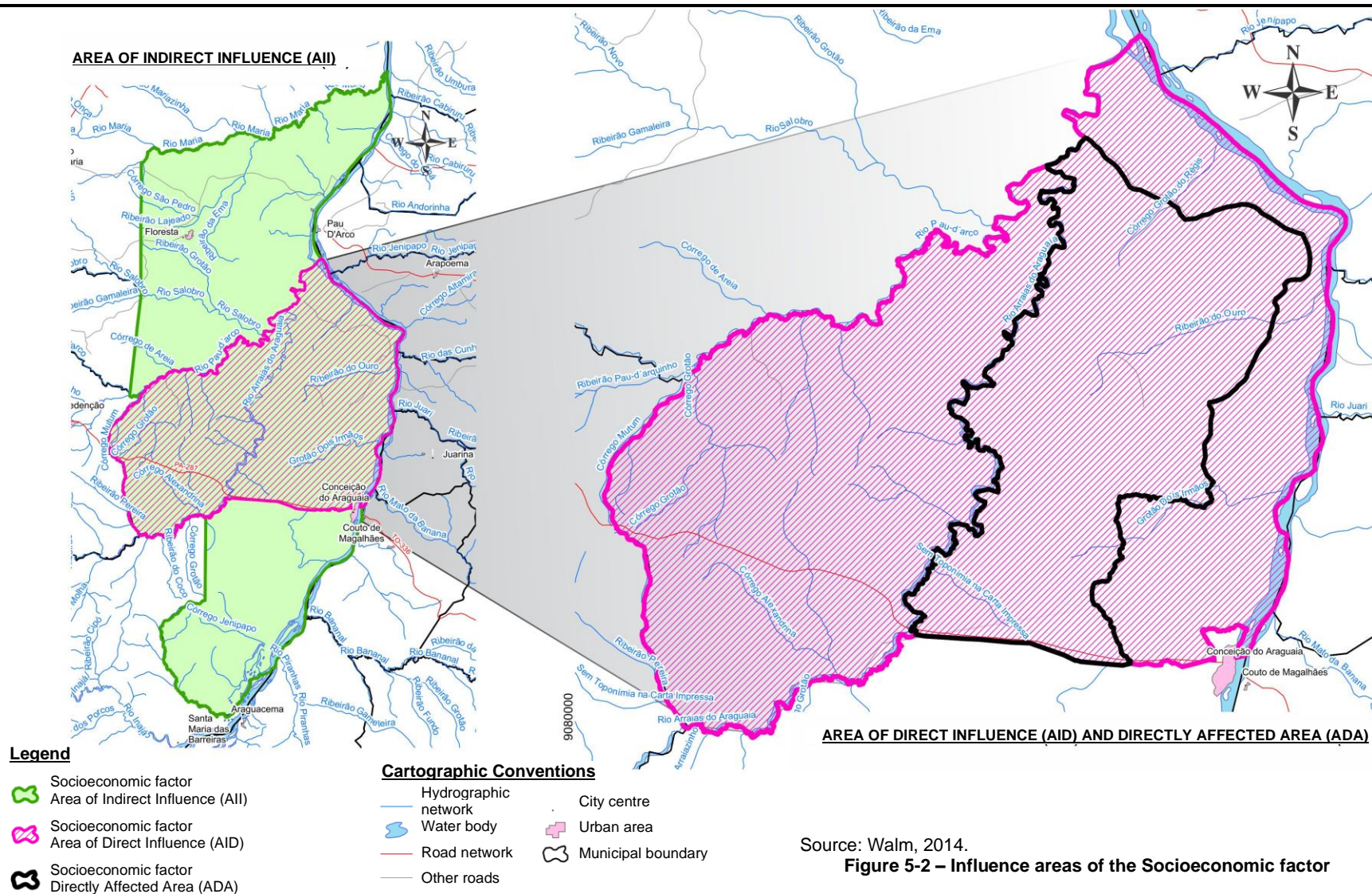


### Directly Affected Area

**(Área Diretamente Afetada, ADA)** - comprises the area where the project will actually be implemented and which will therefore suffer the direct consequences of the project.









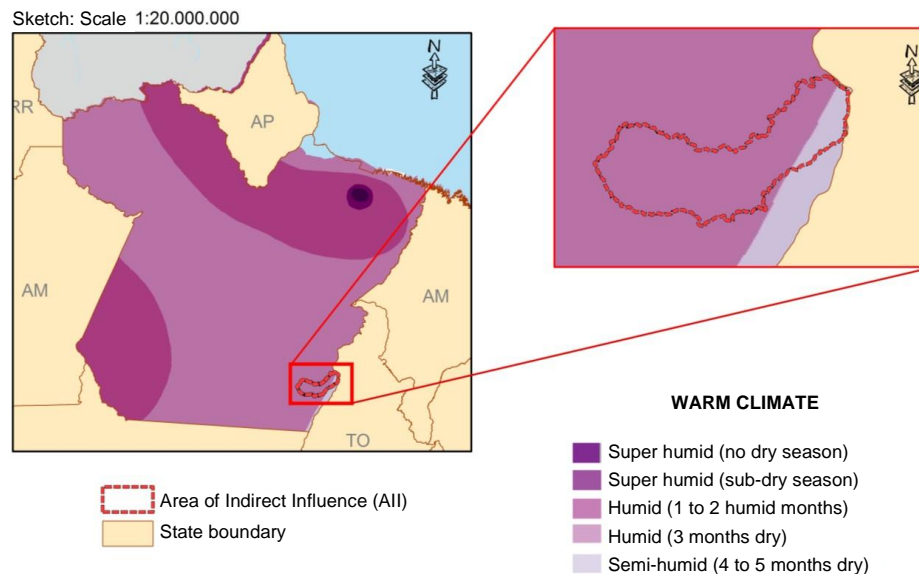
*Physical Factor*



## Climate and meteorological conditions

The project under study is located in a region with an equatorial climate, which means that it is possible to observe high air temperatures throughout the year.

Rainfall is abundant during the summer, reaching up to 268 mm in March. In the dry season (drought), that occurs from May to August, the precipitation (rainfall) can be less than 20 mm.



Source: IBGE, 2014 (adapted).

**Figure 5-3 – Climate Classification (IBGE) of the project All.**

The prevailing winds in the area surrounding the Araguaia Project blow in a northerly direction. The average annual speed does not exceed 6 m/s, although it is possible to observe maximums of up to 11 m/s between June and August. Thus, the highest wind speeds in the region coincide with the dry season (drought).

The area around the project is characterised by small dirt roads. Consequently, it is during the winter in Brazil that the greatest change in local air quality is observed, due to the dust.



**Figure 5-4 Local meteorological monitoring station**

## Geological and geotechnical aspects

The study area is formed by two main geological units, namely: Rocks with high iron and magnesium grade, originating from the cooling of volcanic magma (**ultrabasic rocks**) and rocks originating from the deposition of eroded and subsequently metamorphized sediments (metasedimentary rocks from the Couto Magalhães Formation).



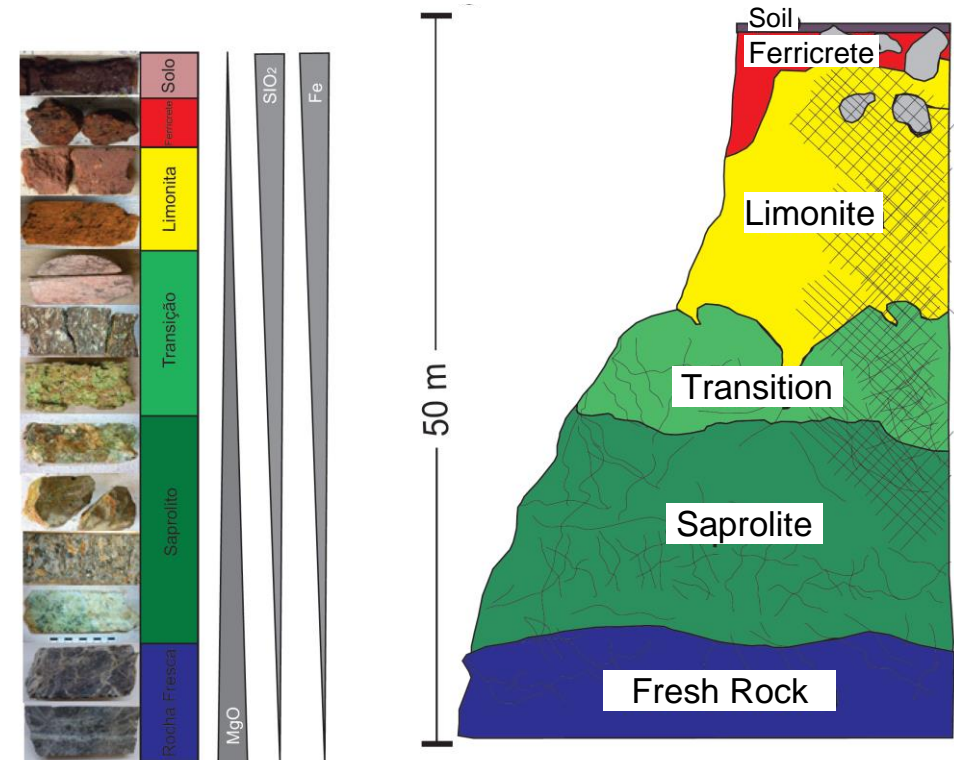
The **ultrabasic rocks** are rich in nickel ore and represent more than 80% of the areas that will be mined



Figure 5-5 – Outcrop of ultrabasic rock observed in the study area

**Figure 5-6** illustrates the alteration profile of the ultrabasic rocks in the study area.

It is noteworthy that the transition horizon between limonite and saprolite, at a depth of approximately 25 m, presents the highest nickel concentration.



Source: Araguaia Níquel Mineração Ltda., 2013.

**Figure 5-6 – Typical alteration profile based on the descriptions of the boreholes drilled at the targets.**

Regarding geotechnical stability, the rocks analysed may present moderate to high shear strength and susceptibility to erosion.

### Pedological aspects



Figure 5-7 – Red-Yellow Latosol

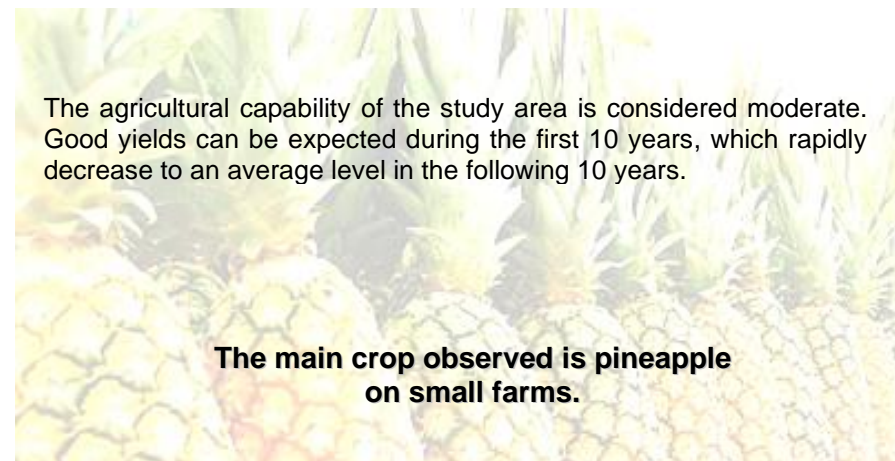
The soils of the study area are the **RED-YELLOW LATOSOLS**, which correspond to deep soils, normally higher than 2 m, typical of flat and well drained areas.

Given the characteristics of the climate (humid tropical with significant rainfall contrast between the seasons) and the geology (ultrabasic rocks), it is usual to find ferruginous carapace (ferricrete) in the region (**Figure 5-8**).

The dismantling of these carapaces generates a soil with a high concentration of iron and aluminium, red colour and a solid porous aspect, as it can be seen in **Figure 5-7**, above.



Figure 5-8 – Ferruginous Carapace



The agricultural capability of the study area is considered moderate. Good yields can be expected during the first 10 years, which rapidly decrease to an average level in the following 10 years.

**The main crop observed is pineapple on small farms.**

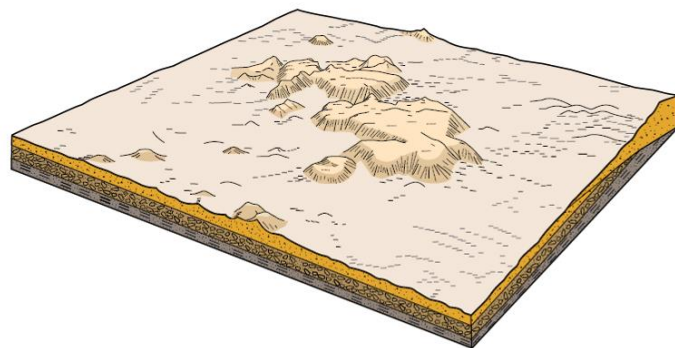
### Relief Shapes

The Araguaia Project is located in a relief compartment called the “Middle and Lower Araguaia Depression”.

The Middle and Lower Araguaia Depression represents a surface that has been lowered over the centuries by the wear of the geological structure, giving rise to a landscape with flat or undulating forms located below the level of the neighbouring regions, with an average altitude of 200 m.

In the midst of this great lowered landscape, it is usual to observe residue forms, in other words, forms originated in terrains that present greater structural resistance to the wear of fluvial waters (from rivers and streams) and pluvial waters (from the rains).





Source: IBGE, 2009.

**Figure 5-9 – Profile of the typical relief of the study area. In the centre, plateaus immersed in a depressed landscape.**

The predominant form in the study area is the plateau. It is a residual relief, flat and with strongly inclined slopes in rectilinear to gently convex curvatures, as well as ramped when in a less inclined setting. The drainage network on the top of the plateaus is not very dense and slightly fitted.

### Superficial Water Resources

Pará state Water Resources Policy (Law No. 6.381/2001) divides the state territory into seven hydrographic regions. The Araguaia Project is inserted in the region of the Tocantins and Araguaia rivers.

It is the second largest hydrographic basin in the country in terms of area and flow, only smaller than the Amazon basin, and the largest in the country with a drainage area located entirely within the national territory (ANA, 2009).

The Araguaia project is in the highest portion of the region, representing a water divisor area. To the east of the project it is noted that the rivers drain towards the Araguaia river, to the west it is possible to observe the waters that will flow towards the Arraias do Araguaia river.

The flat relief of the region generates a low density of drainage when compared to other regions in Pará. There is a high concentration of small or **ephemeral** rivers in the surroundings of the land defined for the project construction.

**Ephemeral** rivers are water bodies that have surface runoff only during or immediately after rainy periods. Between June and August (drought) these rivers normally dry up.

Through sampling carried out by the Araguaia Níquel Mineração team, it was found that the waters of the region present values of Iron, Total Phosphorus, Zinc and Sulphide above the current legislation. However, it should be noted that these elements are found in the rocks of the region and do not necessarily indicate pollution.

Source: IBGE, 2009.

**Figure 5-10- Arraias do Araguaia river**





Source: IBGE, 2009.

**Figure 5-11 – small tributary of the Arraia do Araguaia**

## Groundwater Resources

To characterise the underground resources, Araguaia Níquel Mineração installed 73 piezometers (water level monitoring wells) and registered all springs in the region.

With this effort it was possible to identify great variation in the local groundwater level, which ranges from 2.0 metres to more than 20 metres deep.

Regarding surface outcrops, the survey identified 194 springs in the surroundings of the Araguaia Project.

The quality of these waters was also a concern for the company. Therefore, the quality of the underground springs was monitored over a 12-month period through 05 'cacimba' wells already installed in the region.

**'Cacimba' wells**, also known as cisterns, are large-diameter wells (at least 1 metre), manually dug and lined with bricks or concrete rings.

According to the results obtained, the elements Iron, Nickel, Zinc and total Phosphorus are above the limit established by legislation in some months. Thus, like the assessment of surface water resources, it is important to note that these elements are found in the rocks of the region, and do not necessarily indicate pollution.



**Figure 5-12 – View of a monitored 'cacimba' well**



*Biotic Factor*





## Vegetation

The Study Area is inserted in a landscape that can be separated into three different vegetation occurrences according to the scale of observation. At a broader scale (All), we have the transition zone between the Amazon Rainforest (Tropical Rainforest) and the **‘Cerrado’**.

**‘Cerrado’** comprises sparse small trees with twisted, curved trunks and thick leaves in the midst of thin and low vegetation.

On the other hand, the region encompassing the AID and ADA has a marked presence of modified environments (pasture), with crops followed by forest formations of the Open Ombrophylous Forest type and Cerrado, to a lesser extent.



**Figure 5-13 - Ombrophylous Forest in the dry season**

**Figure 5-14 - Ombrophylous Forest in the rainy season**



**Figure 5-15 - Aspects of ‘cerrado’ with border on pasture areas in the rainy season**

**Figure 5-16 - Aspects of ‘cerrado’ with border on pasture areas in the dry season**



**Figure 5-17 - ADA aspect with predominance of pastures**



## Fauna

The distribution of animals is linked to the environment available, from where they obtain food and shelter for their survival, offering in return the pollination of flowers and dispersal of fruits and seeds. Hence, the importance of the conservation of these areas, which are the animals' habitat. Thus, the monitoring of fauna in the surroundings of the project was carried out giving priority to the green areas in the region.

During the fauna survey campaigns, 46 species of **mammals** distributed into 21 families and 9 orders were recorded. The species with the highest abundance (number of contacts) found in the AID and ADA were the bats (*Chiroptera*), skunks (*Didelphimorphia*), rodents (*Rodentia*) and monkeys (*primates*).

The results obtained in this study indicate a **high abundance** in all the sampled sites. Of the 46 species recorded, 39 (**84.8%**) were observed in open ombrophilous and seasonal forest environments.

Figure 5-18 – 'Morcego-nariz de-lança'  
(*Phyllostomus hastatus*)



Figure 5-19 – 'Morcego-da-cara-listrada'  
(*Vampyroides caraccioli*)

Figure 5-20 – 'Catita'  
(*Monodelphis domestica*)



Figure 5-21 – 'Cuíca-cauda-de-rato'  
(*Metachirus nudicaudatus*)

Figure 5-22 – 'Macaco-de-cheiro'  
(*Saimiri sciureus*)

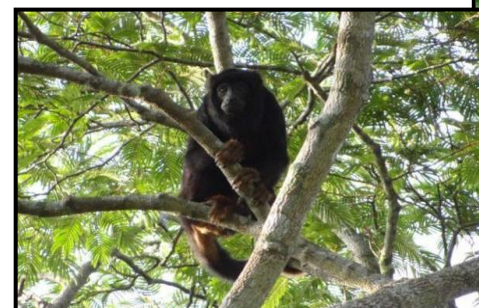


Figure 5-23 – 'Macaco-bugio'  
(*Alouatta belzebul*)

In terms of **birds**, 4,789 individuals were recorded, distributed into 26 orders, 62 families and 228 species. The families with the highest abundance (number of contacts) verified in the AID and ADA were: 'bem-te-vis' (*Tyrannidae*); 'tiês' (*Thraupidae*); woodpeckers/tucans (*Picidae*); parrots and alike (*Psittacidae*) and 'choquinhas' (*Thamnophilidae*).

The *Thraupidae* family ranks 4th among the largest Brazilian bird families. The families *Thraupidae*, *Tyrannidae* and *Thamnophilidae* represent around **55%** of the species considered most abundant in the country.

Figure 5-24 – 'saripoca-de-gould'  
(*Selenidera gouldii* - male)



Figure 5-25 – 'saripoca-de-gould'  
(*Selenidera gouldii* - female)

Figure 5-26 - 'bem-te-vi'  
(*Pitangus sulphuratus*)



Figure 5-27 – 'araçari-letrado'  
(*Pteroglossus incriptus* - male)

Figure 5-28 – 'araçari-letrado'  
(*Pteroglossus incriptus* - female)





In the All, different species of alligators, turtles, snakes, lizards and anuran amphibians (frogs) were recorded. In the AID and ADA, 44 species of anuran **amphibians** were recorded, distributed in 18 genera and 09 families, the most representative being the families of 'pererecas' (Hylidae), toads (Leptodactylidae) and 'rãs' (Leiuperidae).

The environments with modified areas (e.g. pastures and roads) presented about 50% of the total number of species recorded for the study area.

At the surroundings of the Araguaia Project, there is a relevant and diverse abundance of amphibians because it is a transition zone between the 'Cerrado' and the Amazon.

Figure 5-29 –  
'perereca-de-bolinha'  
(*Hypsiboas punctatus*)



Figure 5-30 – 'rãzinha-pintada'  
(*Chiasmocleis albopunctata*)



Figure 5-31 – 'rãzinha'  
(*Leptodactylus podicipinus*)

Figure 5-32 – 'sapo-flecha-de-veneno'  
(*Adelphobates galactonotus*)



Figure 5-33 – 'perereca-cabrinha'  
(*Hypsiboas multifaciatius*)

During the campaigns 49 species of **reptiles** were recorded, distributed in three orders: the Order Squamata (lizards/snakes) was the most representative, with 13 families and 44 species; the Order Testudines (turtles) presented three Families and three species and the Order Crodolyia (alligators) represented only by the Alligatoridae family, with two species recorded.

The reptiles in the sample represent around 17% of the total number of species recorded for the 'Cerrado' and Amazon biomes.

The modified areas (pastures and roads) had the greatest abundance, followed by the Semideciduous Seasonal Forest and the Open Ombrophylous Forest.



Figure 5-34 – 'calango-verde'  
(*Ameiva ameiva*)

Figure 5-35 – 'jararaquinha-do-campo'  
(*Erythrolamprus almadensis*)



Figure 5-36 – 'papa-vento'  
(*Norops brasiliensis*)

Figure 5-37 – 'jacaretinga'  
(*Caiman c. crocodilos*)



Figure 5-38- 'tracajá'  
(*Podocnemis unifilis*)



*Socioeconomic Factor*





### Demographic Profile

The study of the population contributes to the analysis of demographic variables, such as age distribution, migration, sex ratio, life expectancy at birth, among others. These variables constitute important information for the projection of the population context, aiming at improving planning or increasing the adequacy of basic services and care to the population.

Using 2010 census data obtained from the ADA, a resident population of 2,784 people was recorded, out of this total, 1,562 were men and 1,222 were women. The age group with the highest number of people was 0 to 4 years old, with 283 children. The elderly population aged over 70 years (36 people) corresponded to only 2% of the total.

**56%**  
Men



**44%**  
Women

### Economic Profile

The assessment of the economic profile is based on income data, covering the distribution between households and the population residing in the areas of interest.

The population in the neighbourhood of the area proposed for the project has a monthly income per person between R\$75.50 and R\$255.00, with 16% of them having no income.

### Quality of life

Data from 2010 IBGE Census indicated 5,860 people in extreme poverty in Conceição do Araguaia municipality. This means that 12.9% of the population in Conceição do Araguaia lived with an income below R\$ 70.00 per person. Out of the total number of extremely poor, 3,432 (58.6%) lived in rural areas and 2,427 (41.4%) in urban areas.

According to the bulletin of the Ministry of Social Development and Fighting Hunger (2010), 807 people aged over 15 years in extreme poverty could not read or write, which represents 23.3% of the extremely poor in this age group. Among them, 377 were family breadwinners.

Regarding the home infrastructure of the extremely poor population, 2,032 people (34.7% of the total) lived without electricity, 757 (12.9%) did not have a proper water supply in their homes, 5,740 (98.0%) did not have access to a sewage system or septic tank, and 3,817 (65.1%) did not have their rubbish collected.

## Land Use

The area around the Araguaia Project is **predominantly** used for **rural** purposes, mainly encompassing cattle pasture areas. In a more sparse way, there are small farms with crops and animal husbandry (poultry, cattle, pigs, goats and some fish farms).

There are 1,024 households in the ADA, as well as several business premises, which are part of the small villages.



**Figure 5-39 - Animal husbandry at West Pequizeiro**



**Figure 5-40 - Household at Volta Nova village.**



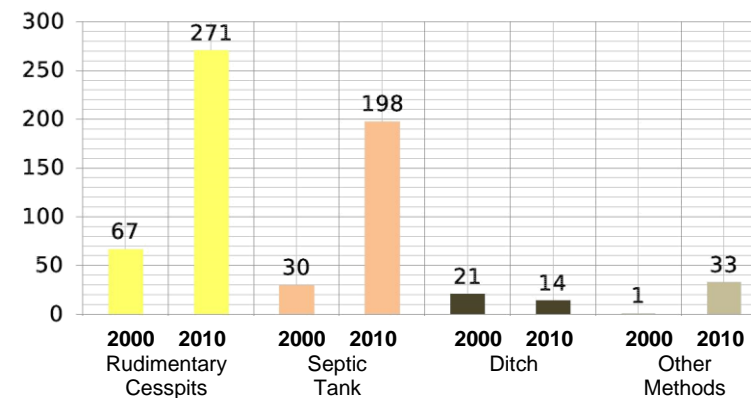
**Figure 5-41 - Pineapple plantation on the road to Mendonça village.**

## Basic Infrastructure

According to 2010 IBGE demographic census, there were 796 households in the ADA. From these, only 25% had electricity.

Regarding water supply, in 2000, 12 households were connected to the general network, 407 used water from wells or springs on the property and 112 households had another form of supply.

Between 2000 and 2010, there was a 300% increase in the number of households with a bathroom in the ADA. However, 35% of households in the ADA still did not have a bathroom in 2010.



**Figure 5-42 - Type of Sanitation in the ADA, in 2000 and 2010.**  
Source: IBGE, 2000 and 2010.



## Cultural and Historical Heritage

Within the boundary encompassing the ADA, no legally protected property or property in the process of being **protected** was identified. Nor were any traditional communities identified.

**Legally protecting** (or 'tombamento', in Portuguese) is the act of recognising the cultural value of a property, which transforms it into official heritage and establishes a special legal regime for the property, considering its social function.

### Archaeological Heritage

**Archaeological heritage is constituted by the material traces of ancient human occupations which generally occur amidst sedimentary rocks or soils.**

By interviewing the population, it was found that archaeological sites generally occur in areas close to the Araguaia river and other lower-order river channels. A total of **06 archaeological sites** were located, 04 within the ADA and 02 ceramic occurrences.



Figure 5-43 - Collecting ceramics from Baião 01 site.



Figure 5-44 - Location and delimitation map of the identified sites. Note the position of the sites compared to the ADA boundaries. Note the ceramics collected at Baião 01.

## 6. Impacts and Mitigation Measures

CONAMA 001/86 Resolution defines environmental impact as being:

“...any change in the physical, chemical and biological properties of the environment, caused by any form of matter or energy resulting from human activities that directly or indirectly affect the health, safety and welfare of the population; social and economic activities; the biodiversity; the aesthetic and sanitary conditions of the environment; the quality of environmental resources.”.

The Environmental Impact Study sought to systematically identify the impacts arising from the actions of the project, potentially causing environmental modifications, as well as to qualify and quantify these impacts.

Knowing the areas of influence defined and studied in the Environmental Assessment of the Physical, Biotic and Socioeconomic Factors, and also with the understanding of how the Araguaia Project will be implemented and operated, it was possible to produce a list of the actions/activities which will be implemented and which could cause some environmental impact on the areas under study.

### ❖ *Raising expectations in the population regarding the implementation of the project, including job creation and income generation*

During the implementation phase of the project, the population in the ADA will tend to expect a number of things, particularly with regard to the possibility of new jobs and the changes that will occur in land use, since the project will be located in areas that comprise rural properties.

One method of mitigating this impact is to set up communication channels with the affected population through the actions proposed in the Social Communication Programme.

### ❖ *Involuntary resettlement of the affected population*

Mining projects are geographically rigid, as they bring together all the mineral extraction and processing activities around the mineral deposit, which is naturally fixed. Based on the Araguaia Project Resettlement Action Report - Conceição do Araguaia (prepared by Integratio Mediação Social e Sustentabilidade, April/2014), involuntary resettlement was considered when the affected people do not have the right to prevent the acquisition or use of the land, resulting in physical or economic displacement. The former is motivated by the loss of housing, and the latter applies when the means of production or survival are lost.

This impact is negative, sure, long-term, located, caused by the project and permanent. Its magnitude is medium and it has compensatory measures with a high degree of resolution, such as the Resettlement Programme.

### ❖ *Migration induced by the expectation of employment with public infrastructure overload*

The lack of detailed information on the number of people who are expected to be hired during the project enables the population, especially the population of the AI and nearby municipalities, to speculate on employment prospects, creating expectations of being hired at a certain time.

The possible attraction of this population to Conceição do Araguaia urban area may have an impact on the population already living in this area, as well as increase the demand for basic services.



Considering the urban interference generated by this temporary population increase, this impact is negative, located in the All, mainly in the municipality of Conceição do Araguaia, probable, short-term, dispersed, causing, temporary and of great magnitude.

The mitigating and preventive measures consist of prioritising the hiring of local labour as much as possible in accordance with the **Environmental Construction Plan (ECP)** and the **Social Communication Programme**. Regarding pressure on the public infrastructure, continuous quantitative monitoring is recommended through the **Monitoring Programme for Migratory Flow and Interference in Public Services**, in order to predict any possible interference on the quality of service to the resident population during the construction work.

#### ❖ *Modification in the population's health conditions*

Possible modifications in the health conditions of the population may result from the increase in the local population, resulting in the emergence or expansion of endemic and infectious diseases, in addition to increasing the number of injuries resulting from accidental and violent acts.

This impact is of negative nature, located in the All, mainly in the ADA, and can be minimised, as long as preventive and educational measures are adopted, which have a high degree of resolution, defined by the **Monitoring Programme on the Health Conditions of Population and Workers**, so that the impact is reduced to low relevance. The essential contribution of the **Monitoring Programme for Migratory Flow and Interference in Public Services** is also highlighted, aiming to anticipate possible damages or deficiencies in keeping attention and care for the health of Conceição do Araguaia population.

#### ❖ *Modification in the population's daily lives*

During the implementation phase of the project, there will be an increase in the number of people and vehicles circulating, mainly in Conceição do Araguaia municipality, both in urban and rural areas, which will result in changes to the routine and daily lives of the people living in these areas.

People linked to the project, but who are strangers to the social life of local groups, will circulate through the region, affecting their level of well-being, mainly in terms of social activities and security. This increased circulation may cause social conflicts, as the modification in daily life may lead to an increase in violence, alcohol consumption, infectious and contagious diseases, prostitution and sexually transmitted diseases.

Therefore, the alteration in the daily life of the populations is configured as an impact of a negative nature, located in the All, but mainly in the ADA.

The mitigating measures consist of: the **Social Communication Programme**, active communication between the population and the company will ensure that the community is aware of the modifications that may occur in their locality; the **Environmental Education Programme** will address, among other matters, issues relating to sex education and citizenship, disseminating attitudes of respect and peaceful coexistence for the population of the area of influence and for the project's employees, as hiring progresses.

Finally, the **Road Access Recomposition Programme** will have a high degree of resolution as long as it allows the normal flow of people between the municipalities in the region. With these measures, the impact may have reduced relevance.

❖ ***Increase in the income level due to job creation, in the wage volume in circulation and in tax payments***

The increase in the number of jobs and in the wage volume in circulation during the implementation phase of the Araguaia Project is due to the hiring of labour installed in the AI during the development of the project. During the implementation phase, jobs will be created for different levels of skills.

The positive impact on family income is expected considering the employment of local labour. Thus, the increase in regional income will occur due to the payment of salaries and social charges to contractors, and also by the purchase of materials and equipment from various suppliers. This will result in the growth of the regional economy, resulting in improved income levels for several economic agents.

In light of the above, this impact is considered positive, with dispersed location (AI, AID and ADA). It should also be noted that in the *mine closure process*, there will be a loss of jobs by workers in the operation phase and a loss of tax revenue, mainly at the municipal level. This situation is provided for in the **Mine Closure Plan**, which indicates the need for *diversification of the local economy, generation of new supply chains and promotion of quality of life for the population* impacted by the project throughout the process, in order to avoid an increase in socioeconomic vulnerability of the municipality related to the end of the project.

The **Local Development Agenda** has an essential contribution to make in this regard, since, based on the monitoring of socioeconomic parameters, it can enhance the already mentioned gains from these impacts, pointing out ways to make better use of and distribute resources, promoting the growth of other economic sectors. These actions, as provided for in the Mine Closure plan, are essential to ensure that this positive impact during the

implementation and operation phases does not turn into a negative impact during the decommissioning phase.

❖ ***Interference at the Archaeological Sites***

The archaeological study identified the occurrence of six archaeological sites, four of which are within the ADA (Baião 1, Baião 2, Baião 3 and Pimenta site). Therefore, they are at risk of being affected by the implementation and operation of the Araguaia Project.

The identified impact on archaeological heritage will occur during the implementation and operation phases of the Araguaia Project. This is a negative impact, located in the ADA, of certain occurrence, in the short-term, causing and of great magnitude because it is irreversible.

The contribution of the educational activities inserted in the **Heritage Education Programme** is highlighted, which may enable the recovery of the archaeological material, avoiding the physical loss of the sites. Moreover, the development of educational activities with the workers and the surrounding community to raise awareness about the historical and scientific importance of these sites will increase the preservation of these fragments.

❖ ***ADA Landscape Modification***

Once the Araguaia Project is implemented, the local landscape will be impacted in terms of both relief and visual features, which will change the spatial reference point for the local population.

Considering that these factors affect the visual perception that the resident population has of the area that is part of its spatial reference and that will be modified, we consider the negative nature of this impact, represented by the loss of the current spatial reference perceived by the local population.



The Degraded Areas Recovery Plan (DARP), together with the Mine Closure Plan, aims to mitigate the damage presented herein, making it less harmful to the population, in addition to enabling the resumption of the original or alternative use of the areas that suffer direct interventions resulting from the construction work.

### ❖ *Modification in air quality*

Operations related to earthmoving and transportation of construction debris, as well as the increased emission of pollutants from the vehicles' engines, machinery and equipment that will be used during the construction period, could modify the local air quality.

The main pollutant anticipated is dust, also known as TSP (Total Suspended Particle), which is an inert, earthy material that may resuspend from the region's dirt roads, which may cause modifications to the landscape and is associated with deposition of dust on surfaces, as well as visibility on the traffic routes close to the construction work.

In the operation phase, in addition to the resuspension of earthy particles, it is worth highlighting the emission of CO<sub>2</sub> from the coal drying and reduction furnace, as well as SO<sub>2</sub> and NO<sub>2</sub> from the coal drying and reduction furnace, calcining, smelting and slag.

Thus, this impact presents a negative nature and occurs in the ADA. From this perspective, it is proposed that the controls on the emissions generation of particulate matter in suspension and the discharge of pollutants from vehicle engines, machinery and equipment should be done through the implementation of permanent monitoring of maintenance/operation conditions. It is also pointed out that the Air Quality Management Programme (AQMP) and the Environmental Construction Plan (ECP) should guide the actions in this area.

### ❖ *Modification in environmental noise level*

The possibility of modifications in the ambient sound pressure, during the implementation of the Araguaia Project, is mainly associated with the movement of heavy vehicles, machinery and/or equipment needed for the construction of the metallurgical plant and other industrial facilities.

In the operation phase, in addition to the abovementioned vehicle traffic, the noise generated in the metallurgical plant should be considered, with particular emphasis on the ventilation system present in the rotary kiln and the transportation of gases from the calcining kiln.

Thus, this impact has a negative nature and occurs in the ADA. The Noise Level Monitoring Programme presents control and mitigation measures with a medium level of resolution.

### ❖ *Loss of agricultural areas or areas with potential for agriculture*

The implementation of the mining pits, waste dumps, road system, slag pile, cooling reservoir, as well as the entire metallurgical plant and support structure of the Araguaia project will inevitably require the loss of areas suitable for agriculture or with potential for agriculture, since the project is located in an area of rural use in Conceição do Araguaia municipality.

This means that 11.5 km<sup>2</sup> of land with some agricultural potential, where the soils have moderate limitations for a large number of climatically-adapted crops, could be lost.

Regarding the effectively agricultural areas that will be suppressed, it can be seen that only 0.07 km<sup>2</sup> of the area where the project will be implemented is currently in agricultural use, being used predominantly for

pineapple plantations (a short-cycle crop), on small properties (less than 50 ha), primitive production and family organisation.

This impact has a negative nature, occurs in the ADA and has medium magnitude, since the area in which the use is officially agricultural represents less than 1% of the area required.

The socioeconomic aspects inherent to the removal of areas where agricultural production is already in place will be controlled by the Resettlement Programme.

### ❖ *Intensification and triggering of morphodynamic processes*

The implementation and operation of the Araguaia Project will require some activities where soil movement and temporary exposure is recurrent, such as building roads, mining pits, vegetation suppression, setting up the construction site, digging trenches for pipelines, drainage channels, among others.

These actions related to soil movement and exposure cause modifications to the land surface due to the removal of the superficial layer, with subsequent physical changes in its structure, making it vulnerable to the abrasive impact of winds and rains.

In this situation, several measures must be adopted by the company in order to prevent and minimise the onset of morphodynamic processes (erosion, silting, mass movement, among others) in the areas affected by the project implementation works.

In this sense, the Programme for the control and monitoring of morphodynamic processes provides for actions to monitor and follow up on

this impact. These are preventive and mitigating measures with a high level of effectiveness, whose implementation is the company's responsibility.

### ❖ *Modification in water and soil quality*

During the project's construction period, civil construction waste is expected to be generated, as well as domestic solid waste from the cafeteria, toilets and administrative areas, and also machinery and equipment maintenance waste. These wastes offer a potential risk of contamination to surface and underground waters, as well as to the soil due to its vulnerable characteristics and constant exposure in this phase of the Project.

During the operation period, similar impact around the metallurgical plant is expected, mainly attributed to diesel-fuelled equipment such as comminution roller and rotary kiln (crushing and homogenisation process), rotary dryer and roller crusher (drying and tertiary crushing process) and rotary kiln (calcining).

It is also worth mentioning the generation of liquid and solid effluents, which when lacking appropriate procedures for collection, segregation, storage, transport and final disposal may lead to risks to public health and surface contamination.

It is important to highlight, in relation to environmental control, that all residues generated at all stages of the project will be managed as set forth in the **Environmental Construction Plan**, which sets out the guidelines to be complied with by the contractors hired to carry out the construction work.

The mentioned Plan will follow the selective collection procedures proposed by the CONAMA resolution 275/2001. The Water Resources



Management Plan (WRMP) - Surface Water Monitoring Subprogramme and Groundwater Monitoring Subprogramme, and the Waste Management Programme are also control measures for this impact.

Thus, the impact described herein is negative, occurring in the ADA and AID. However, the proposed control measures have a high level of resolution.

#### ❖ *Modification in surface water regime*

The water regime of a region is characterised by the availability of water in its system (deficiency or excess). In this sense, interferences such as abstractions, diversions, rectification, canalisation, dams, dredging and crossings modify, to a greater or lesser extent, the local water regime.

The implementation phase of the Araguaia Project includes surface crossings of 6 water bodies (necessary for the implementation of the project road system) and a dam on the tributary of the Arraiazinha stream, necessary for the construction of the cooling reservoir.

The Araguaia Project's operation will require<sup>1</sup> approximately 219.66 m<sup>3</sup> of water per hour. This amount will be mainly used for industrial supply (refining process, machinery cooling, road humidification and dust suppression in the work fronts) and human consumption (drinking water, toilets, canteens, cleaning procedures, among others).

The water required to operate the project will be collected from the Arraias river and transported to the project through a pipeline (to be built) approximately 10 km long.

It is worth noting that the maximum catchment volume of the Araguaia Project (230.74 m<sup>3</sup>/h) represents only 0.0064% of the water availability - dry season - of the region (3,600,000 m<sup>3</sup>/h), which gives low magnitude to this impact.

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<sup>1</sup> Considering processing an average of 900 kton of ore per year.

This impact is negative and occurs in the ADA and AID. However, the company will present alternative sources of water catchment (rainwater and groundwater) that constitute mitigation measures with a medium level of resolution.

For the construction phase, the Water Resources Management Plan (WRMP) - Surface Water Monitoring Subprogramme constitutes control measures with a high level of resolution.

#### ❖ *Modification in the underground water regime (lowering of the water table)*

A large part of the nickel deposits of interest for the Araguaia Project is located below the underground water level. The storage and circulation conditions of these waters constitute a major difficulty for mining operations, so that lowering the water table by automatic pumping becomes inevitable.

Groundwater pumping will trigger, during the lowering phase, an increase in the availability of local water resources, given the formation of a hydraulic gradient (a pressure difference) between this area and its surroundings. This gradient causes water to continuously flow from the aquifer towards the pumping point. However, the difference in gradient driven by pumping will cause a decay curve in the water level (lowering cone) of the properties neighbouring the project.

Thus the impact could affect local springs, it is estimated that 64 springs may be suppressed (disappearance), of which 56% (36 springs) are in the Pequizeiro target.

The oscillation of underground water levels in the region of the project may result in modifications in the water quality, since mineral bodies containing sulphides in their composition, such as zinc sulphides and a wide variety

of iron minerals found in the rocks present there, may lead to the formation of acid mine drainage.

The **Water Resources Management Plan (WRMP) - Groundwater Monitoring Subprogramme** constitutes a control measure for the modification on the underground water balance, as it provides for the monitoring of the water flow in the subsurface, monitoring of the springs identified in the Environmental Impact Study, as well as the water quality monitoring.

It is also worth considering the actions of the **Communication Programme** with the local population, so that those responsible for the wells drilled in the region must be informed about the monitoring and the works that will be carried out, as well as being informed about the communication channels to be used for complaints about any oscillations in water availability and quality standards.

#### ❖ *Reduction of native vegetation fragments*

In order to construct the Araguaia Project, part of the vegetation covering the land will have to be disturbed; approximately 490 hectares of native vegetation will be removed from the ADA. However, most of the vegetation to be removed (880 ha) is pasture and crops, as well as built-up areas (rural property buildings).

As a preventive measure, it is suggested to rescue the germplasm (genetic material) and propagules (structures that become detached from an adult plant to give rise to a new plant) from the vegetation to be removed. As a compensatory measure, the surrounding vegetation must be restored. These measures will be made possible by the **Vegetation Conservation and Management Programme** and the **Environmental Compensation Programme**.

#### ❖ *Increased degradation and isolation of the fragments*

A forest fragment is a portion of preserved native forest. The opening of roads and paths will facilitate access to the remnants (isolated points) of vegetation, increasing the transit of people and domestic animals within the fragments. The flow of workers for the construction of the project will also increase the transit of people through the remnants. The increased circulation of people through the fragments will lead to an increase in selective timber extraction, an activity identified in the assessment as frequent in the region, but which could be intensified by the project.

In order to minimise the impact, all people involved in the project should be informed about the activities that could potentially cause damage to the vegetation, in all phases of the project. This information may be communicated using lectures or leaflets providing guidance on the appropriate way to behave, as part of the **Social Communication and Environmental Education Programmes**. The neighbouring population can also be informed, using information boards and Environmental Education campaigns.

The fencing of some fragments or fragments stretches, especially those closest to the construction site, accommodation, mining pits areas or subject to other situations of greater exposure, is also an action that minimises this impact, restricting the increase in traffic within the remnants. Another preventive measure made possible through the **Environmental Construction Plan (ECP)** will be the periodic wetting of the service roads to minimise the emission of dust, especially in the drier months of the year.

The increase in the degradation of vegetation remnants is an impact classified as negative, dispersed, mainly in the surroundings of the areas where mining activities will take place.



❖ *Modification or destruction of habitats, habitat fragmentation, and local loss of specimens and/or species of fauna*

The removal of vegetation which is the habitat of fauna consequently has an impact on them, either by the absence of refuge or food resources.

On the other hand, according to the environmental assessment, it is concluded that there are already problems regarding the faunal stability in the region, and they are currently associated to the suppression of vegetation, hunting and fire.

This impact can be offset by the **Fauna Monitoring and Management Programme** and, on a regional scale, by protecting the remaining native vegetation areas in the surrounding mining areas, to ensure that no more significant environmental loss occurs as a result of the implementation of the project. The **Vegetation Conservation and Management Programme** will enable the recomposition of suppressed vegetation, and the **Environmental Compensation Programme** will promote vegetation conservation actions by fostering the Conservation Unit, both also classified as compensatory measures. In addition, the fauna should be directed to escape during the suppression and opening of roads (**Vegetation Suppression Subprogramme**).

These are negative impacts that will occur in the ADA and surrounding areas and will be intensified by the project, since deforestation in the region is constant and frequent. Due to the particular characteristics of the fauna, this impact is irreversible, certain and of medium importance. Even considering the compensatory measures with medium level of resolution that can be taken, the impact was classified as of medium magnitude, due to the time

required for the mining areas to be recovered when the activities are concluded.

❖ *Displacement and disturbance of fauna*

The activities resulting from the construction and operation of the project, such as the removal of vegetation, intense truck and machinery traffic, mining activities, processing activities in the industrial area and the increase in the number of workers in the region will scare fauna away. For all these activities, the main factor that will cause the displacement of fauna is the generation of noise in the implementation phase, resulting from civil construction works, and in the operation phase, both from exploration and ore transportation activities.

To minimise this impact, the **Environmental Construction Plan** should undertake frequent maintenance of trucks and equipment, so that they maintain the noise level within that specified by the manufacturer and prescribed by law. The activities that cause the highest levels of noise should be carried out outside the periods in which the animals go out to search for food, in other words, in the early hours of the day between 5am and 9am, and at evening between 5pm and 8pm.

In a complementary manner, educational activities are required to alert on the practice of efficient inspection by environmental agencies, with a view to repression of hunting, as provided for in the **Environmental Education Programme**. In addition, traffic education activities should be provided for in the **Environmental Construction Plan (ECP)**, in order to minimise collisions with the fauna.

❖ *Proliferation of vector fauna*

During the operation and implementation of the project, the installation of construction sites and activities carried out by mining workers may create

environments that are favourable to disease vector species, such as the *Culex* mosquito, which transmits visceral leishmaniasis.

The mitigating measures related to the proliferation of disease vector insects are part of the **Environmental Construction Plan**. They will be used to monitor and guide the work to avoid the formation of depressions that could give rise to puddles and flooding in the construction areas, including the mining areas and the waste dump areas of the project.

At the same time, the **Vector Entomofauna Monitoring Programme** will be responsible for carrying out systematic surveys in the ADA area, identifying mosquito outbreaks in lakes, ponds and degraded forested environments to assess the eventual formation of breeding sites for vectors and to propose corrective measures.

#### ❖ *Modification or destruction of aquatic habitats and local loss of fauna specimens*

For the implementation and operation of the project, construction of access and soil movement activities will be continuous. Through these activities, it is possible to predict that habitats will be modified by the transformation of water bodies, either by silting up local streams or by suppressing springs and emerging areas due to the lowering of the water table.

Some of the actions resulting from the project have no mitigation measures, for example, the formation of tailings and slag dumps in valley areas. However, the impacts associated with silting and damming of waterways can be avoided by installing a rainwater drainage system along the roads and around the waste dumps and ore stockpiles, or by correctly sizing the pipes or bridges over waterways when building new access roads. These structures must be planned in the project execution and their correct installation and maintenance must be monitored by the **Environmental Construction Plan**.

For the impacts where there are no mitigating measures, the **Programme for Monitoring and Management of Ichthyofauna and Hydrobiological Communities** must prepare and carry out the **Plan for Conservation and Monitoring of the Fish Community**. The **Water Resources Management Plan (WRMP)** must analyse data on the water quality in order to prevent possible modifications and analyse the density and population diversity of the monitored species, evaluating their ecological characteristics and checking their bioindicator nature.

#### ❖ *Reduction of fragmentation, formation of vegetation corridors*

With the closure of the mining process, the area should be recovered, enabling a new use. Considering that this is a rural area with few small urban centres in the region, the mining area of the project should be re-established as an area for rural use (pasture) or recomposition of the native vegetation.

In this regard, at the end of the exploitation process the areas likely to receive native vegetation must be recovered, promoting the formation of ecological corridors. In this activity, the vegetation species with the highest environmental value that were identified in this study must be reintroduced, as well as in the complementary studies that will be carried out by the **Vegetation Conservation and Management Programme**.

For the impact from these actions to be effective, it is important to apply appropriate recomposition measures considering the soil and topography characteristics of the area to be recovered. The proper application of these procedures can enhance the action of this impact.

Thus, this impact is considered positive, localized in the plantation areas, but dispersed if its implementation is successful, as it will promote the dispersion of new individuals. It will be direct, permanent and irreversible,












and should be established with a preservation area after recovery. The effects are felt in the medium and long-term, because the recomposition process is slow, of certain occurrence, being a condition of legislation, of high importance considering that the area is chronically degraded, even being an ecotone area (environmental transition areas) and assessed with high diversity for different groups.

### ❖ *Fauna attraction and reoccupation*










With the closure of the mining activities, the intense traffic of trucks and machinery should cease, as well as the mining activity and the processing activity in the industrial area, thus reducing the number of workers and other activities in the region. Consequently, noise production should fall to significantly lower levels.






In addition, with the mine closure, vegetation recomposition activities should be carried out, fostering, in the medium-term, the formation of new habitat areas for fauna. It is also noteworthy that the recomposition should include the planting of plant species that provide resources for the regional fauna.




However, it should be considered that these actions are gradual and long-term, so proper planning and execution of this closure process are essential for the *positive impact* to be effective for the regional fauna, and these are the actions that will maximise this impact. This impact will be monitored by the Fauna Monitoring and Management Programme.




Impact	Project stage	Related environmental programme	Relevance
Raising expectations in the population of the Directly Affected Area (Área Diretamente Afetada, ADA)	Implementation	Social Communication Programme	
Involuntary resettlement of the affected population	Implementation	Resettlement Programme	
Migration induced by the expectation of employment with public infrastructure overload	Implementation	Environmental Construction Plan (ECP), Social Communication Programme, Monitoring Programme for Migratory Flow and Interference in Public Services	
Modification in the population's health conditions	Implementation and Operation	Monitoring Programme on the Health Conditions of Population and Workers, Monitoring Programme for Migratory Flow and Interference in Public Services	
Modification in the population's daily lives	Implementation and Operation	Social Communication Programme, Environmental Education Programme, Road Access Recomposition Programme	
Increase in the income level due to job creation, in the wage volume in circulation and in tax payments	Implementation and Operation	Mine Closure Plan and Local Development Agenda	
Increase in the income level due to job creation, in the wage volume in circulation and in tax payments	Closure	Mine Closure Plan and Local Development Agenda	
Interference at the Archaeological Sites	Implementation	Heritage Education Programme	
ADA Landscape Modification	Implementation, Operation and Closure	Degraded Areas Recovery Plan (DARP) and Mine Closure Plan	



Impact	Project stage	Related environmental programme	Relevance
Modification in air quality in the Directly Affected Area (ADA)	Implementation and Operation	Air Quality Management Programme (AQMP) and Environmental Construction Plan (ECP)	
Modification in environmental noise level	Implementation and Operation	Noise Level Monitoring Programme	
Intensification and triggering of morphodynamic processes	Implementation and Operation	Programme for the Control and Monitoring of Morphodynamic Processes	
Modification in water and soil quality	Implementation and Operation	Environmental Construction Plan, Water Resources Management Plan (WRMP) - Surface Water Monitoring Subprogramme and Groundwater Monitoring Subprogramme, and Waste Management Programme	
Modification of surface water availability	Implementation and Operation	Water Resources Management Plan (WRMP) - Surface Water Monitoring Subprogramme	
Modification in the underground water regime (lowering of the water table)	Operation and Closure	Water Resources Management Plan (WRMP) - Groundwater Monitoring Subprogramme and Social Communication Programme	
Reduction of native vegetation fragments	Implementation and Operation	Vegetation Conservation and Management Programme and Environmental Compensation Programme (compliance with SNUC)	
Increased degradation and isolation of the fragments	Implementation and Operation	Social Communication and Environmental Education Programmes and Environmental Construction Plan (ECP)	
Modification or destruction of habitats, habitat fragmentation, and local loss of specimens and/or species of fauna	Implementation and Operation	Fauna Monitoring and Management Programme, Vegetation Conservation and Management Programme, Environmental Compensation Programme (compliance with SNUC), Vegetation Suppression Subprogramme	

Impact	Project stage	Related environmental programme	Relevance
Displacement and disturbance of fauna	Implementation and Operation	Environmental Construction Plan (ECP), Environmental Education Programme.	
Proliferation of vector fauna	Implementation and Operation	Environmental Construction Plan (ECP), Vector Entomofauna Monitoring Programme	
Modification or destruction of aquatic habitats and local loss of fauna specimens	Implementation and Operation	Environmental Construction Plan (ECP), Programme for Monitoring and Management of Ichthyofauna and Hydrobiological Communities, Water Resources Management Plan (WRMP)	
Reduction of fragmentation, formation of vegetation corridors	Closure	Vegetation Conservation and Management Programme	
Fauna attraction and reoccupation	Closure	Fauna Monitoring and Management Programme	

Magnitude of Negative Impact			
	Large	Medium	Low

Magnitude of Positive Impact			
	Large	Medium	Low



## 7. Environmental Programmes

### ***Social Communication Programme (Programa de Comunicação Social, PCS)***

For a successful implementation of the Araguaia Project, it is necessary to establish communication channels with the groups of interest and/or affected by the project. The lack of/or dissemination of incorrect information about the project may result in speculation that leads to wrong opinions and expectations about the process. The Social Communication Programme should be prepared taking into account the fact that people, especially those directly affected, need to know in advance what will take place in the area where they live.

The overall goal to be achieved is to create an interactive and continuous communication channel to provide information on the implementation and operation of the Araguaia Project to the several segments of local and regional society, directly or indirectly involved in the process.

### ***Environmental Education Programme (Programa de Educação Ambiental, PEA)***

The Environmental Education Programme proposes that those directly and indirectly involved in the Araguaia Project learn and discuss new concepts, get to know alternatives to make their workplace healthier and adopt practices that respect the environment and increase ecological and citizen awareness for a better coexistence in society and with nature.

The educational process is an important tool for the population to better understand the changes generated by the implementation and operation of the Araguaia Project. It also contributes to the debate and reflection with the different target audiences about each one's role in preservation and sustainable development.

### ***Monitoring Programme on the Health Conditions of Population and Workers***

The Monitoring Programme on the Health Conditions of Population and Workers aims to promote and communicate preventive actions and also to intervene to reduce the effects of the anticipated changes on the population, mainly in the ADA and the construction site workers, encouraging prevention, monitoring the epidemiological profile of Conceição do Araguaia and Floresta do Araguaia, and providing health and medical care for the construction site workers.

The Programme will use informative materials developed based on health booklets prepared by public institutions to guide the population on topics such as worker's health, sexually transmitted diseases and parasitic diseases, among others.

### ***Monitoring Programme for Migratory Flow and Interference in Public Services***

The expectation for jobs in the project tends to attract workers from other regions, mainly to Conceição do Araguaia's rural area. The arrival of the direct employees to work in the construction and the additional workforce may affect the social dynamics of the local community, causing a certain degree of overload on the urban services, such as health centres, hospitals, schools and police stations in the municipality of Conceição do Araguaia.

The activities proposed by the Monitoring Programme aim to establish a technical approach to assess the actual degree of overload on public services caused by the influx of people attracted by the Araguaia Project, in order to devise actions to mitigate the impacts: "Migration induced by the expectation of employment with public infrastructure overload" and "Modification in the population's health conditions".



### *Road Access Recomposition Programme*

During the implementation stage of the Araguaia Project, access to construction sites and support areas may require adjustments to the existing local road system, with the construction of new road sections for truck and equipment traffic. It will also be necessary to recover access to the properties affected by the project's structures.

This programme aims to intervene in road accesses, adapting them, as necessary, in the sections of access roads to the construction works and the recovery of internal roads and accesses to properties directly affected by the Araguaia Project's infrastructure. Also noteworthy is the implementation of appropriate signage in order to inform the population about the traffic from the construction works, minimising the risk of accidents and ensuring the safe flow of the population through the site.

### *Heritage Education Programme*

Heritage education is important because it enables the local population to understand and appreciate the region's cultural, archaeological or historical assets.

In addition to the community, the target audience also includes the staff directly or indirectly involved in the project construction and operation. This programme should be developed by a multidisciplinary technical team comprising a historian, an archaeologist and an educator.

The main objectives of this programme are:

- Avoid that, due to misinformation, the staff involved in the construction of the project damage archaeological sites;
- Promote co-responsibility for the preservation of local and regional archaeological, historical and cultural heritage.

### ***Local Development Agenda***

This programme constitutes the main form of articulation between the socioeconomic actions, measures and programmes prepared for this project. It is responsible for managing the potential negative impacts of the project, by analysing the information from the *Monitoring Programme for Migratory Flow and Interference in Public Services* to predict and manage any possible pressure on Conceição do Araguaia's infrastructure. Above all, it is responsible for taking action to enhance the positive impacts related to income generation, fostering local development and diversifying the local productive base, thus achieving the goals proposed in the Mine Closure Plan, and preventing the municipality from becoming socioeconomically fragile due to the closure of Araguaia Project.

This programme essentially aims to improve the capacity to serve the population by reorganising services and opening up options for generating employment and income, thus promoting local and regional socioeconomic development.

### ***Resettlement Programme for the Affected Population***

Any action aimed at using lands already occupied, especially by fragile communities, requires planning and negotiation measures in order not to result in the increase of poverty, the introduction of new adversities for the community, as well as the creation of conflicts which, in extreme situations, may make the implementation of large projects unfeasible.

Therefore, the Resettlement Programme for the Affected Population proposes careful planning for the adoption of measures, such as dialogue and transparency, that may mitigate the negative effects of this action, demonstrating the openness to negotiation and avoiding the tone of imposition of expropriation procedures.

The objective of this Programme is to design and implement the resettlement of rural families whose living conditions will be made unviable by the Araguaia Project, so as to minimise their losses and compensate them for the modifications created.

### *Environmental Construction Plan (ECP)*

This programme consists of the company's commitment to the environment, using techniques that minimise and monitor the expected impacts.

In order to make this programme swifter and more comprehensive, in all phases of the project, as well as to incorporate environmental management tools into the environmental licensing system, it is proposed to consolidate an environmental management system based on the NBR ISO 14001 standard. This way, the PAC will be articulated in an integrated manner through the following instruments:

- Environmental Management System;
- Implementation Environmental Monitoring Programme;
- Construction Works Environmental Control Programme.

The main objectives of the PAC planned for the implementation of the Araguaia Project are to provide the company with a management structure capable of efficiently carrying out the deployment of various environmental programmes, enabling it to ensure perfect coordination between the sectors responsible for implementing the project.

### *Noise Level Monitoring Programme*

The construction works to be developed during the implementation phase and operation of the Araguaia Project may emit noise, in different levels of intensity, likely to cause interference in receiving agents located, in particular, in the immediate surroundings of the construction works, as already pointed out in the related impact.

In light of the possible impacts mentioned above, it is important to monitor the noise levels resulting from the planned actions to ensure that the emissions are in accordance with federal, state and municipal legislation, i.e. that the comfort, health and well-being of the local population and fauna are guaranteed.

Thus, the overall objective of this plan is to monitor the impact caused by noise from the construction and operation of the Araguaia Project, in order to comply with CONAMA Resolution 001/90, which establishes criteria and standards for noise emissions from industrial, commercial or social activities, and which considers acceptable noise levels set out in ABNT standards NBR 10.151/87 and NBR 10152.



### ***Air Quality Management Programme (AQMP)***

During the installation and operation of the Araguaia Project, emissions of atmospheric pollutants are expected as a result from typical civil construction activities and nickel ore processing operations, as well as emissions from vehicle and machinery traffic resulting from engine combustion.

As such, this programme seeks to ensure that the emissions of atmospheric pollutants resulting from the installation of the project comply with the current legislation, thus ensuring that the environmental performance of the project is as expected.

Therefore, it is proposed:

- Systematically monitor the air quality in the immediate surroundings of the site where the project will be implemented, comparing the results with the limits adopted as standards in the legislation;
- Identify the meteorological aspects of the region and their interaction with air quality;
- Enable the preparation of an air quality diagnosis and/or prognosis.

### ***Solid Waste Management Programme (SWMP)***

The construction of the structures planned for the Araguaia Project involves several activities that generate solid waste, which in turn require the adoption of measures to minimise and control pollution, in order to avoid any harm or inconvenience to health, public welfare and the environment.

Considering that the waste generated can cause damage to the environment, or even waste material that could be recycled, the implementation of a solid Solid Waste Management Programme (SWMP) is necessary, in order to define procedures and instructions aimed at solid waste processing and final disposal.

The overall objective of this Programme is to implement an environmental management and supervision system aimed at minimising and mitigating potential environmental impacts caused by the generation and storage of waste, during the implementation and operation phases, ensuring that the lowest possible quantity is generated during the project's construction, as well as throughout its life of mine.

### ***Water Resources Management Plan (WRMP) - Groundwater Monitoring Subprogramme***

Considering the natural risk of any civil work causing contamination in the water resources in its area of influence, a water quality monitoring programme is necessary to identify and quantify possible contaminants before they cause damage to the environment.

The overall objective of this subprogramme is to understand the hydrogeological and hydrochemical conditions of the area, in order to identify the evolution of the underground hydrological cycle starting from the pumping of the mining faces, to predict interference to the local users of the underground springs in order to anticipate mitigation measures, as well as to identify any contamination that requires actions in the future.

### ***Water Resources Management Plan (WRMP) - Surface Water Monitoring Subprogramme***

As with the groundwater monitoring programme, a surface water monitoring programme is necessary to monitor and minimise the degradation of these water bodies as a result from the construction and operation of the Araguaia Project.

Thus, this subprogramme seeks to monitor the variations/interferences in the existing surface water bodies in the surroundings of the construction work planned for the Araguaia Project, in order to ensure compliance with the quality parameters established by CONAMA Resolution 375/2005, as well as minimal hydromorphological modifications when compared to the situation before the start of the construction work.

### ***Morphodynamic Process Monitoring Programme***

The Morphodynamic Process Monitoring Programme is a tool to identify the phenomena responsible for modifying the shape of the land, whether or not caused by the activities associated with the construction work to implement the project.

The implementation of the Araguaia Project will involve a major intervention in terms of soil movement. In addition, the project will involve interventions in drainage and overlaying areas of significant geological and geotechnical variability.

The Programme aims to manage the preventive and corrective operational actions to control the silting up of water bodies, erosion and mass movement resulting from the construction work, and to avoid instability problems from soil movement.

### ***Accident Prevention and Control Plan (APCP) and Emergency Action Plan (EAP)***

The Accident Prevention and Control Plan (APCP) is preventive in nature and should be implemented to avoid problems during the construction and operation of the Araguaia Project. When this is not possible, the Emergency Action Plan (EAP) must be triggered, in a corrective manner.

The Accident Prevention and Control Plan is designed to take steps to minimise or avoid accidents during the construction work. During the operation phase, which is the company's responsibility, the PCPA shall prevent accidents by adequate maintenance and inspection of the site, promoting, for this purpose, training and periodic audits.

The purpose of the Emergency Action Plan is to define the technical and administrative procedures to be adopted in the event of difficulties that may occur, resulting in fast and effective actions to preserve human life and the safety of the surrounding communities.



## *Degraded Areas Recovery Plan (DARP)*

The programme consists in the environmental reconfiguration after the closure of the activities, aiming at the stabilisation of all mining areas, paying special attention to those more susceptible to erosive processes.

This programme is justified by the need to prevent the start or intensification of erosive processes and to recover areas that will be degraded by the implementation of the project, reintegrating habitats and degraded landscapes, thereby enhancing the use of soil, water, flora and associated fauna resources.

PRAD also seeks to establish requirements and procedures for the rehabilitation of areas eventually degraded due to the construction, operation and decommissioning of the Araguaia Project's processes.

## *Mine Closure Plan*

Proper closure planning management can protect the local community, suppliers, shareholders, governments and future generations from the socioeconomic impacts of closure, as well as reduce environmental liabilities, restore degraded environments and result in a positive outcome for the region where each mine is located.

The Mine Closure Plan consolidates Araguaia Níquel Mineração's strategy and vision regarding the closure of the Araguaia Project's activities. The overall objectives (or principles) of this plan are:

- Achieve the pre-defined future use of the area in a gradual and continuous manner, developing recovery activities during the implementation and operation phases;
- To enable a beneficial and lasting legacy for the communities involved and impacted by the project after the mining activities are ceased;
- Ensuring the protection of environmental quality, safety and public health.

### ***Vegetation Conservation and Management Programme***

This programme seeks to enhance knowledge about the regional vegetation, to manage the adoption of measures to reduce the impact of the necessary removal processes and, finally, to encourage the recovery planting and/or the planting to enrich the existing vegetation, in order to contribute to the maintenance of the local biota.

Thus, the Vegetation Conservation And Management Programme is a compensatory measure for the vegetation suppression, aiming to mitigate this impact as much as possible.

This programme is divided into four subprogrammes, detailed below:

- Local vegetation monitoring;
- Germplasm rescue;
- Vegetal suppression procedure;
- Compensatory planting and planting in areas degraded by the construction work.

### ***Vegetation Monitoring Subprogramme***

Considering that the implementation and operation of the project may contribute to the removal and loss of diversity and density of plant species, it is necessary to encourage an enhancement of the knowledge about the regional flora, in order to obtain better results in future recovery processes.

In order to obtain additional information and to enable a more in-depth analysis of the dynamics of ecological succession and the remaining plant communities around the project, a regional vegetation monitoring programme is proposed.

The main objectives of this programme are to monitor the forest fragments and vegetation in the region of the project, analysing population trends in the dynamics of these plant communities in response to regional environmental conditions.

### *Plant Germplasm Rescue Subprogramme*

This subprogramme is directly aimed at reducing the loss of genetic diversity in the populations along the Area of Direct Influence, as well as the effects from the fragmentation of the remaining areas and the appropriate destination of the products of vegetal suppression (epiphytes, seedlings and seeds).

The rescue of epiphytes, seeds and seedlings aims at the preservation and conservation of vegetation individuals based on the enhancement of forest fragments located in the surroundings, to help preserve, in part, the local floristic diversity and the genetic variability of plants, besides minimising the impacts of the loss of botanical species and habitats, documenting the local flora and detecting endemic, rare or endangered species.

### *Vegetation Suppression Subprogramme*

To avoid unnecessary loss of botanical material and direct the fauna's escape, the deforestation activity must be supervised, identifying possible failures and monitoring suppression in the predetermined areas, as well as promoting adequate destination of the resulting material.

Thus, the main objectives of this subprogramme are:

- Characterise the vegetation to be removed;
- Controlled deforestation, avoiding unnecessary losses;
- To promote the use of plant resources resulting from the removal of vegetation in the area to be flooded;
- Supporting terrestrial fauna migration, keeping an interface with the Terrestrial Fauna Monitoring and Management Programme.



### ***Compensatory Planting and Planting in Degraded Areas Subprogramme***

The project's operational activities, mainly in the access areas, mining pits and waste and slag piles, will cause modifications to the local landscape as a result of earth and ore transportation.

The degraded areas must be recovered, seeking to restore the environmental conditions as close as possible to the situation prior to the intervention, seeking to return the balance of environmental processes to these areas and enabling new uses or, if possible, the use prior to the degradation.

The aim of this subprogramme is to promote regeneration and efficiency of the vegetation recovery techniques in the region, both in terms of its floristic and structural characteristics and in terms of the re-establishment of its ecological processes.

### ***Terrestrial Fauna Monitoring and Management Programme***

The actions involved in implementing the project will modify the remaining vegetation, thus modifying the availability of shelters for the regional fauna. In this regard, the Terrestrial Fauna Monitoring and Management Programme must be implemented.

This programme is structured in two stages: monitoring and rescue. Animal monitoring will help in the understanding of the ecological characteristics of the groups living in the region and in the adaptation process to new habitats.

The objectives of this Programme are:

- To contribute to the taxonomic knowledge of local and regional mammals, birds and reptiles/amphibians fauna (mastofauna, avifauna and herpetofauna, respectively), promoting further detailed studies on the biology of these groups;
- Preserve part of the diversity of the species affected and rescue the species that have difficulty in displacing themselves;
- Accompany the animals in self-displacement during the vegetation suppression stages;
- Monitor species introduced into new habitats;
- Define preferential refuge areas to be monitored later.

### ***Programme for Monitoring and Management of Ichthyofauna and Hydrobiological Communities***

This programme will be necessary in light of the potential impacts on water bodies in the area of the project, that may suppress part of the aquatic biota and restrict their movement and reproductive/trophic processes.

The main objectives of this programme are:

- To enhance the fish community studies, to obtain data on the biology, ecology, distribution, migration, reproduction and feeding of the species identified in the assessment;
- Detail information on fish species of interest for fishing (medium-sized species);
- Identify the groups which will be most affected by the project and define mitigation measures for the impacts on ichthyofauna (fish species);
- Monitor the water quality conditions in the project's area of influence through the analysis of the hydrobiological communities, taking into account the local characteristics of the waterway and seasonal hydrological variations.

### ***Vector Entomofauna Monitoring Programme***

The monitoring study of vector entomofauna (fauna consisting of insects capable of transmitting an infectious agent) indicated the presence of species of the *Culicidae* family that are potential vectors of disease, although the observed density of these insects was considered low.

It should be considered that some diseases are associated with the dynamics of vector populations and intermediate hosts, being directly related to deforestation, the availability of environments with standing water and human population dynamics and, especially, with migration, which are factors that should be recorded in the implementation phase of this project. In addition to the diseases already recorded in the region, the most common under these aspects are: leishmaniasis and dengue. Therefore, this programme is preventive and its structuring was based on environmental surveys carried out in the region.

The main objectives of this Programme are:

- Identify and monitor the population of disease vector species;
- Prevent the establishment and proliferation of vector habitats at support infrastructure points and in the project area;
- To support health campaigns coordinated by public institutions, contributing to and participating in the information and awareness about these vectors, mainly among construction site workers, aiming at disease control.

### *Environmental Compensation Programme*

This programme meets the requirement from the Terms of Reference issued by the environmental authority and is proposed by the company as a compensatory measure for the environmental damage caused by the project, for analysis by the Environmental Compensation Chamber (Câmara de Compensação Ambiental, CCA) of the Environmental Secretariat, established by SMA Resolution 18/2004. This document presents the Full Protection Conservation Unit proposed to receive the resources resulting from the environmental compensation, as established in the legislation in force: (i) Law 9.9985/00; (ii) Federal Decree 4.340/02 and (iii) Federal Decree 6848/09.

This programme complements the compensatory measures, in view of the negative impacts that include the removal of vegetation, reducing niches and consequently the regional biodiversity of both flora and fauna.

## 8. Concluding Remarks

The Environmental Impact Study (Estudo de Impacto Ambiental, EIA) argues that the Araguaia Project is located in a very favourable context for its continuity. If, on the one hand, the market shows growing trends for nickel consumption, on the other hand, the proposed project is located in a region with propensity to mining, where there is appropriate basic infrastructure, logistics infrastructure, available labour and areas already modified by human action (predominantly pasture).

It is also worth noting that by developing the objectives mentioned earlier, the Araguaia Project can help the socioeconomic development of the region, by creating new jobs, integrating local services into its production chain and generating revenue for Conceição do Araguaia municipality by paying taxes and fees.

The 27 Environmental Programmes and Subprogrammes, already listed in item 7 of this RIMA, will be essential to avoid, minimise and offset the negative impacts of the Araguaia Project, as well as maximising the positive impacts. The appropriate implementation and active management of these programmes will enable a balance between financial, environmental and social issues.



## 9. Technical Team

NAME	PROFESSIONAL EDUCATION	FACTOR – OVERALL ROLE (EIA - Rima)
Jacinto Costanzo Junior	Geologist	Technical Person in Charge and EIA General Coordinator
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