ARCADIS Design & Consultancy for natural and built assets

# RIMA

## Environmental and Social Impact Assessment Report

## Piaui Nickel Project

PIAUÍ NÍQUEL METAIS S.A

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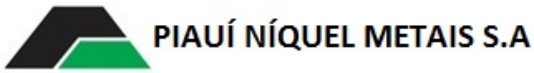


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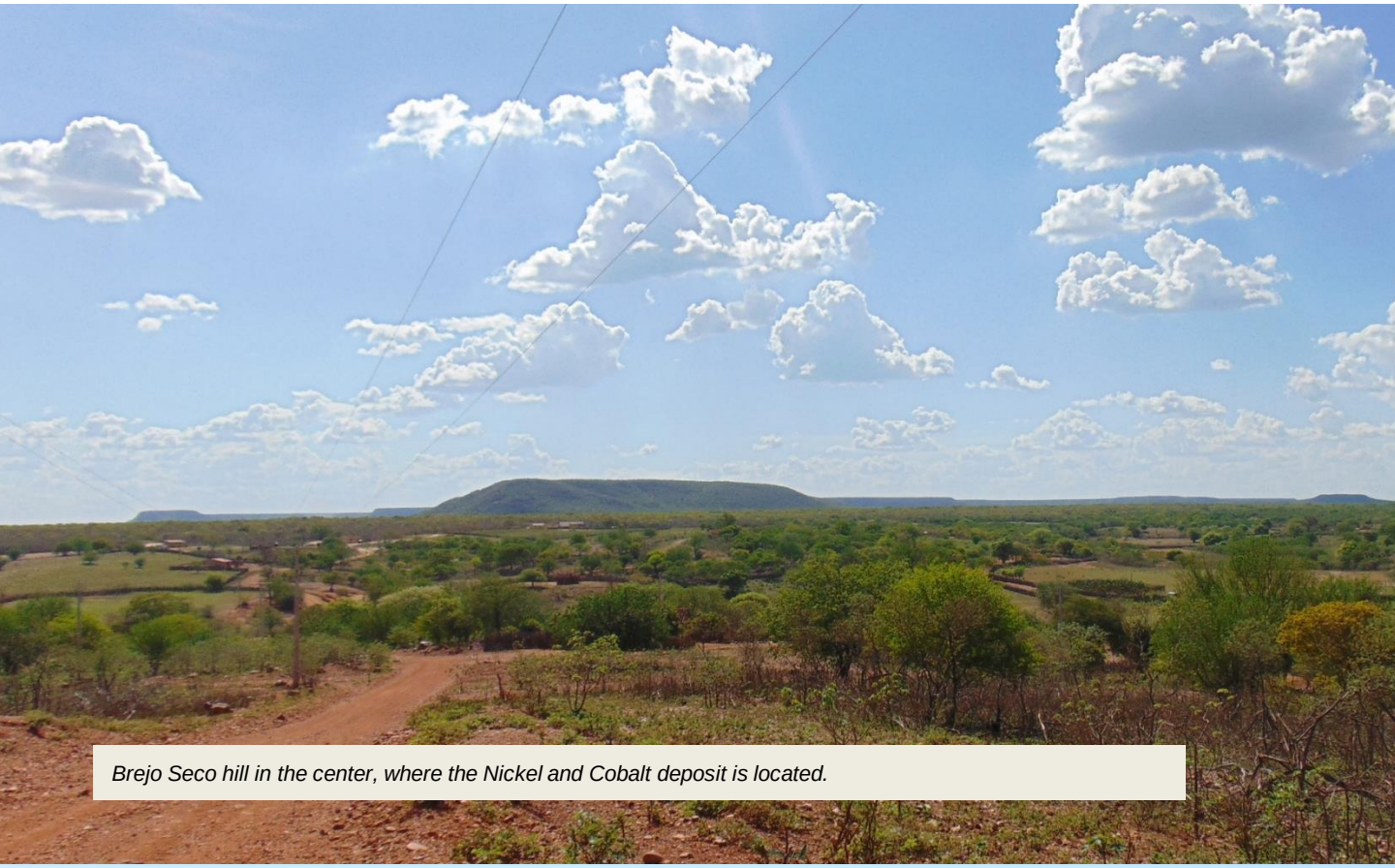
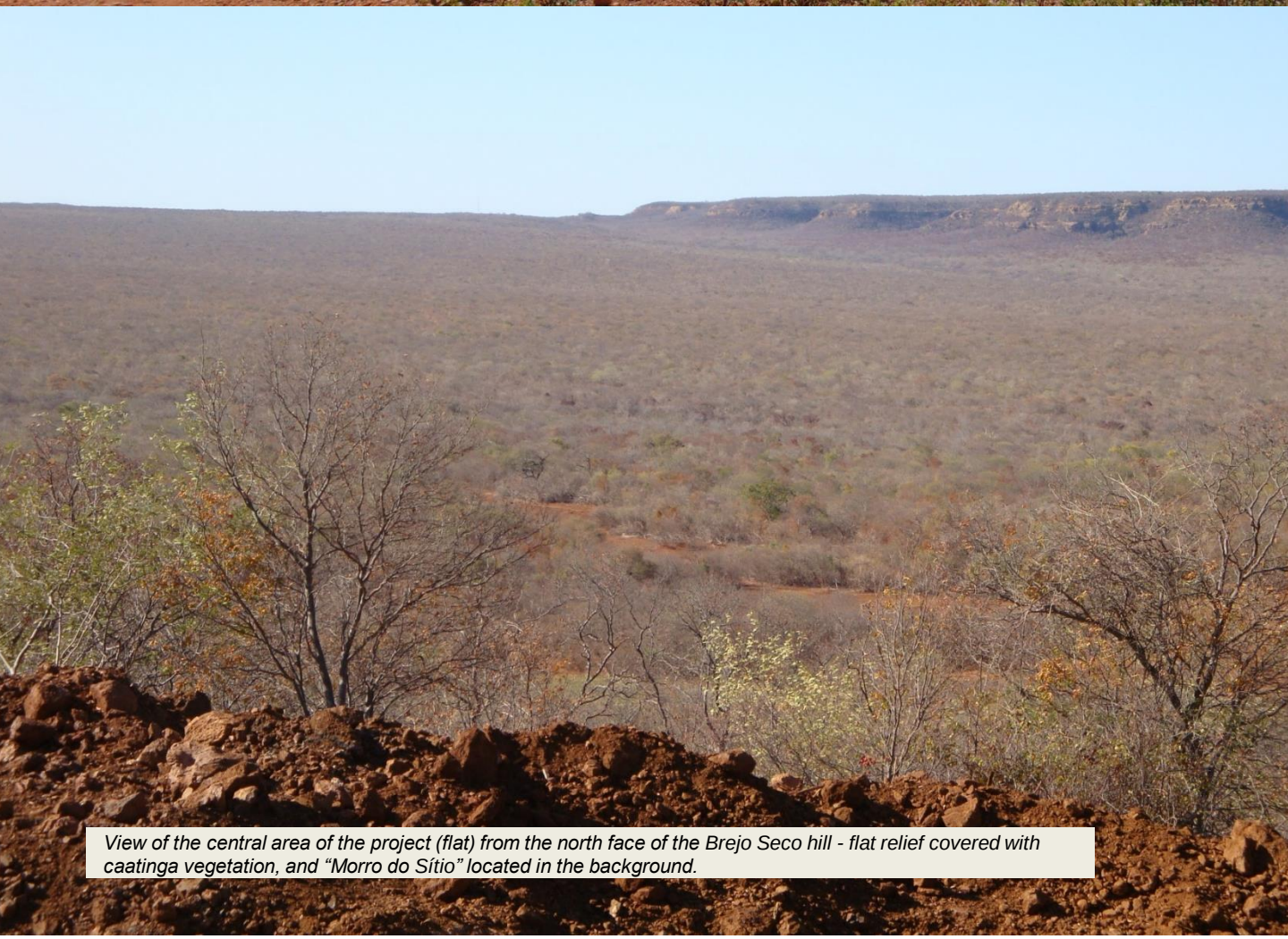


*Brejo Seco hill in the center, where the Nickel and Cobalt deposit is located.*



*View of the central area of the project (flat) from the north face of the Brejo Seco hill - flat relief covered with caatinga vegetation, and "Morro do Sítio" located in the background.*

# Environmental and Social Impact Assessment Report
Piaui Nickel Project
November/2017

# Presentation

The company Piauí Níquel Metais SA - PNM hired the consultancy Arcadis SA to prepare the environmental studies necessary to start the environmental licensing of its new project called “Piaui Nickel Project”, for the extraction and processing of Nickel and Cobalt ores, scheduled to be implemented in the rural area (Brejo Seco) in the municipality of Capitão Gervásio Oliveira / PI, with some support structures in the rural areas of the neighbouring municipalities São João do Piauí / PI, Campo Alegre do Fidalgo / PI and Dom Inocêncio / PI.

The Piaui Nickel Project Environmental and Social Impact Assessment - ESIA presents all the characteristics of the proposed industrial enterprise from its conception to its operation, as well as the current social and environmental conditions of the areas where it will be inserted. Based on this information, the Arcadis technical team predicts and assesses the socio-environmental impacts expected by the Project's implementation (positive and negative), as well as proposing the actions and programs necessary to ensure the preservation of the environmental, social and cultural quality of the project and the region, where it will be constructed and active.

Therefore, this Environmental and Social Impact Report - RIMA reflects the main information and conclusions of the referred ESIA, and is presented in an objective, summarized manner, with illustrations by maps, charts, graphs and other visual communication techniques, in order to allow that the general public can easily understand the concept, objectives and stages of the project, as well as all possible environmental, social and economic consequences for the region throughout its implementation, operation until its decommissioning.

The ESIA and RIMA were filed to SEMAR - Piauí State Secretariat for the Environment and Water Resources (in compliance with the Terms of Reference for the preparation of this ESIA/RIMA which was validated by SEMAR through Technical Opinion nº 7,975/16 issued on December 12, 2016), to apply for the first Permit of the Piaui Nickel Project in the environmental licensing process and which entitles environmental feasibility, called *Licença Prévia - LP*.

# Project History

PNM's current “Piaui Nickel Project” consists of a mineral-industrial complex and support structures to extract the Nickel and Cobalt ores from the Brejo Seco hill, and produce the “Nickel Hydroxide Product” (NHP) and a separate Cobalt product.

Previously owned by Companhia Vale do Rio Doce - CVRD, mining concession 804.290/1970 and the project were sold through international tender in 2014 to Piauí Níquel Metais - PNM. After obtaining financial resources in 2016, PNM made maintenance and adjustments to the Demonstration and Testing Plant built by CVRD in 2007 in the Brejo Seco hill region, and has been conducting productive tests ever since with the use of its own technology, in order to generate the necessary data for the preparation of the detailed engineering studies necessary for the next stage of this project, as well as to demonstrate its feasibility and thus attract future investors to allow its implementation on an industrial and commercial scale (object of this ESIA/RIMA).

The technical results of the tests achieved so far have been very positive, in particular, demonstrating that the technology developed is technically feasible and has a low environmental impact. It is worth mentioning the fact that around 50 direct jobs were created for its execution, with the vast majority of employees being hired locally in the municipalities of Capitão Gervásio Oliveira, Campo Alegre do Fidalgo and São João do Piauí, and trained to work with the process and in an industrial environment. This important socio-economic benefit will be much greater for the region with the implementation of the Piaui Nickel Project on an industrial scale, as presented in this document.

*Demonstration Plant*

# Project Description

# What is the Piauí Nickel Project?

The **Piaui Nickel Project** is a project aimed at the extraction and processing of nickel ore for the production of **Nickel Hydroxide Product (NHP)** and another separate **Cobalt Precipitate** product.

The Project can be understood from the following division of the main structures: 1) **Process Plant and Nickel Mine** (Brejo Seco Complex); 2) **Limestone Quarry** (Umbuzeiro); 3) 69Kv **Transmission Line**; 4) **Water Pipeline** (Jenipapo Dam) and, 5) **Access Routes** (new and existing).

The **process plant and the nickel mine** will be constructed in Brejo Seco, in the municipality of **Capitão Gervásio Oliveira**. The main access to the project will be made through a **new road** to be implemented from the **PI-465 highway**.

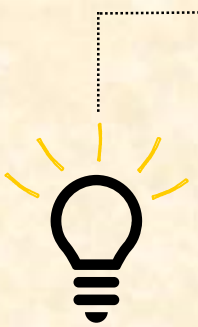
One of the main inputs of the Piaui Nickel Project, **limestone**, will be obtained from a quarry which will be in the location of **Umbuzeiro**, in the municipality of **Dom Inocêncio**, and the project should also implement road access to this deposit.

**Sulfuric acid**, another important input, will be produced in the sulfuric acid plant, which will be built next to the Brejo Seco **Process Plant**, from elemental sulfur which will be imported and transported to the site by road.

The demand for **electricity** will initially be met by the substation of *Companhia Hidro Elétrica do São Francisco* - CHESF, located in São João do Piauí, through a **Transmission Line** to be built with a 42.6 km extension to the project. During the operation, the sulfuric acid plant will produce electrical energy by **cogeneration of steam**, making the project **self-sufficient** and capable of **exporting surplus energy** to the electrical system.

The capture and pumping of **raw water** necessary for the production process will be done from an **existing reservoir** called **Jenipapo**, located 25 km from the industrial plant, in the municipality of **São João do Piauí**.

Finally, all Project waste will be filtered and in a solid state so that it will be stacked in a specific and protected area, bringing operational and socio-environmental security.

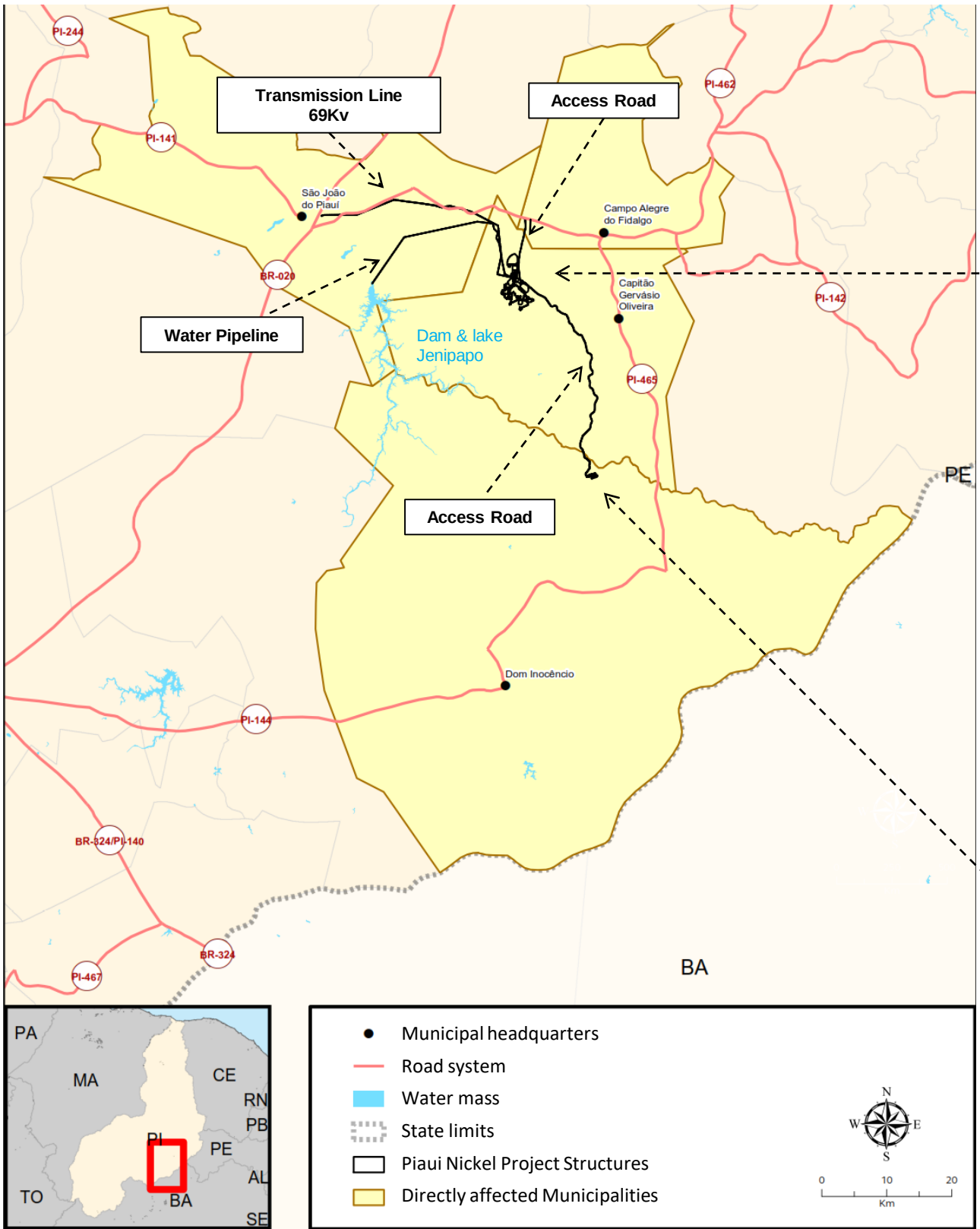


## Did you Know?

Much of nickel is currently used in combination with other metals to make what are known as "alloys". The main alloy containing nickel is **stainless steel**, corresponding to about 70% of the world's nickel consumption.

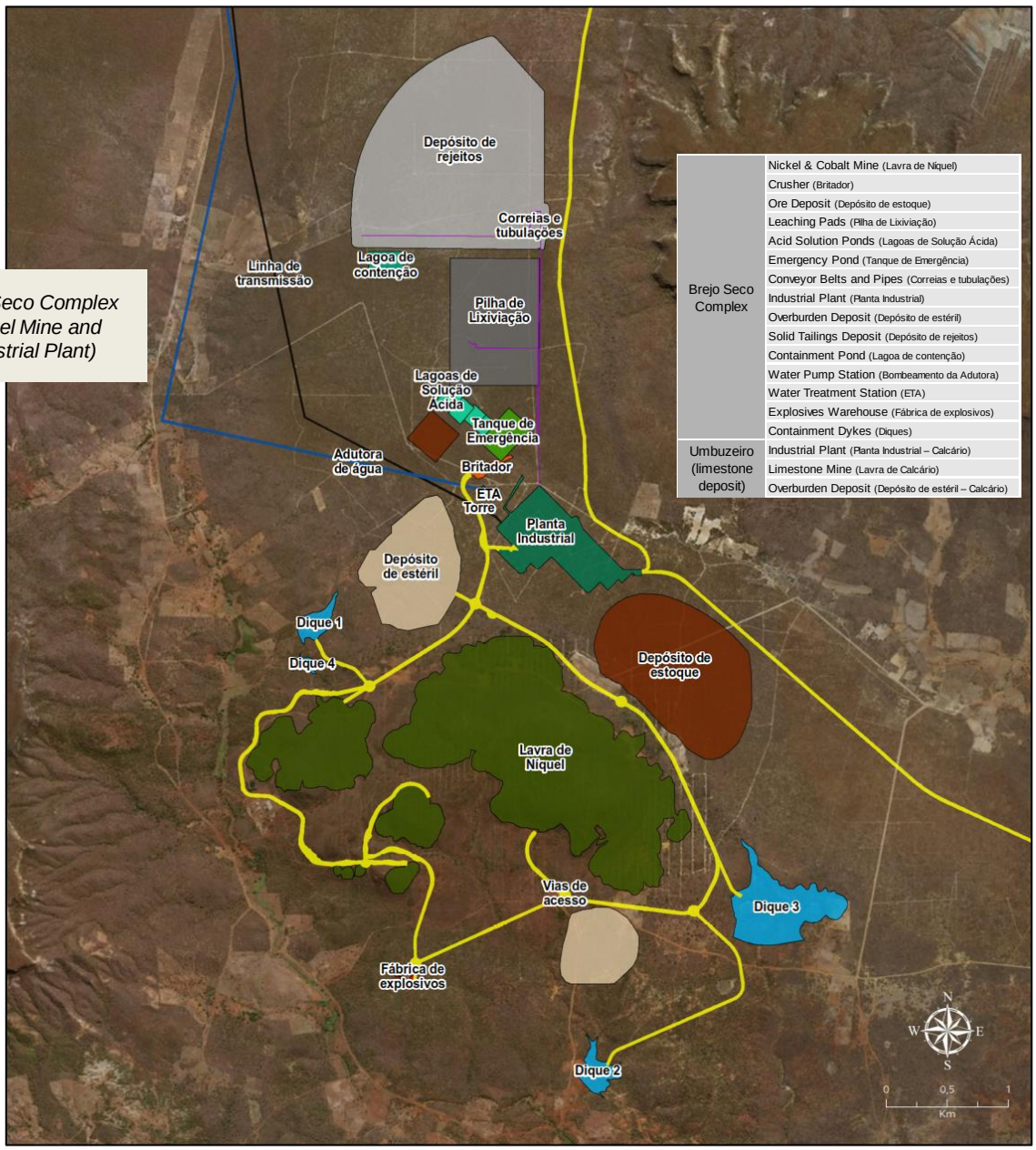
Nickel is also used in other steel alloys, some copper-nickel alloys and in **batteries**, and is expected to be increasingly sought after by the rechargeable battery market for **electric vehicles**, which are becoming increasingly popular and even required by some governments for the environmental, social and economic benefits they bring to society.

# Where will the project be implemented?



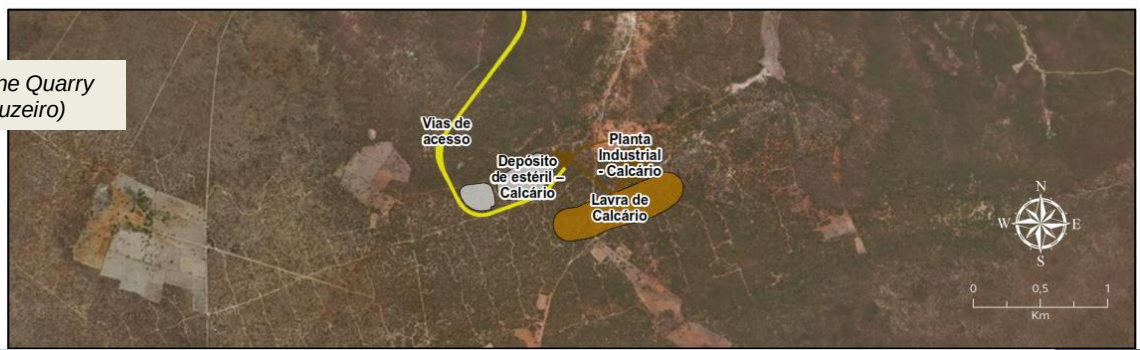
# Main Project Structures

*Brejo Seco Complex (Nickel Mine and Industrial Plant)*




| | |
|---|---|
| Brejo Seco Complex | Nickel & Cobalt Mine (Lavra de Níquel) |
| | Crusher (Britador) |
| | Ore Deposit (Depósito de estoque) |
| | Leaching Pads (Pilha de Lixiviação) |
| | Acid Solution Ponds (Lagoas de Solução Ácida) |
| | Emergency Pond (Tanque de Emergência) |
| | Conveyor Belts and Pipes (Correias e tubulações) |
| | Industrial Plant (Planta Industrial) |
| | Overburden Deposit (Depósito de estéril) |
| | Solid Tailings Deposit (Depósito de rejeitos) |
| | Containment Pond (Lagoa de contenção) |
| | Water Pump Station (Bombeamento da Adutora) |
| | Water Treatment Station (ETA) |
| | Explosives Warehouse (Fábrica de explosivos) |
| | Containment Dykes (Diques) |
| Umbuzeiro (limestone deposit) | Industrial Plant (Planta Industrial – Calcário) |
| | Limestone Mine (Lavra de Calcário) |
| | Overburden Deposit (Depósito de estéril – Calcário) |

*Limestone Quarry (Umbuzeiro)*



# Alternative technologies and locations?

## Why this technology?

The following technological alternatives exist for the processing of nickel:

- Smelting of ferronickel
- High Pressure Acid Leaching (HPAL)
- Nickel Pig Iron (NPI)
- Atmospheric tank leaching (AL)
- Heap Leaching

The most suitable technology for the processing of the type, quantity and concentration of Nickel present in Brejo Seco is **heap leaching** using sulfuric acid, since the other options would require much larger investments, in addition to consuming more energy and other inputs.

Additionally, the Piaui Nickel Project will use its own and efficient technology, which will also give the following advantages in relation to other projects of this nature:

i) **high resource utilisation** of the ore;
ii) **lower consumption of water, energy, limestone, sulfur and sulfuric acid**;
iii) **Energy (carbon free) self-sufficiency** (through energy co-generation *);
iv) use of **solid residue disposal**, instead of the conventional liquid tailings dam (which offers greater operational and socio-environmental risks);
v) **smaller vegetation clearing area**.

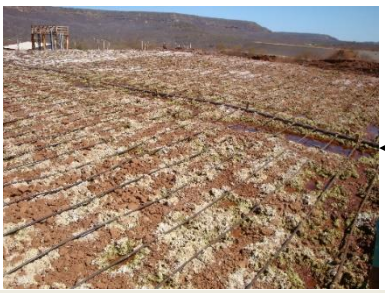
### Did you know?

* Cogeneration: In this case, the excess heat generated by burning sulfur to manufacture sulfuric acid will be used to create superheated and high pressure water vapor to power a turbo generator to generate electricity.

*Construction of heaps for leaching*

*4m high heaps in protected area*

***Photos of the existing Demonstration Plant***



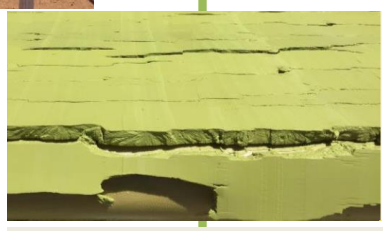
*Piping network on the heaps for drip irrigation with dilute acid solution*

# Heap Leaching

Leaching of the heaps with dilute sulfuric acid solution repeatedly to increase the concentration in the solution

*Mineral-rich solution for the process plant*

**Photos of the existing Demonstration Plant**



*Residue filtration process = solid waste ("iron cake")*

*Nickel-rich filtration process = solid end product*

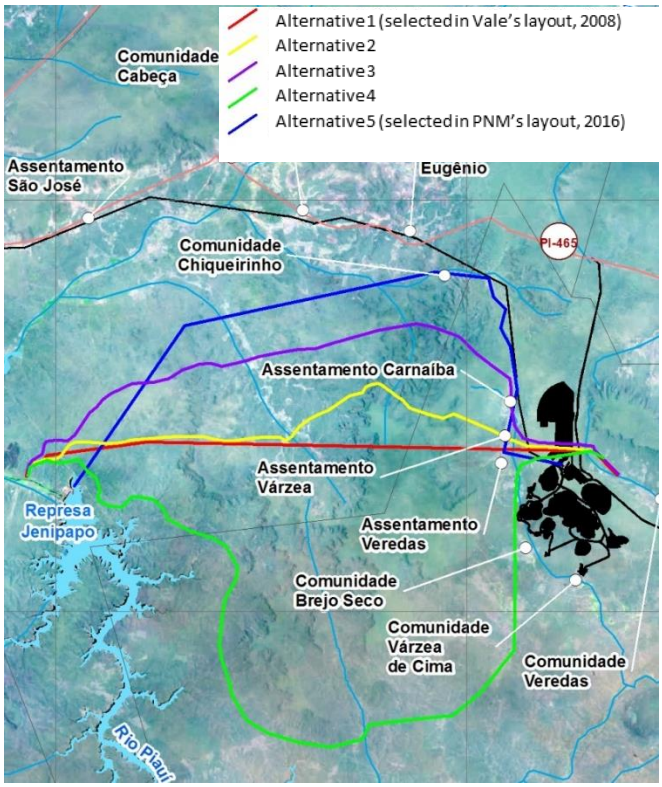
# And the location options?

For mineral exploitation, there can be no other option for the location of mining other than where the ore to be exploited exists.

For the water pipeline that will supply the Brejo Seco complex, five alternatives were evaluated from the Jenipapo dam to the project.

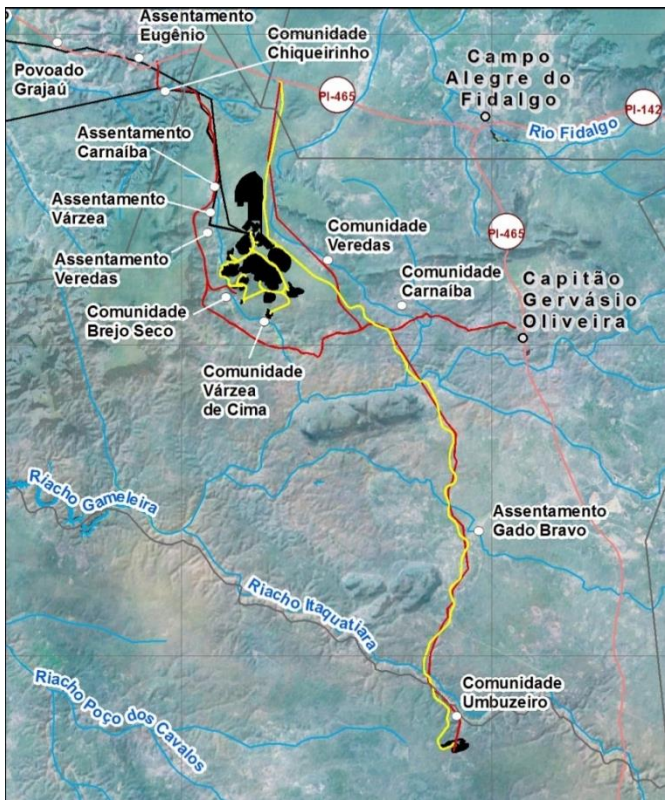
**Alternative 5** (map) was chosen because it should generate **less environmental impacts** in more preserved areas (*Chapada do São Francisco*), taking advantage of already impacted areas (open roads and deforested land), in addition to being the route with the least unevenness in the terrain (although it is longer than other alternatives).

**Comparison between water pipeline layout alternatives**




Regarding the access roads, the project opted for the **construction of a new exclusive use road** (in yellow on the map) connecting the future Process Plant with the PI-465 State road, instead of using the pre-existing routes that border the communities and neighboring settlements, with the objective of reducing discomfort to the local population with truckloads of inputs and products, generating dust and noise, and also increasing safety for all and thus reducing risks of road accidents and running over of animals - especially goats, sheep and donkeys which roam free in the region.

**Comparison between access routes alternatives**



# Main Features of the Project

| Structures | Municipalities (rural zones) | Expected Dimensions (1.164 hectares - ha) |
|---|---|---|
| Nickel mine & Processing Plant (Complex Brejo Seco) | Capitão Gervásio Oliveira | 972 ha (83.5% of the area) |
| Limestone Quarry (Umbuzeiro) | Dom Inocêncio | 45.5 ha (3.9% of the area) |
| 69kV Transmission Line (Project connection to CHESF substation) | Capitão Gervásio Oliveira São João do Piauí | 42.6 km long (1.2% of the area) |
| Water Pipeline (Jenipapo dam) | Capitão Gervásio Oliveira São João do Piauí | 33.5 km long (2.3% of the area) |
| Access Roads (new) | Capitão Gervásio Oliveira São João do Piauí Dom Inocêncio Campo Alegre do Fidalgo | 70.8 km of road (9.1 % of the area) |

| Technical aspects (Nickel mine) | Quantities |
|---|---|
| Estimated mineral resource | 72.2 Mt at 1.00% Ni & 0.048% Co |
| Mineral resource to be mined | 52.5 Mt at 1.08% Ni & 0.048% Co |
| Project life | 17.6 years |
| Ore processing capacity | 3,000,000 metric tonnes per annum |
| Production of Nickel Hydroxide Product (NHP) | 100,000 metric tonnes per annum |
| Production of Cobalt Product | 5,000 metric tonnes per annum |
| Sulfuric acid consumption | 250 kg per tonne of ore |
| Power Consumption (MWh) | 21 MWh |
| Power Generation (MWh) | 29.7 MWh |
| Limestone consumption (tpa) | 476,000 tpa |
| Industrial water use | 460 $m^3/h$ |

# Implementation Phase

The implementation phase of the Piaui Nickel Project consists of the construction or improvement of all the necessary infrastructure to allow the operation of the project.

This phase of construction of all the operational and support structures of the Project (already presented) will last about **24 months**, and it can be started only after PNM obtains the Installation License - LI of the Project from SEMAR.

The work plan comprises the following stages:

- Execution of **Preliminary Infrastructure Services** (vegetation clearing, topsoil removal and earthworks);
- Installation / adaptation of **infrastructure to support construction** (offices, construction sites and temporary accommodation, access roads, energy distribution network, etc.);
- Implementation of **Operational and Support** Structures (already presented);
- Deactivation / Disassembly of **Temporary Support Structures**.

## Preliminary Infrastructure Services

These are the first actions to modify the land in order to adjust it to receive the planned structures.

### Vegetation Clearing

This activity will be carried out only after the required authorization has been issued by SEMAR, and will follow good practices aiming to cut only the vegetation that is necessary in authorized areas in an appropriate way to minimize impacts.

### Topsoil Removal and Storage

After clearing, the areas where the project structures will be installed will be scraped to remove topsoil. The topsoil will be stored in the areas destined for future ore stockpiles to be used later in environmental recovery actions.

### Earthworks

Earthmoving operations will aim to make all work areas level for the construction of structures. The Project will seek to make the best use of the volumes of cut and fill in order not to need further areas for additional fill or to store cut.

## Support Structures

### Construction sites

In the **Brejo Seco Complex**, the construction sites will occupy an area of about 10.4 ha, and will be built in the area destined for the future north Overburden deposit, thus reducing the need for clearing vegetation from new areas.

At the Limestone Quarry of **Umbuzeiro**, there will be a smaller construction site that will occupy about 5 ha to serve the works and assemblies of local equipment, also taking advantage of the future overburden deposit area of the mine.

## Access Roads

Approximately **70.8 km** of internal and external access roads to the mining areas will be built, including a new connection road between the Process Plant and the PI-465 highway of approximately 10.5 km in length for the exclusive use of the project (flow of labor, transportation of inputs and equipment, and products' output).

This new connection route was designed far from the existing neighboring communities and will be paved to reduce discomfort to the local population avoiding additional flow of vehicles on the existing roads, generating noise and dust from this movement, improving operational safety and reducing accident risks.

## Accomodation

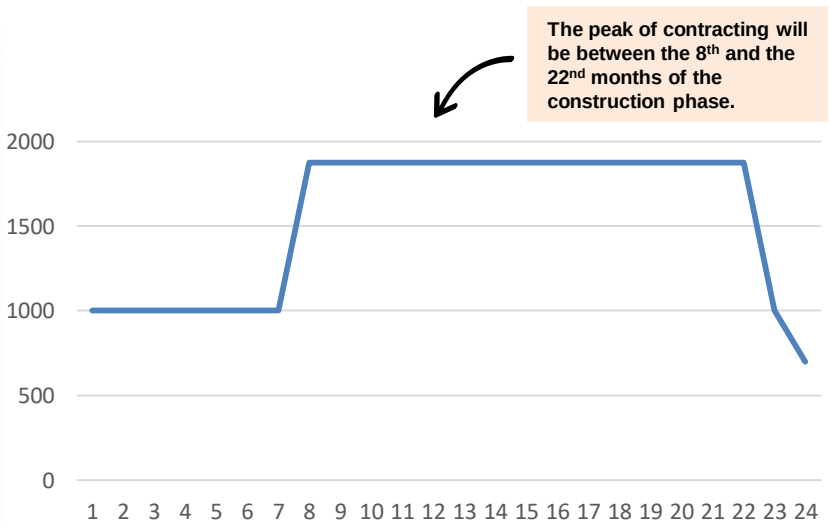
If necessary, temporary housing for workers will be built during construction only, at the Brejo Seco Complex, to reduce the distance travelled by workers and also interfere less with the life of the local community.

## Machinery & Supplies

- **Fuel** to feed the fixed and mobile machine fleet and vehicles;
- **Concrete**, with a concrete plant planned within the Brejo Seco Complex;
- Civil construction aggregates such as **sand, gravel and cement**;
- **Electric power** from the existing distribution network that currently powers the Demonstration Plant (cabling will be changed);
- **Water**, supplied by water trucks and pumped from the wells operating at the Demonstration Plant**.**

# And what about manpower during construction?

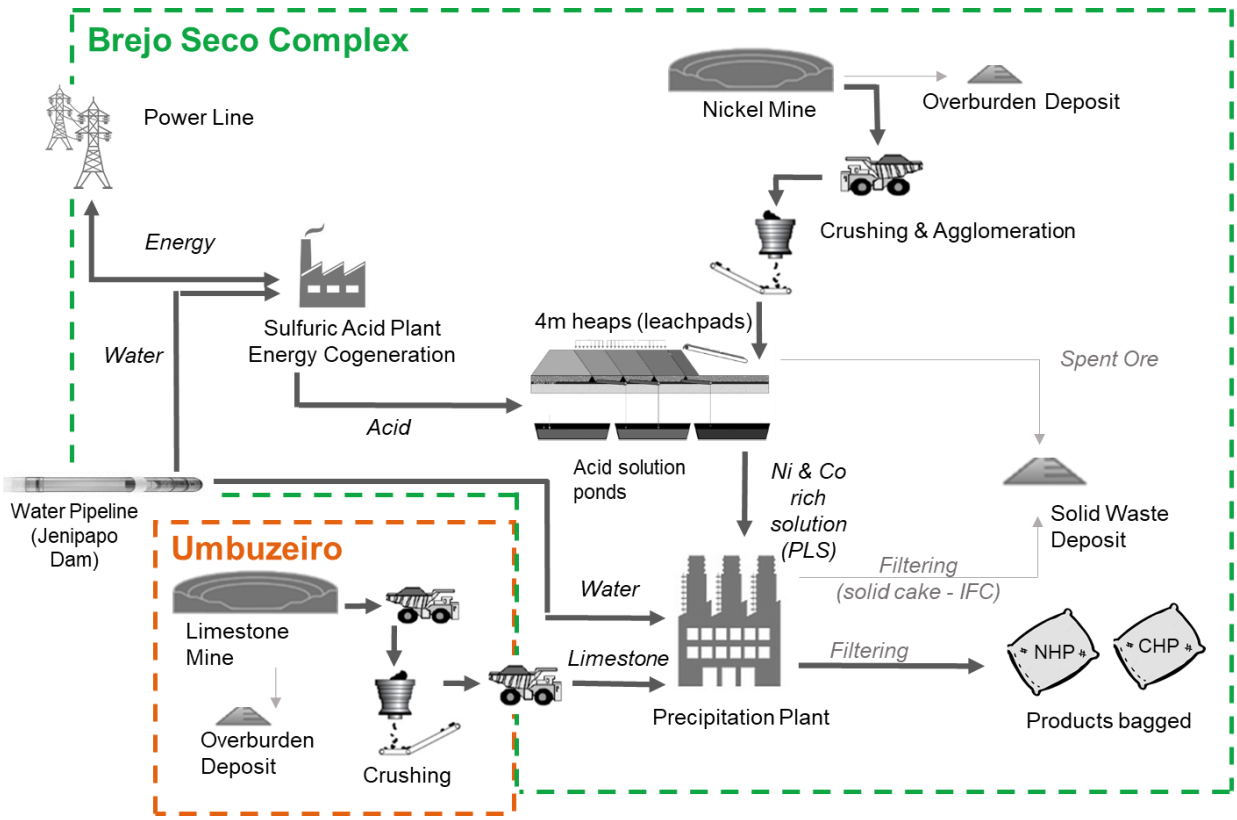
To build the project, direct labor of up to 1,875 workers will be necessary (peak of works). It is estimated that about 30% of this labor can be hired locally, depending on the availability of interested people having the minimum technical qualifications necessary to meet the demands of construction works.



# Operational Phase

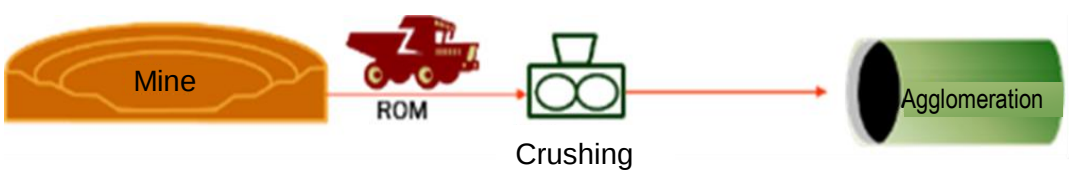
The operation of the Piaui Nickel Project foresees the extraction of 3,000,000 metric tonnes of ore per year, for the production of 100,000 metric tonnes per year of NHP and 5,000 metric tonnes per year of Cobalt Product.

**Summary of the main activities and structures of the Piaui Nickel Project**




# Ore Mining

An open pit mine will be set up with benches and the ore will be mined mostly by mechanical excavation (excavators) and when necessary by blasting. The material extracted at the mine will be transported by dump trucks to the storage areas, and stacked for crushing. The overburden material (not ore) will be taken to its own storage areas to be stored correctly.



# Crushing and Agglomeration

The crushing of the ore comprises the first stage of the process. The large rocks pass through 2 crushers to reduce the size of the ore and allow it to be stacked.

The "ground" ore now passes through the Agglomerator, to be moistened with water and sulfuric acid (joining the fine particles), thus facilitating the next process of stacking and leaching the heaps.

*Small Crusher at the Demo Plant*

*Agglomerator at the Demo Plant*

# Heap Leaching

After the ore is crushed, agglomerated and moistened, 4 meter high heaps are assembled for the leaching process ("irrigation") with a sulfuric acid solution diluted with water. The heap area is sealed with an impermeable liner (heavy duty plastic) and a system of buried tubes to collect the leached solution and prevent any from falling directly into the soil. At the top of the stacks, a piping / irrigation system is installed to be able to irrigate the heaps. The system is fed slowly (dripped) from the ponds, and the solution irrigates the ore by gravity repeatedly (for up to 9 months) until the final solution is rich in nickel and cobalt.

*Agglomerated (wet) ore being transported to assemble leach cells in the Demo Plant*


*Leaching heaps 4m high, mounted on a pad with an impermeable plastic liner*

*Pond of acidic solution diluted with water to leach the heaps (bottom) in a closed circuit for several months*

*Plastic piping network installed on top of the heaps for slow dripping with acid solution diluted with water*

# Precipitation Plant

The mineral-rich solution resulting from the leaching step (known as PLS or Pregnant Leach Solution), is then taken to the Precipitation Plant to **separate** nickel and cobalt from other unwanted minerals (iron, aluminum, chromium). The resulting solution is then **filtered** to **produce** the **solid** waste and products as follows:

A) **Iron Precipitation**: the PLS solution is first taken to tanks where **limestone** is added for precipitation and removal of unwanted metals from the solution (iron, chromium, aluminum). The resulting precipitates are then separated from the solution containing nickel and cobalt in a thickener, receiving flocculants to help sedimentation. Then the precipitates are taken to the filtration area (item C).

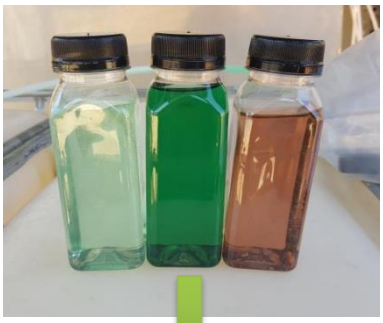
B) **Ion Exchange Unit**: The nickel and cobalt solution then goes to this unit, which contains a resin that can separate nickel from cobalt from the solution. **Sodium carbonate** (or Magnesium oxide) is then added to these separate solutions to precipitate the products as Nickel and Cobalt Hydroxides Products (NHP and CHP). These precipitates also then proceed to filtration (item C).

C) **Filtration**: Both the impurity precipitates, and separately, the Nickel and Cobalt hydroxide products (now thickened with more solids and less water), finally go to a belt filters that remove as much water as possible from the precipitates to produce a solid tailings “cake" (called “Iron Filter Cake" or IFC), and the desired solid nickel and cobalt products. The products are then bagged for sale, and the IFC is taken to a specific lined area to form stable piles.

*Solution rich in metals resulting from the leaching step in the Demo Plant before being taken to the Precipitation Plant. Note the Brejo Seco hill in the background*

*Precipitation tanks of the Demo Plant separating nickel and cobalt from other unwanted minerals (iron, aluminum, chromium), by adding limestone*

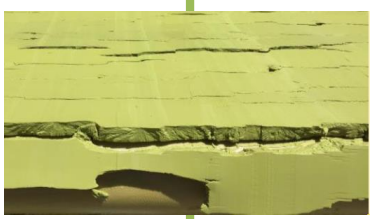
***Photos from the Demonstration Plant***



*From left to right, flasks containing: mixed nickel and cobalt solution (light green), nickel solution (dark green) and cobalt (brown) separated by the Ion Exchange Unit at the Demo Plant.*

*Belt filter at the Demo Plant drawing water from the final nickel product.*

*Waste solution filtration process = solid waste ("iron filter cake")*



*Nickel-rich precipitate filtration process = solid end product*


*Nickel and cobalt product mixed (in this case) ready and bagged for distribution for testing.*

## Limestone Quarry (Umbuzeiro)

- Demand of 476,000 tonnes / year of limestone for the nickel production process.
- The limestone extraction will also take place in an open pit on benches (much smaller than the nickel mine), with the use of explosives.
- The limestone will be crushed at an on-site crushing plant, before being sent to the Brejo Seco Complex via trucks.
- Waste rock material will also be stacked in an appropriate storage area.

## Sulfuric Acid Manufacturing Plant

- Part of the Brejo Seco Complex.
- Production for consumption of 750,000 tons / year of sulfuric acid, by burning sulfur (250,000 tons / year).
- The heat generated in the process will be recovered in a water boiler, and the superheated high pressure water vapor will cause a turbine to generate 29.7 MW of energy (cogeneration), of which 21 MW will be used in the activities of the complex itself and the surplus energy will be made available to the national electricity system.

## Water pipeline

- Demand of 460 $m^3$ / h of water for the entire production process.
- Water collection at the Jenipapo Dam and pumping by pipeline to the Brejo Seco Complex (33.5 km).
- Authorization (Permit) to capture all necessary water already issued by the National Water Agency - ANA (Resolution nº 1,340/2014).

## Transmission Line

- 69 kV Transmission Line.
- Connection between Brejo Seco Complex and CHESF substation (42.6 km and 103 towers).
- Electric energy for the project's operation will initially be supplied by CHESF and then supplied by the energy to be generated in the sulfuric acid plant (cogeneration).
- The excess energy generated in cogeneration (approximately 8.7 MW) will be transmitted to the national electricity system.

## Other Reagents

- Fuel and lubricants: for the entire fleet of vehicles and equipment, sulfur-burning furnace and boiler - 7 million litres / year of diesel expected.
- Sodium Carbonate (Soda Ash) or Magnesium oxide (MgO) for nickel and cobalt precipitation process – some 112 thousand tonnes / year.
- Flocculants: for the process of sedimentation of precipitates in thickeners and to improve filtration.
- Explosives for mining and quarrying activities in the 2 areas.

## And what about manpower during operation?

*Demonstration Plant*

When fully operational, the entire project is expected to generate about **668 direct jobs**, with 15 managerial positions, 37 supervisors and 616 operational workers.

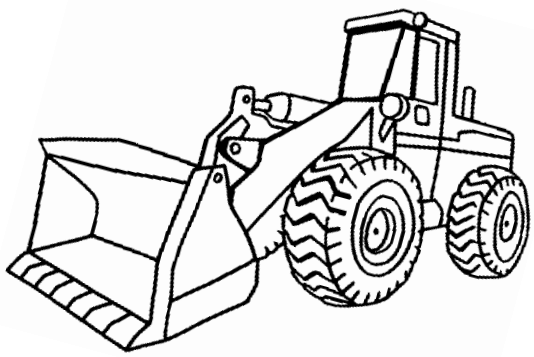
PNM is committed to giving **priority** to the recruitment and **hiring of local labour**, aiming to offer employment and income opportunities, and sustainable development for the region.

## Machines and Equipment

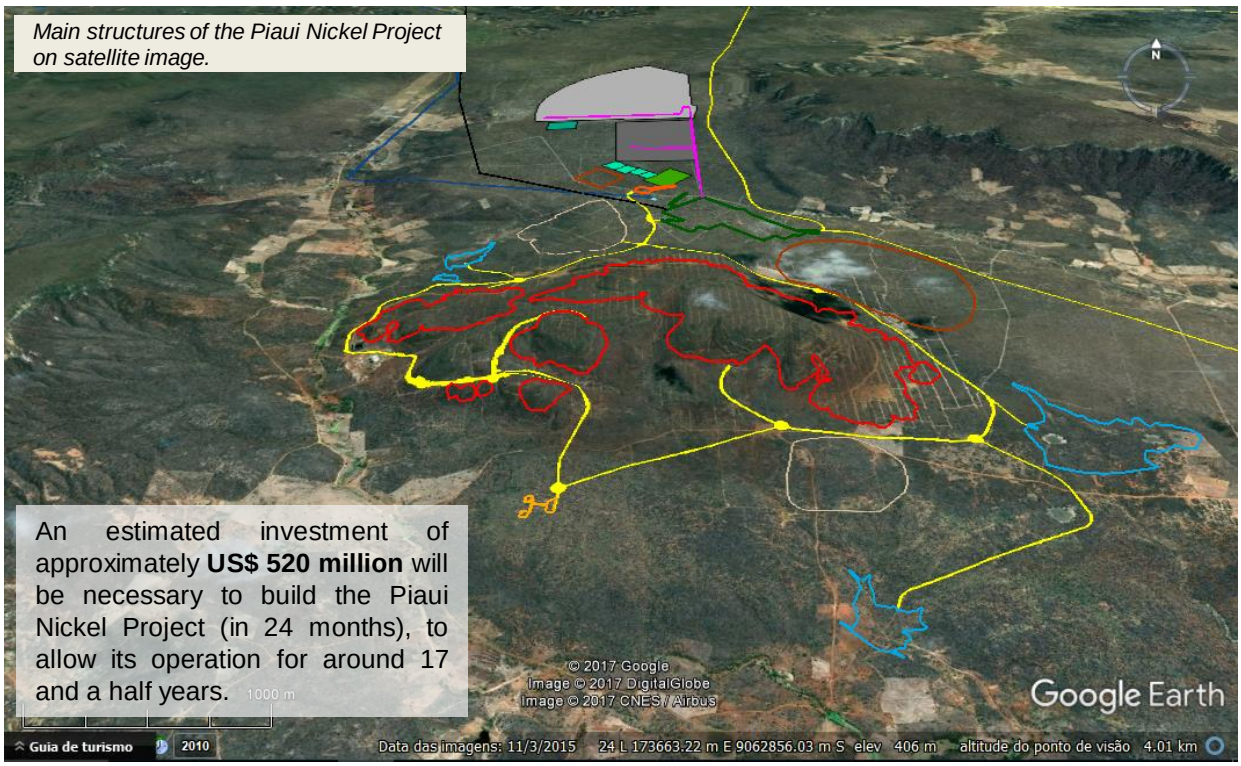
Hydraulic excavators, rear unloading dump trucks, crawler tractors, tire tractors, wheel loaders, motor graders, water tank trucks and lubrication lorries, among others, will be required for mining activities.

It is also planned to use a specific drill for sampling ore and trucks to prepare and load explosives. For crushing units, equipment such as crushers, belts, screens and silos will be used.

In the processing plant, various equipment for pumping, dewatering, filters, and tanks.



# Investment and Schedule




| Overall Schedule | Year 1 | | | | | | | | | | | | Year 2 | | | | | | | | | | | | Year 3 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| ***Construction Phase*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Support Intrastructure** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| - Site access road | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| - Low voltage electricity connection | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| - Construction Building sites / camp | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| - Water pipeline (Jenipapo) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| - 69kV Transmission Line | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Nickel Mine** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Leaching Area** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Limestone Mine - Umbuzeiro** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Precipitation Plant** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Acid Plant** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| - Long-lead item fabrication (external) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| - Erection at site | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Operation Phase*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Support Intrastructure** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Nickel Mine** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Leaching Area** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Limestone Mine - Umbuzeiro** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Precipitation Plant (Ramp-up)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Acid Plant** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Full Nickel production capacity** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# Environmental Control Systems

An Environmental Control System is a set of mechanisms or operations that have the function of controlling and reducing negative environmental impacts on the environment and the population, through the generation of liquid effluents, atmospheric emissions, solid residues, noise and vibrations during the implementation phase, and / or operation of the enterprise. The following are some of the mechanisms provided for in the project.

## Liquid effluents and surface water

- Construction of a septic tank system and, in the operation phase, construction of a Sewage Treatment Station with adequate disposal of the sludge to be generated;
- Implementation of a Water and Oil Separator system;
- Implementation of an efficient drainage system to guide rainwater;
- Implementation of a containment pond for water infiltrating from the solid waste heap (which will be reused in the production process or sent to an appropriate location);
- Implementation of inspection boxes and emergency ponds in the area of acid solution ponds.


*Example of acid solution ponds at the Demo Plant, lined with heavy duty plastic and provided with an inspection box (indicated) for immediate diagnosis of any leaks.*


*Example of septic tank cleaning operations in the Demo Plant for proper disposal of sanitary sludge.*

## Sediments

- Construction and operation of 4 barriers (dykes) to contain soil particles originated from the erosive processes that may be caused by rainwater that falls on all the project's structures.

## Air Quality, dust and other particular emissions

- Sprinkling of water on unpaved roads in the project area by water trucks;
- Vehicle speed controls;
- Covering trucks that transport materials such as sand and cement;
- Implementation of vegetation cover over unprotected areas, when feasible.

# Environmental Control Systems

## Solid residues and mine waste rock

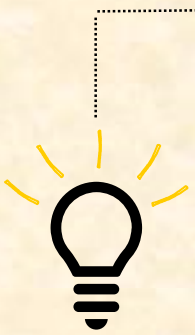
- Implementation of an impermeable lined pond for temporary storage of solid waste;
- Selective collection system for recyclable waste;
- Deposit of unusable mineral material (overburden) in controlled and monitored heaps;
- Deposit of processing waste in a lined pond (associated with the containment pond).



*Example of disposal of solid waste generated in the Demo Plant process in a canvas-proof waste basin.*

## Noise and Vibration

- Preventive and corrective maintenance of vehicles, machines and equipment used during the construction stage;
- Use of advanced technologies, planning, communication and signaling of events in the case of blasting rocks by explosives;
- Definition and control of daytime hours for the operation and movement of equipment, avoiding inconvenience to the population at night.



**Did you know?**

**Noise** is a set of unwanted sounds that can cause some unpleasant sensation to people and animals. The intensity of a noise is not the only factor that determines whether or not that sound is dangerous, it also takes into account the time of exposure to that noise.
**Vibration** is a tremor, the result of the movement of machines, other heavy structures and detonations, which can cause discomfort to people and sometimes damage to the structures of houses and other buildings.

# Areas of Influence

## What are Areas of Influence?

Areas of influence are the areas where the environmental and social impacts resulting from the implementation of the enterprise could occur. They are important to define the scope of the necessary actions to be developed to address impacts, and are defined based on the characteristics of the project and the region in which it is located.

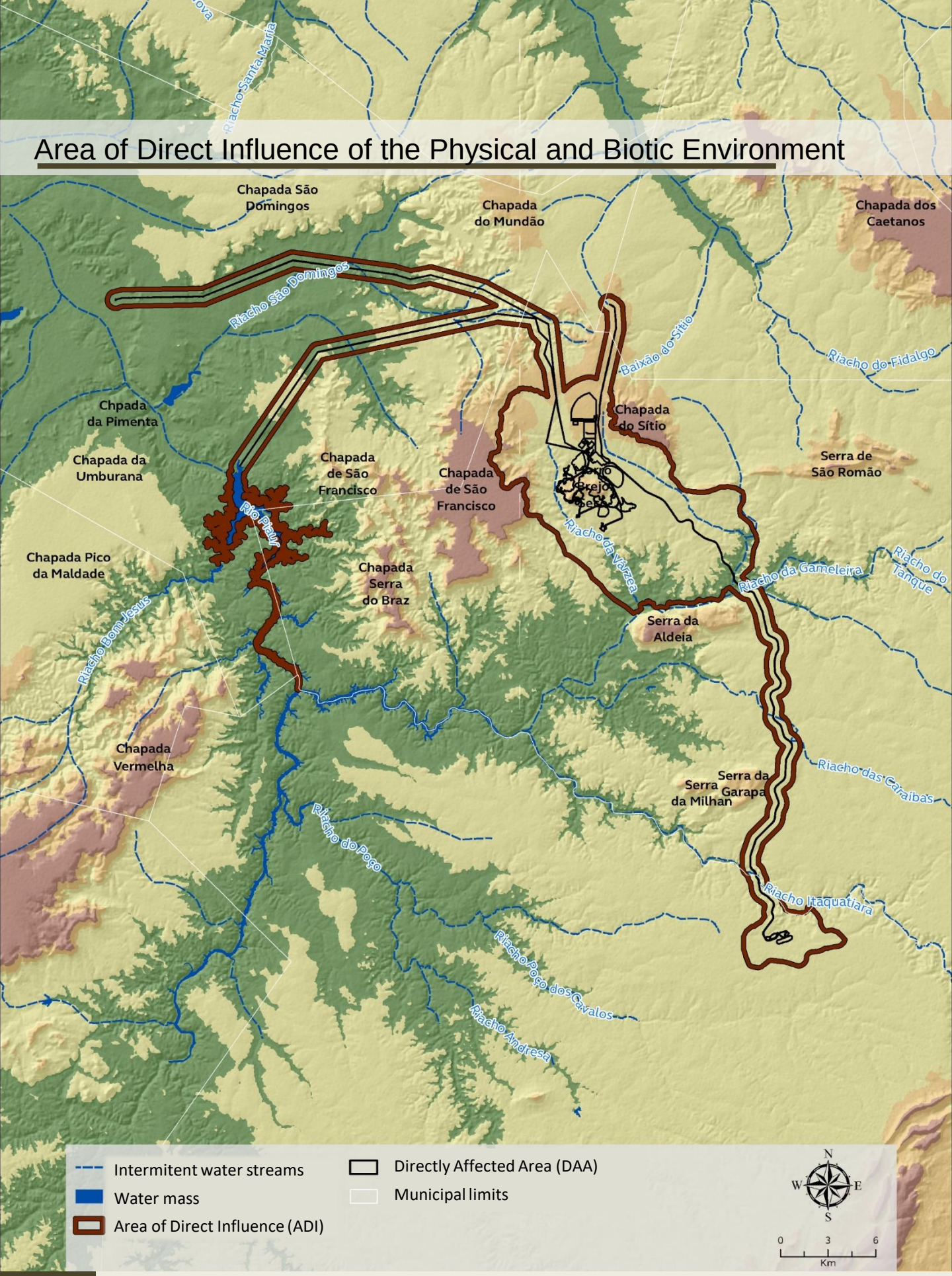
## Areas of influence defined in this study:

**Directly Affected Area** (DAA): corresponds to the places where the necessary actions / interventions for the implementation and operation of all the structures of the project will take place. It is the same area for all the studied environments.

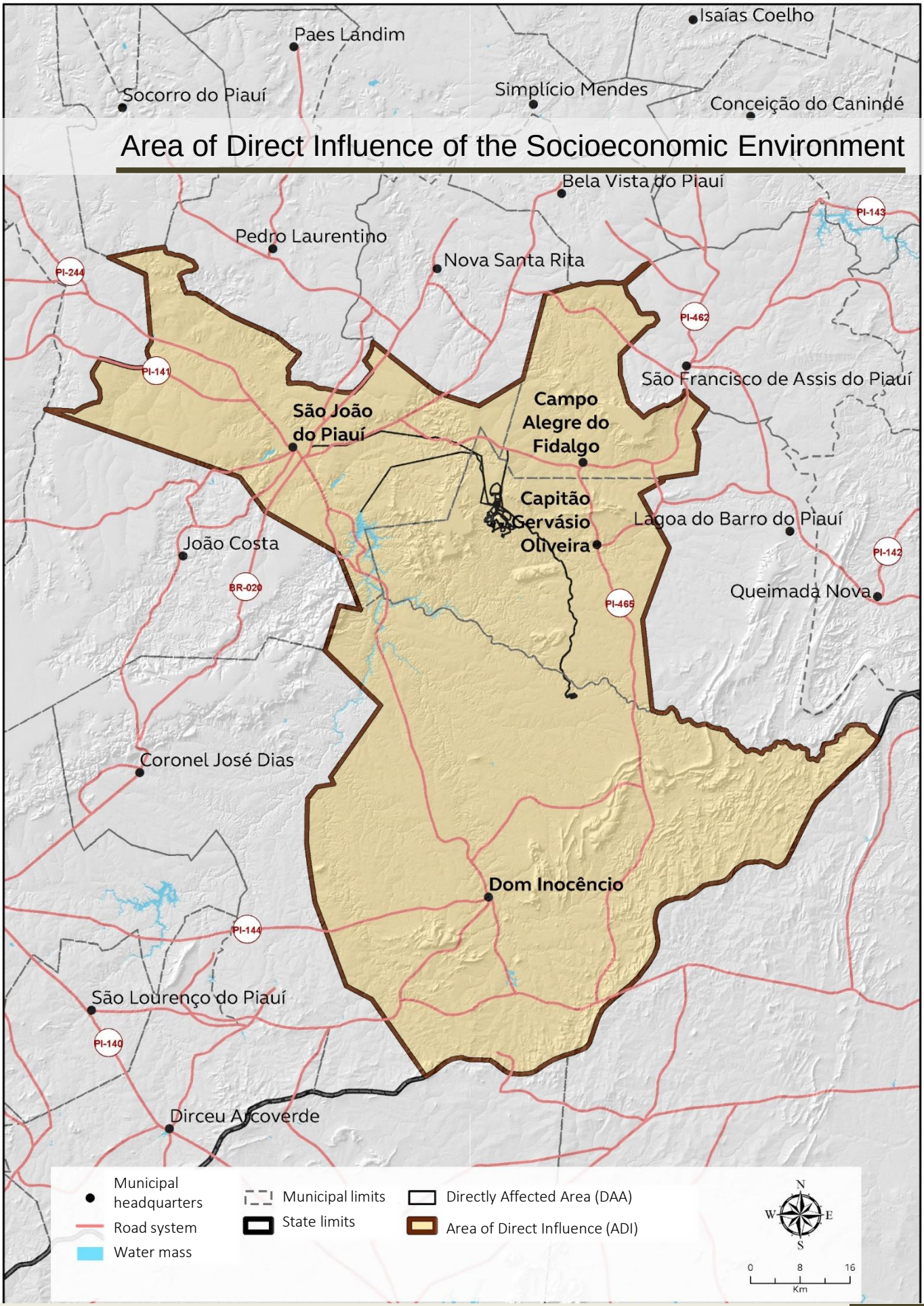
**Area of Direct Influence** (ADI): geographical area surrounding the DAA that can be directly affected by the significant impacts, positive or negative, directly resulting from the implementation, operation and closure of the project. The ADI of the Physical and Biotic environment was based on geographical factors such as hydrographic basins and relief features for the specific structures and included a 500m strip of land on each side of the linear structures – *Buffer area* (access roads, water pipeline and transmission line). It is different from the ADI delimited for the Socio-economic Environment, which considers the area of the municipalities where the DAA operates: Capitão Gervásio Oliveira, São João do Piauí, Dom Inocêncio and Campo Alegre do Fidalgo.

**Area of Indirect Influence** (AII): the area that involves the ADI and that may suffer any indirect impacts from the implementation and operation of the enterprise, whether positive or negative. The AII of the Physical and Biotic Environment was defined according to geographical criteria involving the relief and the network of rivers and drainage in the region (basins). The AII of the Socio-economic Environment in turn includes the municipality of Petrolina in addition to those already mentioned in the ADI.

# Area of Direct Influence of the Physical and Biotic Environment



# Area of Direct Influence of the Socioeconomic Environment



# Environmental and Social Assessment

## What is an Environmental Assessment?

The **Environmental and Social Assessment** is a picture of conditions in the region before the implementation of the **Piaui Nickel Project** and should present the environmental situation of the area where the project will be constructed and its vicinity (**areas of influence**). The Environmental Assessment is developed from studies carried out by specialists for the physical, biotic and socioeconomic environments.

### Physical Environment

The **Physical Environment** studies the **climate**, types of **soil**, **relief**, **rocks**, **surface waters** (rivers) and **underground waters** (aquifers) and **caves**, among others.

### Biotic Environment

In the **Biotic Environment**, **fauna** (terrestrial and aquatic animals) and **flora** (plants) are studied, highlighting the species that are indicative of environmental quality, of scientific and economic value, rare or threatened with extinction, in addition to the **Permanent Preservation Areas** (APPs) and **Conservation Units** (CUs).

### Socioeconomic & Cultural Environment

The Socioeconomic Environment studies the conditions of **life**, **work** and **income**, **education**, **health**, **housing** and **security** of existing populations, and the services and infrastructure offered by the respective municipalities. The **historical** and **archaeological** characteristics of the region and the cultural aspects of the communities are also studied.

It also includes interviews with representatives of society and local communities to assess their **Environmental Perception** about the conditions of the existing natural resources, and how they evaluate the arrival of the project and its consequences.

# Physical Environment

# Climate


*Source: IBGE, 2004. Created by: Arcadis, 2017.*

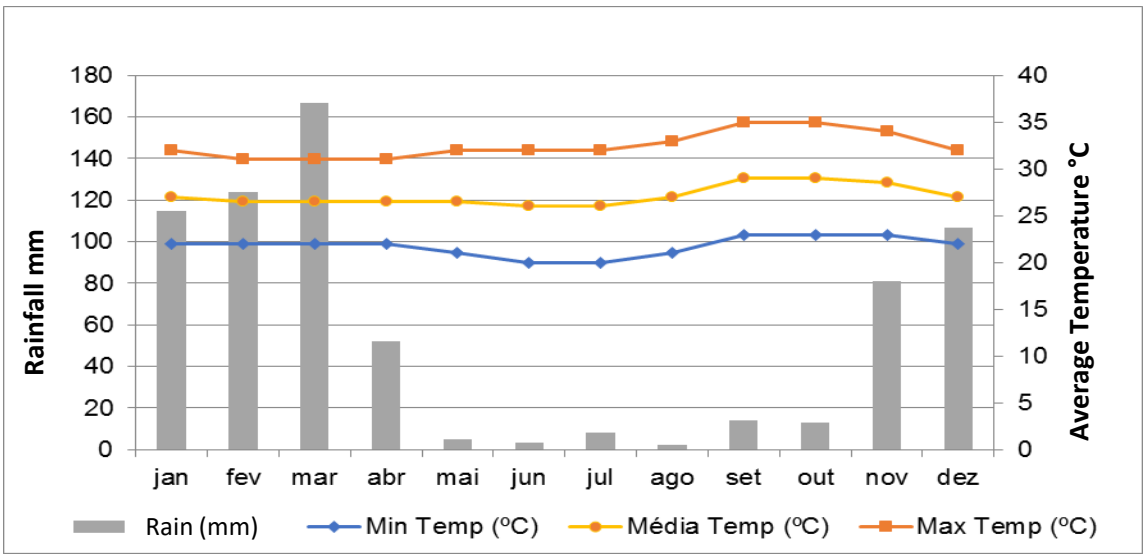
The region where the Piaui Nickel Project will be implemented is part of the **Caatinga** biome and has a **semi-arid hot tropical climate**, with **little rainfall** and many episodes of dryness and **drought.**

*Riverbed in a dry season.*

*General view of the dense Caatinga vegetation.*

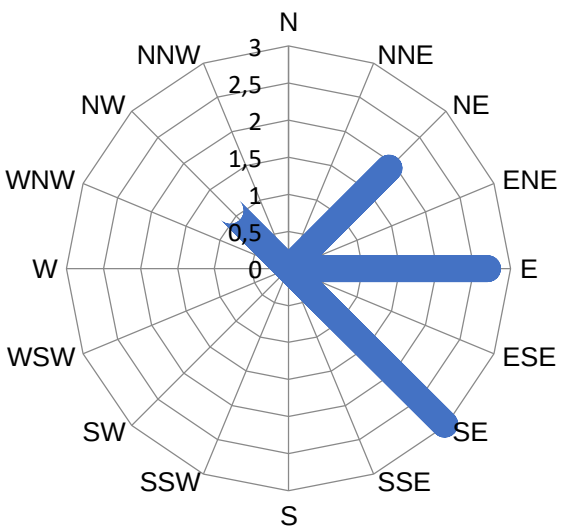
The **average temperature** ranges from **21.7**ºC to **32.5**ºC, while **rainfall** reaches, on average, **691 mm per year** and is concentrated between the months of December and March.

**Climate Graph (Precipitation - mm & Temperature - °C) for the São João do Piauí meteorological station. In the period of 1961-1990.**




*Source: INMET, 1992. Created by Arcadis, 2017.*

In the region of the project, as well as in the entire Northeast of Brazil, the winds are directly influenced by the air masses coming from the Atlantic Ocean and the intertropical convergence zone. The graph below indicates the predominance of **winds** from the **east and southeast** directions.




*Source: INMET, 1992. Created by: Arcadis, 2017.*

# Geology

In the study region, two types of rocks are found: **sedimentary** in the **north**, **metamorphic** and **crystalline** in the **south**.

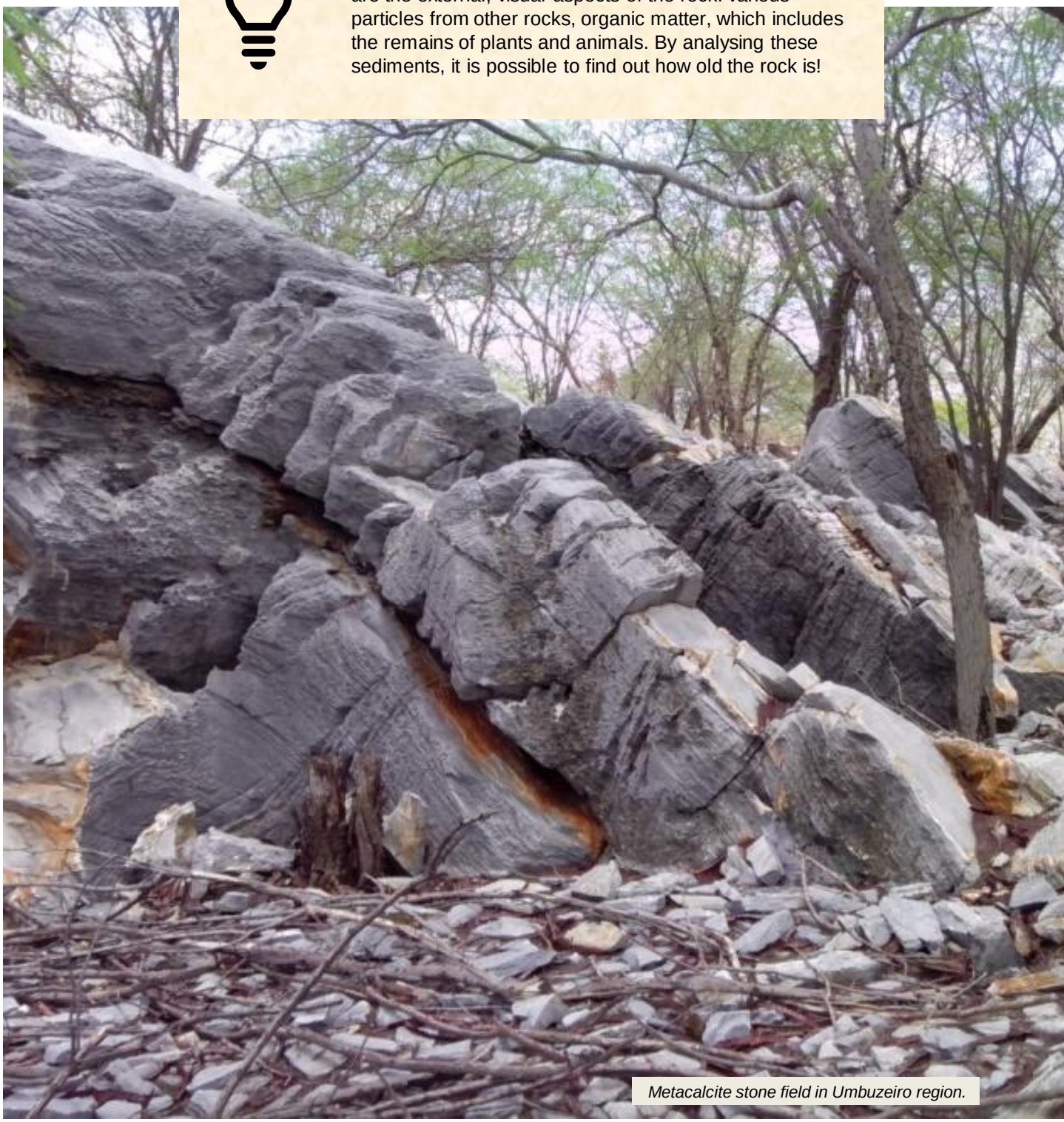
Sedimentary rocks, due to the physical characteristics of permeability (ability to let liquids pass through the interior without altering it), are able to store underground water and form aquifers.

Metamorphic rocks, as the name implies (Greek: meta = change; morphs = shape) are those that have undergone transformations during their formation. These changes involved exposure to different temperatures and pressure for a long time and therefore took on a different shape and mineral composition than the initial rock. This type of rock attracts economic interest, such as the Piaui Nickel Project.

*Banded metamorphic rock with asbestos veins.*

**Did you know?**

PHYSICAL CHARACTERISTICS
are the external, visual aspects of the rock: various particles from other rocks, organic matter, which includes the remains of plants and animals. By analysing these sediments, it is possible to find out how old the rock is!



*Metacalcite stone field in Umbuzeiro region.*

# Soils

Four main types of soil are identified in the project area:
**Red-Yellow Oxisol**; **Litolic Neossols**; **Quartzarenic Neossols**; and, **Red-Yellow Argisols**.

Let's get to know their characteristics and where are they located:

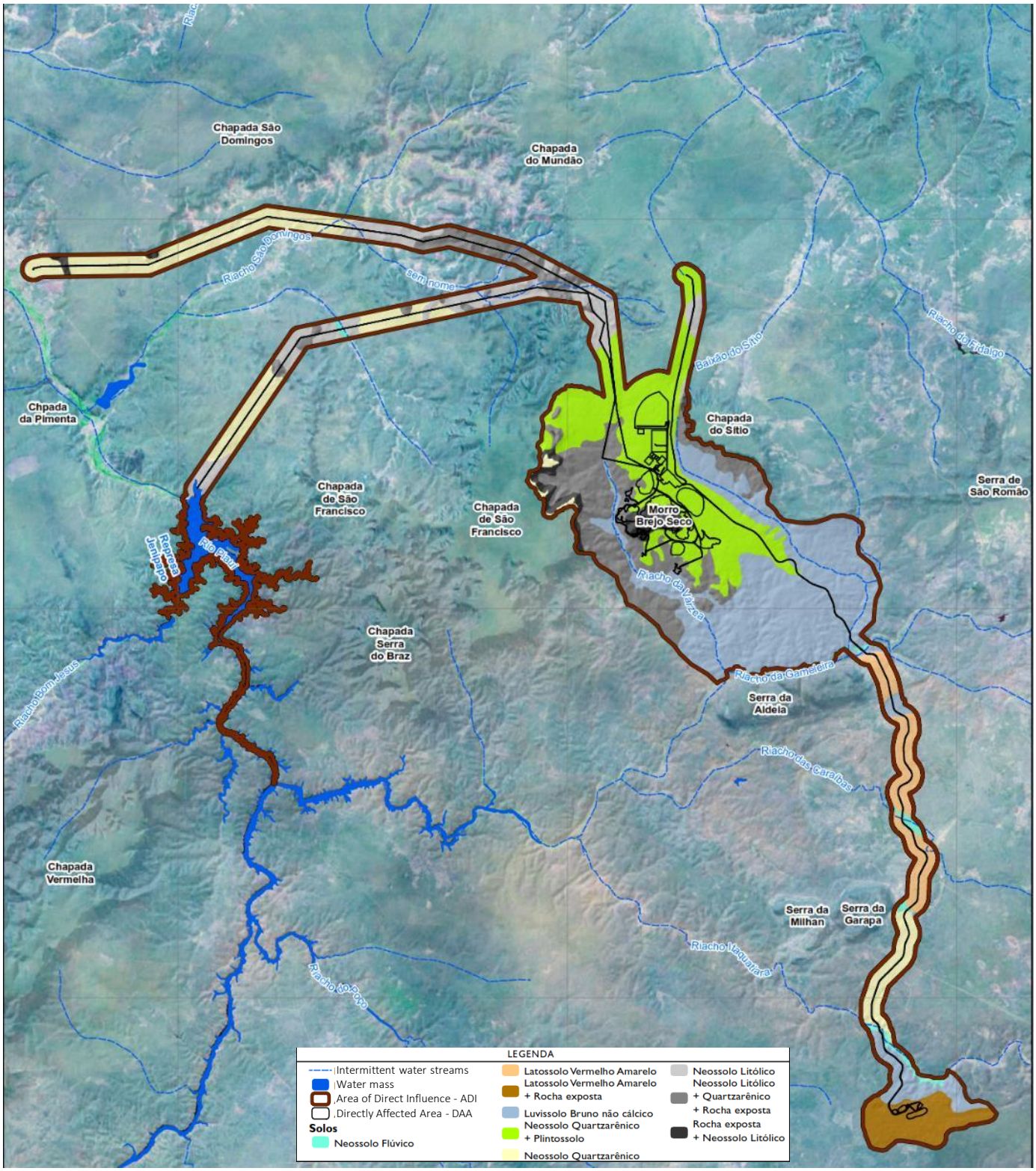
| Soil | Characteristics | Where to Find? |
|---|---|---|
| **Red-Yellow Oxisol** | It has low natural fertility, but it can be used for intensive agricultural production, pasture and forestry. It can also be used as a base for building highways, houses and landfills. They are well drained and resistant to erosion. | Between smooth wavy to flat terrains. |
| **Litolic Neossols** | It has a low predisposition to agriculture. It is shallow and rocky, which makes it difficult for water to circulate inside. It can be used for grazing, as well as an area for borrowing material, and also to preserve water springs and native vegetation. | Sharp terrain |
| **Quartzarenic Neossols** | Used as a substrate for irrigated agriculture and as a sand source for civil construction. This type of soil is well drained and does not retain water or nutrients, which makes it fragile and highly dependent on conservation practices. | In smooth wavy terrain. |
| **Red-Yellow Argisols** | Generally used for planting sugar cane, fruit, pasture, and other crops. They have low natural fertility, but good drainage. | In smooth terrain |

*Oxisol. Source: FUMDHAM, 2008.*

Litolic Neossols . *Source: FUMDHAM, 2008.*

Litolic Neossols. *Source: FUMDHAM, 2008.*

# Types of Soils in the ADI



# Terrain & Landscape

The study region is located within two geomorphological domains: **Sertaneja Depression** and **Parnaíba Basin**.

The region is made up of **small hills** with **low slope**, with some points of the landscape with a steeper slope, such as the plateaus with wide and flat tops.

### Did you know?

GEOMORPHOLOGICAL DOMAIN
Geomorphology is the subdivision of Geosciences that studies (logy) the shapes (morph) of the Earth's surface (Geo).
These forms are grouped according to their structure (morpho structure) and sculpture (morpho sculpture) within groups (domains).

*Testimonial Hill.*

*Flat Top.*

# Erosive Processes

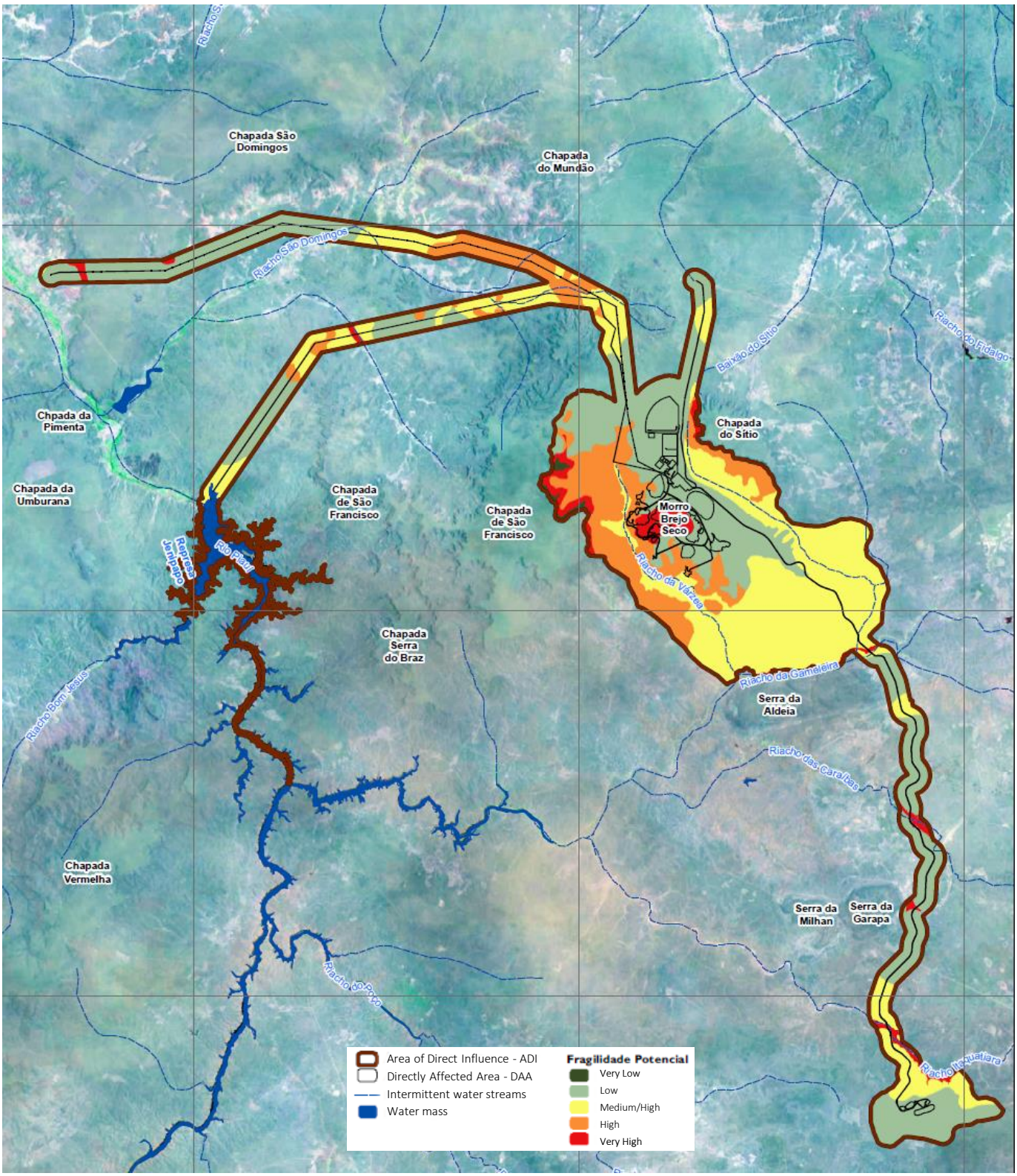
Erosive processes are the wear and tear of the surface, the soil and rock, due to the action of wind, rain, sun, temperature changes, and human interference.

These processes shape the steepest slopes and carry the resulting sediments to flatter areas. They are more intense in the rainy season.

A study was carried out in the region where the Piaui Nickel Project will be implemented, resulting in a classification of the areas in relation to their **fragility** due to erosion processes (following map).

Most of the project's interference zones are on areas considered to be of **low fragility (72%)** for erosion processes.

# Fragility to Erosive Processes in the ADI



# Surface Water

The hydrographic network (the water bodies) in the Piaui Nickel Project area is within the Middle Parnaíba (sub-basin 5 Piauí / Canindé), which accounts for 99% of the drainage network of the State of Piauí, with an area of 333,056 km². This network supplies water to important cities in the State of Piauí, such as Teresina, Parnaíba and Picos, as well as 217 other towns.

The rivers and streams that flow in the project area are **intermittent** due to the climate characteristics of the location, and the irregular and low rainfall. The watercourses disappear during the dry period, and then reappear during the rainy season.

The existing water courses in the project area are: Várzea stream - contributor to Gameleira stream; part of the São Domingos stream and tributaries; part of the Caraibas and Itaquatiara stream; Piauí River, and Jenipapo Dam.

The **Jenipapo Dam** can store 248 million $m^3$ of water, and the average volume of water flowing through it is around 20,160 $m^3/h$.
**The project will use only 460 $m^3/h$** to operate (about 2.3% of the average flow), and its impact on the **current dynamics and water supply** of the Dam and the Piauí River will be insignificant.

**What about the water quality?**

The Project location is in a region that does not have adequate or sufficient basic sanitation. According to the surface water quality assessment, the results do not meet the requirements of the legislation.

The presence of organic material, high levels of turbidity, low oxygenation, as well as bacteria of fecal origin, were recorded in several water samples collected in 3 different campaigns carried out in February, March and May 2008.

*Resident collecting water, Várzea Reservoir (3ª campaign).*

*Dry bed, Itaquatiara stream (1ª campaign).*

*Jenipapo Dam (1ª campaign).*

*Gameleira Stream (2ª c campaign).*

*Sample collection, Itaquatiara Stream (2ª campaign).*

*Cattle in the Eugênio Comunity, São Domingos Stream (3º campaign).*

# Surface Water in the ADI

Where are the main Water Bodies located?

*View of Jenipapo reservoir near its Dam*

# Groundwater

Two main **aquifer systems** are found in the Project area; one is characterized by crystalline rocks and the other by sedimentary rocks of the Parnaíba Sedimentary Basin.

An **Aquifer** is a formation or group of geological formations that can store groundwater.

For the **sedimentary rocks**, the accumulation of water occurs thanks to their physical characteristics: they are porous and permeable, capable of retaining water and yielding it. There are two aquifers with sedimentary rocks in the proximity of the DDA (Directly Affected Area): **Serra Grande Aquifer and Pimenteiras Aquifer.**

The **Serra Grande Aquifer** has great potential for water supply and is one of the largest and most important in the region. Studies carried out in 2008 showed the capacity to pump 200 $m^3/h$ (or more) of water from deep wells installed in it.

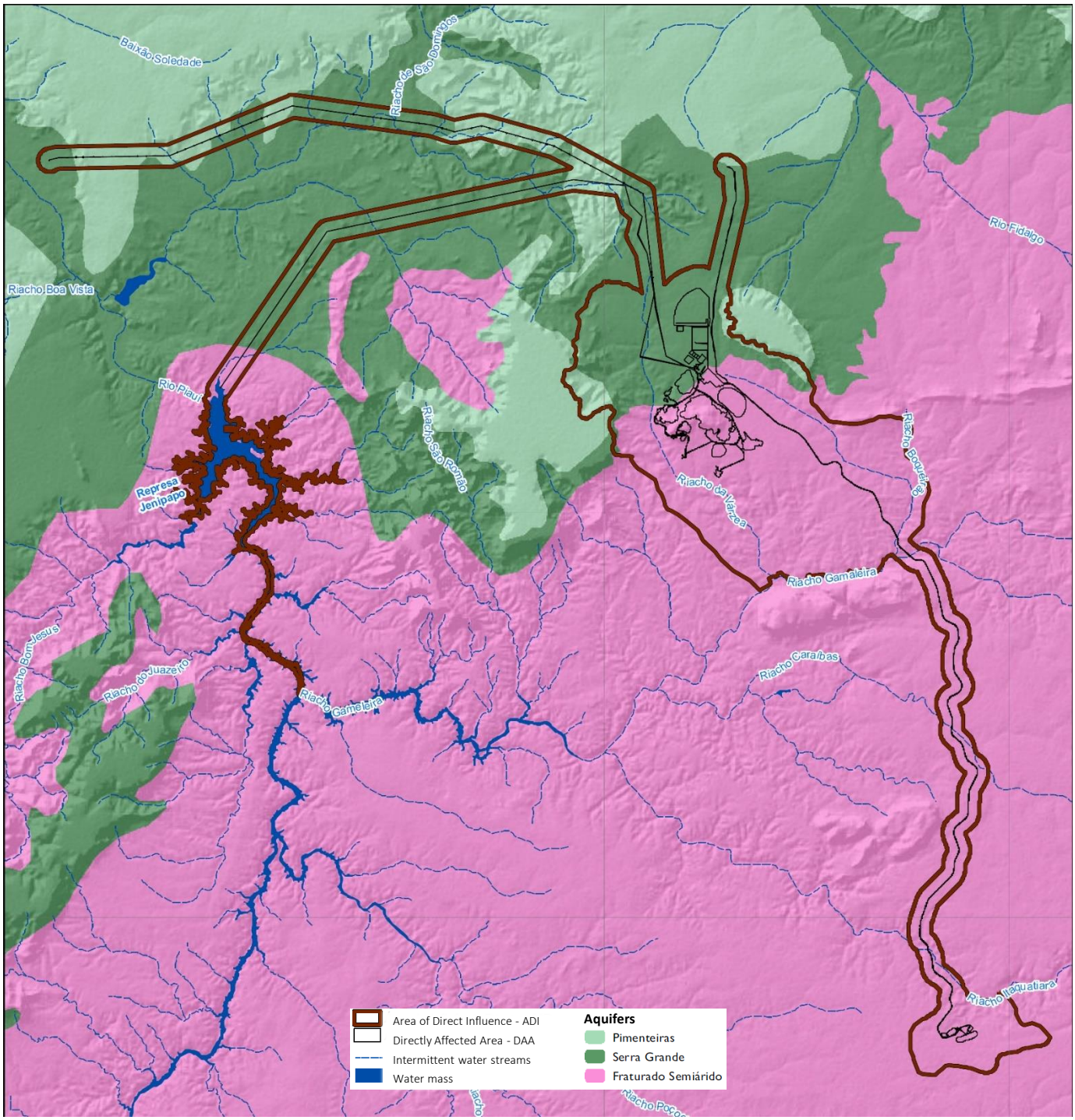
**Did you know?**

AQUIFER DIFFERENCES

- Aquifers with crystalline rocks have low flow and salty water;
- Aquifers with sedimentary rocks have higher flow and the water quality is better.

* flow: speed at which water flows through a channel.

# Aquifers in the ADI



# Air Quality, Vibration and Noise

To assess air quality in relation to substances to be emitted during the operation of the project, a specific study was carried out that considered some pollutants from the future Acid Plant such as sulfur oxides and sulfuric acid mist.

These studies simulated the predicted pollutant emissions and all **results** (concentration of these substances) **were in accordance with the limit values established by the applicable legal standards** (that aim to protect the environment and people's health).

A similar approach was taken for noise and vibrations that may occur due to the mining activities when using explosives. The intensity of these noise and vibrations were estimated using mathematical models; the results indicate that mining operations **will not cause** significant level of distress to the population in the nearby locations due to noise and vibration.

Therefore, the communities located in the vicinity of the project area are **all far enough away and outside the radius of potential impacts** in air quality, noise and vibration that may be generated by the sulfuric acid plant, machinery, and mining activities (including the use of explosives) required in the area of pits of the Project's Nickel and Limestone mines.

# Natural Cavities

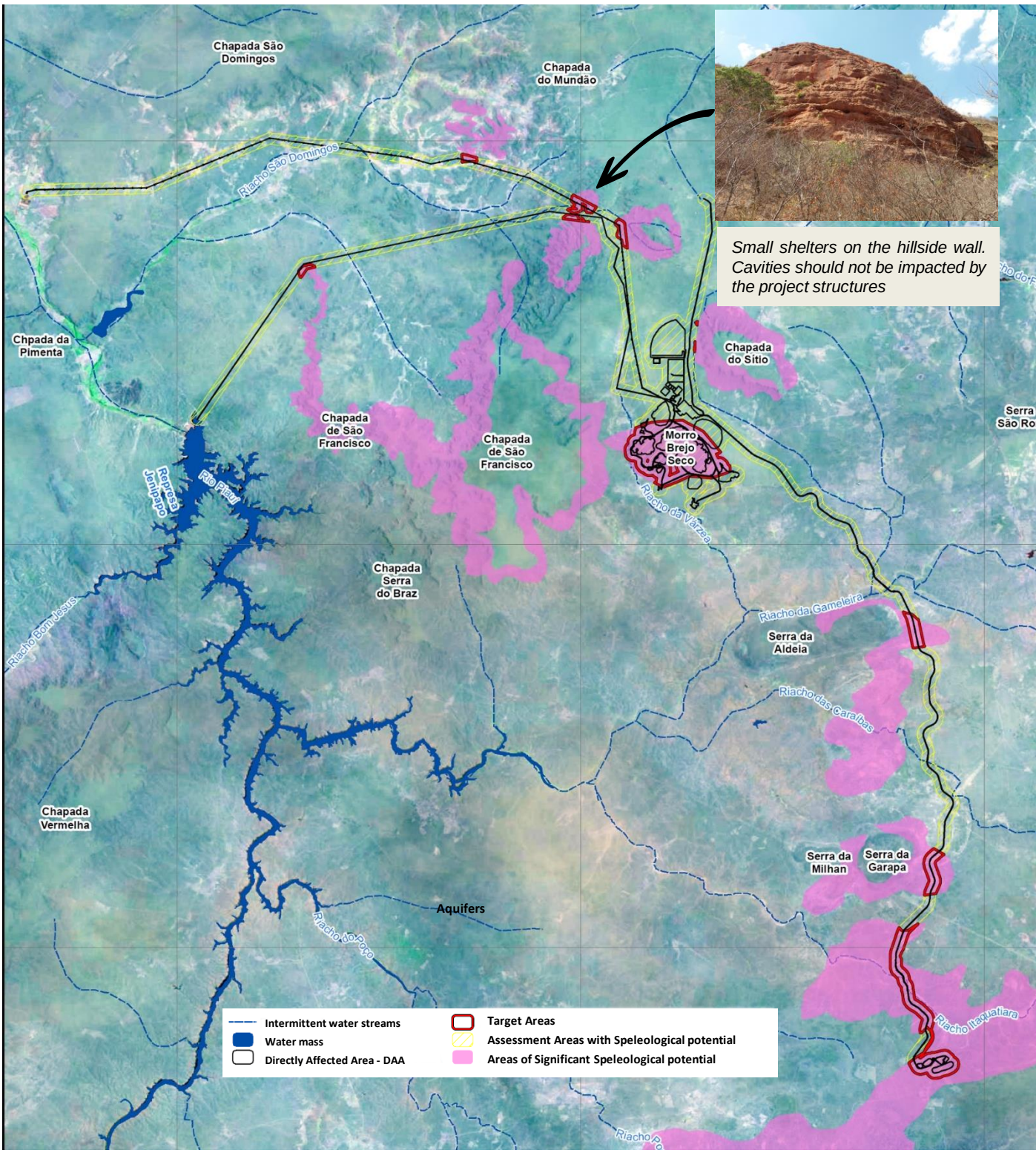
Studies were carried out to verify whether the implementation of the Piaui Nickel Project could cause interference with natural underground cavities (caves and small shelters).
In the first stage, extensive baseline and field work was carried out, covering all areas of the project, including a search distance of 250m from the boundary of the planned structures (*buffer area*), to confirm and define the areas potentially containing caves that could be affected by the project (**Target Areas**).

In a second stage, a denser field search (prospecting) was carried out in the defined target areas (See map on next page).

Only in the Chapada do Mundão, or Serra do Chiqueirinho, small cavities (shelters) on the slopes (walls) were found, and they were distant from the DAA of the 2 structures planned for this location: water pipeline (at the base of the slope) and some towers for the power transmission line (at the top of the slopes).

Considering that these structures will occupy very small areas, have great location flexibility, and their installation will not require major impacts on the land or the use of explosives, the studies concluded that the **project shall not impact natural cavities** for its implementation.

# Areas with Potential Occurrence of Natural Cavities




*Small shelters on the hillside wall. Cavities should not be impacted by the project structures*

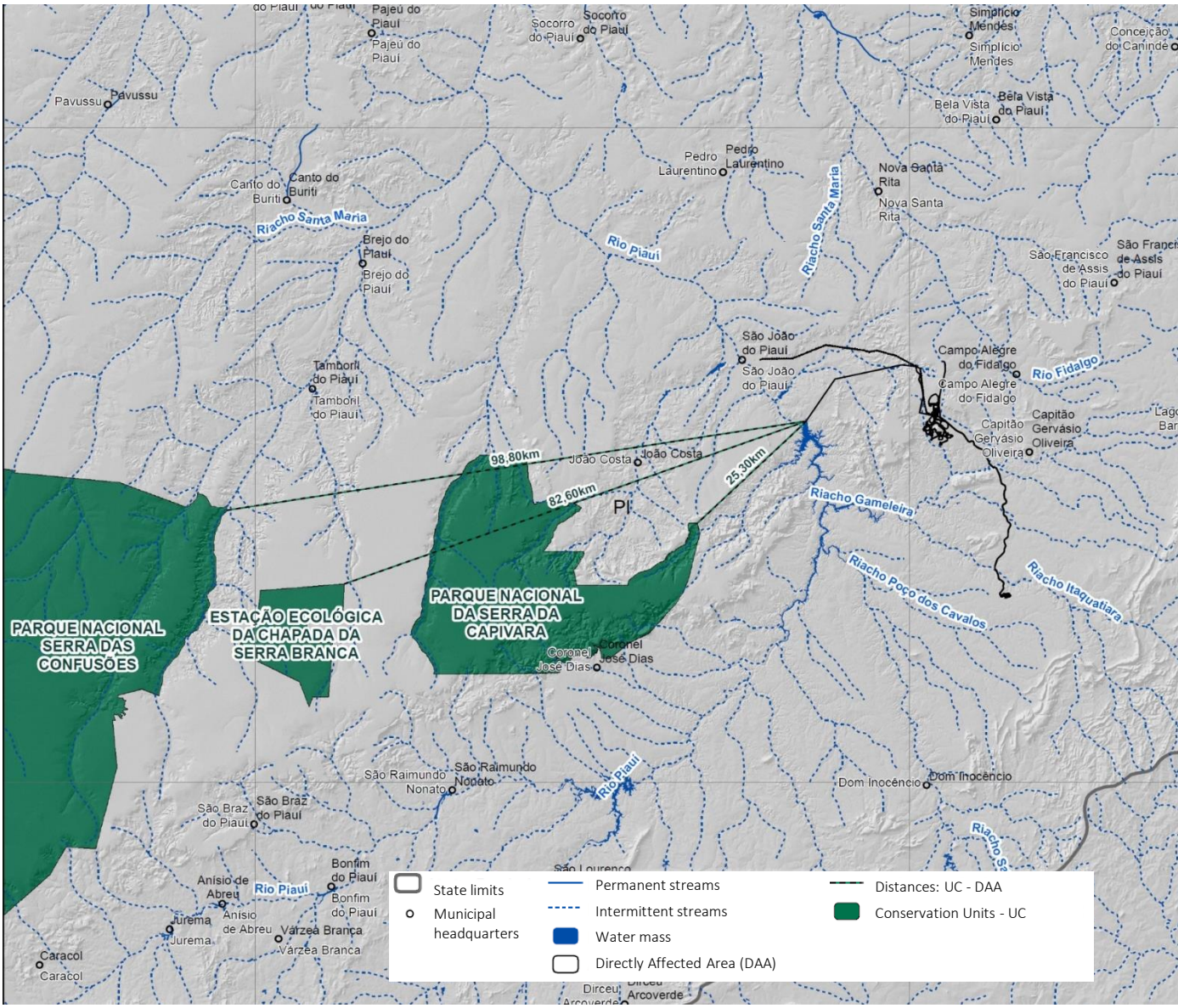
# Biotic Environment

# Conservation Units

**Conservation Units (UC's)** are areas protected by law with characteristics and natural resources considered to be very important.

The Piaui Nickel Project is located outside and distant from any conservation unit. The closest UC to the Project is the Serra da Capivara National Park located about 25 km from the Jenipapo dam (future water pump station) and approximately 41 km away from the future Nickel mine (Brejo Seco Complex). Therefore, the **Piaui Nickel Project will not cause interference in UC's.**

**Closest Existing Conservation Units to the Project Layout (DAA)**



# Vegetation

The natural vegetation present in the Project area is fully contained in the Northeastern Caatinga domain.
This domain presents extreme conditions, where there is a high exposure to sunlight and high temperatures, low relative humidity and little rain (which occurs in a short period of the year, between December and March). These characteristics have a significant influence on the animal and plant life of this biome.

Land use and vegetation mapping completed using satellite imaging and field surveys shows that **82% of the Project's ADI** is **covered by caatinga**. Three types of caatinga were recorded, with the **Open Arboreal-shrubbery Caatinga occupying 40% of the ADI**, and the **Dense Arboreal-shrubbery Caatinga** occupying an additional **32%**.

It is important to highlight that the total caatinga vegetation to be removed due to the project implementation in the DAA represents only 5% of the total caatinga vegetation in the project's ADI. This percentage is even lower (0.15%) if we consider the caatinga existing in the project's AII.

A study to identify groups of vegetation species with economic importance, rare species, endemic species (those that only occur in a given region), species threatened with extinction, and indicators of environmental changes in the areas of influence of the Piaui Nickel Project was completed.

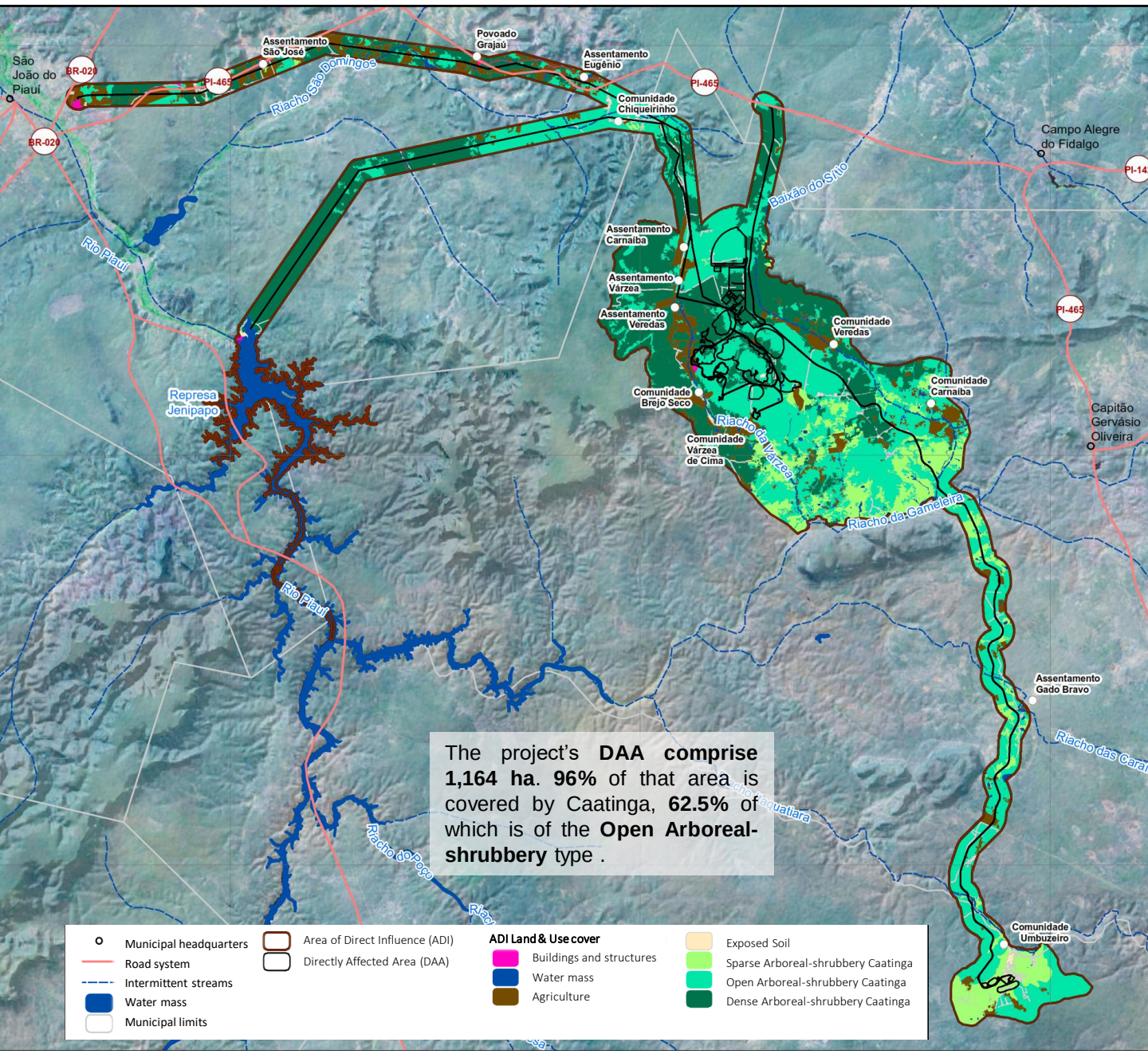
In the project's ADI, 226 types of plants were documented and classified in 49 botanical families, including trees, shrubs, herbs, vines and aquatic plants.

Only one of the registered species, the "ipê-cascudo" - *Handroanthus spongiosus* is considered threatened (categorized as "In Danger") according to the official lists of threatened species.

Currently, there is a high degradation of the existing native vegetation caused by livestock herds roaming freely in the region, especially the goats that selectively consume the seedlings of many native species, altering the natural regeneration processes of the local vegetation.

*Dense Caatinga Arboreal-shrubland vegetation.*

# Vegetation Mapping



*Sparse vegetation composed by Shrubs and Cactae with exposed rocks.*

*Open Caatinga Arboreal-shrubland.*

# Permanent Preservation Areas (APP)

The APP's delimitation was made according to the Brazilian Forest Code and the Federal Law 12.651/2012.

The results indicate that the Project will affect 132 ha of permanent preserved areas. Important to note that around **80% of this interference** is on the Nickel deposit hill, therefore having no alternative for relocation.

Furthermore, the remaining 20% of the APP (some 26ha) that are located next to the rivers and streams, represent only 2.2% of the total vegetation that will be removed by the project's activities and only 0.13% of the total vegetation existent in the ADI of the project.

In the DAA, 82.5% of the APP is in areas of open caatinga arboreal-shrubbery, as detailed in the table below:

| Vegetation Type | APP area included in the DAA | |
|---|---|---|
| | Hectares | % |
| Open caatinga arboreal-shrubbery | 109.06 | 82.51% |
| Dense caatinga arboreal-shrubbery | 17.97 | 13.60% |
| Sparse caatinga arboreal-shrubbery | 3.29 | 2.49% |
| Other Uses | 1.86 | 1.41% |
| **Total** | **132.18** | **100%** |

*APP on the Itaquariara River banks (With Dry bed)*

# Fauna

## Terrestrial Mammals

In relation to small terrestrial mammals, three species were registered during the field survey at the project's ADI, two of which were “possums” and one rodent.

Regarding medium and large mammals, 18 species were recorded during the field survey, including 9 predators, 4 armadillos, 3 rodents, 1 anteater and 1 marmoset.

In general, the registered species have generalist habits, of low environmental demand and with great resistance to anthropic pressures, such as extensive cattle breeding and hunting.

Based on field observations and interviews with residents, it is believed that the low number of species and records in the field survey is mainly related to local environmental variables and the characteristics of the region's mammal fauna, which present low abundance because of human pressure.

Among all species of terrestrial mammals registered to have been proven to occur during field surveys at the project's ADI, only the “**mocó**” **(*Kerodon rupestris*) is considered threatened with extinction** (as “vulnerable”) according to the official list (Portaria MMA 444/14), in addition to being endemic and rare in the caatinga.

It is important to highlight that the environmental study concluded that the project **will not affect the survival** of any species of terrestrial mammal in the region.

*Wood fox individual (Cerdocyon thous) photographed by the camera trap.*

*Photographic record of an agouti individual (Dasyprocta prymnolopha) in a caatinga area.*

*Goats registered by the camera trap.*

# Bats

*Shelter found in a rock crevice used by the species Peropteryx macrotis in the project's area of influence.*

*Individual of the species Pteronotus parnellii captured in a mist net.*

*Individual of the species Micronycteris megalotis captured in an abandoned house near the Jenipapo Dam.*

For the survey of bat species, data from previous studies (Golder Associates, 2005) and field campaign conducted in 2008 were compiled.

Six bat species were recorded through the field survey.

Despite the low diversity found, considering the complementary studies done in the project area, in 2005 (Golder Associates), the diversity richness is as expected for the region.

Predominate in the region species characterized by high diversity of eating habits, some of which are characteristic of environments with rocky outcrops.

It is important to highlight that the environmental study concluded that the project **will not affect the survival** of any species of bat in the region.

**No species is threatened with extinction** according to official lists.

# Birds

The field surveys carried out indicated the presence of 107 bird species in the project region, whose composition is characteristic of the types of environments in which they occur.

11 species are considered endemic to the Caatinga (they only occur in this type of vegetation) and they represent 10% of the total species registered in the project area.

**None** of the species found is considered **threatened with extinction** according to official lists.

It is important to highlight that the environmental study concluded that the project **will not affect the survival** of any species of bird in the region.

*Cliff flycatcher (Hirundinea ferruginea).*

*Researcher in observation activity.*

*Masked water tyrant (Fluvicola nengeta).*

*Masked water tyrant nest (Fluvicola nengeta).*

# Aquatic Communities

Aquatic communities (algae, microorganisms, bacteria and insects) are very important in the functioning processes of rivers, lakes, dams and wetlands.

Most rivers and streams in the project region are intermittent (dry), with their bed dry and exposed for several months during the year.

This characteristic determines radical and periodic changes in the composition and quantity of both plants and animals that inhabit this ecosystem.

With the arrival of the rains there is an accumulation of organic matter (mainly faeces of domestic animals) and solids (soil from erosive processes) in the beds of the smaller rivers, which are then taken to the larger ones by the current.

In this way, permanent rivers and also those regulated by dams become important recipients of this polluting load, as is the case for the Jenipapo dam.

The main aspect associated with aquatic communities that can harm public health is the development of cyanobacteria. In the study area, the Jenipapo dam, which had considerably high densities of the cyanobacterium *Cylindrospermopsis raciborskii*, deserves attention. These organisms can produce toxins in the water that cause problems to human and animal health.

Another important factor is the presence of organisms that can host diseases, such as mosquitoes, whose larvae were found in the Várzea and Itaquatiara creeks, and some mollusks (snails) related to parasites, found in the Várzea, Itaquatiara and Caraíbas creeks, and in the Jenipapo dam.

Thus, the local population that use these sources is vulnerable to water-related diseases, either through direct drinking of water or through contact activities, such as housework, personal hygiene, recreation, among others.

**This requires attention!**

*Jenipapo Dam (São João do Piauí)*

# Fish

During field surveys carried out at the project's ADI 46 species of fish were recorded. Even with the low diversity detected in the present study, the proportion between the different taxonomic groups does not differ from the expected pattern for the region.

It is worth mentioning that the presence of the Jenipapo dam without fish transposition mechanisms may be related to an impoverishment in the diversity of fish upstream.

Generally, intermittent rivers (which dry out) are recolonized each rainy season by fish that remain in the remaining environments from the previous year's rainy season (eg puddles), and by fish from perennial parts (that do not dry) downstream.

It is worth mentioning that the studied environment is already naturally altered, and most of the fish species that live there have a generalist habit.

In summary, this result was already expected since these animals live in an environment that is mostly intermittent, where the quantity and quality of water changes radically throughout the year.

**None of the registered species** is considered to be **threatened with extinction** according to official lists.

*Reservoir arm of Jenipapo (São João do Piauí)*

*Dry bed of the Itaquatiara creek.*

# Reptiles & Amphibians

During the field survey carried out, 14 species of amphibians and 19 species of reptiles were recorded, being 12 lizards, six snakes and one turtle.

**None of the** registered **amphibian and reptile species appears on the lists of endangered species**, however **species that were considered rare or of restricted distribution** were detected, such as the caatinga horned frog (*Ceratophrys joazeirensis*) and the lizards *Procellosaurinus erythrocercus*, among others.

It is important to highlight that the environmental study concluded that the **project will not affect the survival of any species** of reptile or amphibian in the region.

*Ceratophrys joazeirensis*

*Procellosaurinus erythrocercus*

# Insects

The insects survey covered only the main groups considered as vectors of diseases of interest to public health, that are, mosquitoes and bedbugs from the group of kissing bugs.

During the study, collection efforts were concentrated in the vicinity of the Nickel Mine area, the Limestone Mine and in the region planned to collect water from the Jenipapo Dam. In addition to these points, other collections were carried out near the roads and access roads, and in the municipality of Capitão Gervásio Oliveira.

Of the mosquitoes captured, five types of epidemiological importance were identified with the potential to cause disease and two causing discomfort due to their bite.

The study also revealed the presence of **two important species** of the insect "**kissing barber**" with high potential to settle in homes, which can transmit the **Chagas disease**.

However, at the time of the surveys, **none of the groups evaluated** were considered to be at **high risk** of causing problems on a large scale to the population surrounding the project.

Among the groups of insects and others like those that offers risks to humans, it is worth mentioning the presence in the region of beetles known as Potó that cause burns by contact, and the yellow scorpion that may cause problems when stinging children and the elderly.

*Collection of immature mosquitoes in a small dam with entomological shell.*

*Sampling of immature mosquitoes made at the breeding site*

*Female adult of Triatoma brasiliensis (kissing barber) collected during field research.*


# Socioeconomic and Cultural Environment

# Region History

The region where the municipalities considered as **Direct Area of Influence** of the Piaui Nickel Project are located has the origin of its occupation in the 17th century with the introduction of cattle farms.

The city of **São João do Piauí** had its origin in one of the cattle farms, donated by Domingos Afonso Mafrense, to the Jesuits based in Bahia, called Malhada do Jatobá, in 1711 (IBGE Cidades).

With an economy based on livestock activity at its origin, agriculture and extraction in the last two centuries, the municipality has been inhabited, since its colonial origins, mainly by Bahian and Pernambuco families (Sesmaria supporters, tenants and squatters) and, more recently, by countless families from Ceará affected by drought. In the 19th century (1871/72) São João became an emancipated and separate municipality from São Raimundo Nonato, becoming head of the district in 1874 and, finally, receiving the title of city in 1906.

The municipalities of **Dom Inocêncio, Campo Alegre do Fidalgo** and **Capitão Gervásio Oliveira** have more recent origins, such as the division of São Raimundo Nonato, in the first case, and of São João do Piauí in the other two municipalities, presenting, therefore, the same occupation history of the original municipalities.

*Municipality of São João do Piauí.*

*Municipality of Capitão Gervásio*

*Municipality of São João do Piauí.*

# Regional Context

The Piaui Nickel Project is located in the territories of Capitão Gervásio Oliveira, Dom Inocêncio, São João do Piauí, and Campo Alegre do Fidalgo in the southeastern portion of the state of Piauí close to the border with the states of Pernambuco and Bahia.

This region belongs to the Caatinga biome, with little rain, the high incidence of the sun and high temperatures, resulting in a semi-arid climate in which periods of drought usually cause great inconvenience to the population.

According to the territorial organization officially adopted by the government of the State of Piauí, the municipalities in the project's **Direct Area of Influence** are part of the **Serra da Capivara Development Territory**.

The territorial division established by IBGE incorporates the municipalities of the Alto Canindé Microregions (Capitão Gervásio Oliveira, Campo Alegre do Fidalgo, and São João do Piauí) and São Raimundo Nonato (Dom Inocêncio).

# Access

The region where the project is located has few access options, the road system being practically the only alternative, given the absence of rail lines and the low use of the airport located in the municipality of São Raimundo Nonato.

To reach the project's ADI from Teresina, the **BR-316** is used towards Picos, going until the junction with the **BR-230**. From the **BR-230**, head west to the city of Oeiras. In Oeiras, from the **PI-143**, travel south to the city of São João do Piauí (**BR-020**), following the state road **PI-465** to the city of Capitão Gervásio Oliveira (total lenght of 560 km).

From Petrolina, another route possibility, one must follow towards Picos, by the **BR-407**, until the city of Afrânio (PE). In Afrânio, take
the road on the left to Queimada Nova (PI), and from there, follow to Lagoa do Barro and then to Capitão Gervásio Oliveira (passing through Campo Alegre do Fidalgo). This route is about 243 km from Petrolina. Until São João do Piauí there is another 55 km through the state road **PI-465**.

The highway through Petrolina presents roads in good running conditions for almost the entire way, with paving in good condition and satisfactory horizontal and vertical signs.

The roads in the project region present the occurrence of animals as the main hazard, especially cattle, goats and donkeys, on the margins of highways and roads, representing a very relevant risk, since, in various situations, animals cross the roads or even walk along them.

*Animals on the BR-020 highway, near the city of Nova Santa Rita.*

*Donkey on the highway PI-465, near Campo Alegre do Fidalgo.*

# Population

The municipalities in the project's Direct Area of Influence (ADI) are characterized by small populations, with the municipality of São João do Piauí being the most populous.

**Total, Urban and Rural Population, Territorial Area and Demographic Density of the municipalities of the ADI and Piauí State.**

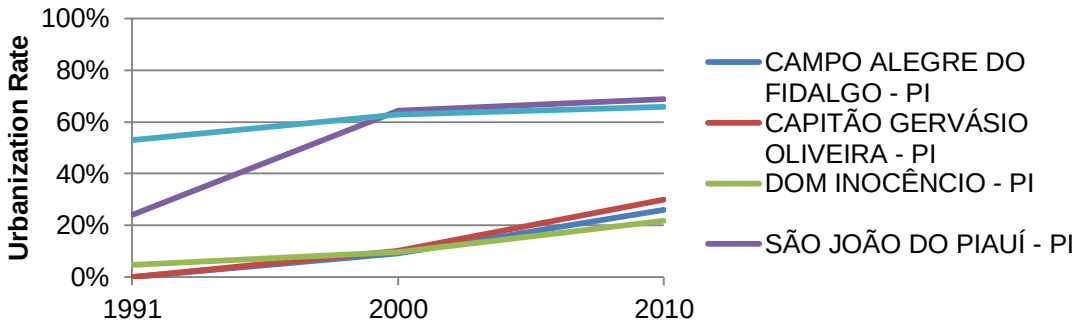
| Municipality | territorial extension (km²) | Total of Population | | Urban Population | Rural Population | Demographic Density (People/ km²) | |
|---|---|---|---|---|---|---|---|
| | | 2016 | 2010 | 2010 | 2010 | 2016 | 2010 |
| Campo Alegre do Fidalgo | 658 | 4,935 | 4,693 | 1,224 | 3,469 | 7.5 | 7.1 |
| Capitão Gervásio Oliveira | 1,134 | 4,021 | 3,878 | 1,162 | 2,716 | 3.5 | 3.4 |
| Dom Inocêncio | 3,870 | 9,396 | 9,245 | 2,018 | 7,227 | 2.4 | 2.4 |
| São João do Piauí | 1,528 | 20,206 | 19,548 | 13,470 | 6,078 | 13.2 | 12.8 |
| Piauí State | 251,612 | 3,212,180 | 3,118,360 | 2,051,074 | 1,067,286 | 12.8 | 12.4 |

*Fonte: Brazilian National Institute of Statistics (IBGE), 2010 e 2016. Organized by: Arcadis, 2016.*

With the exception of São João do Piauí, which has just under 70% of its urban population, ADI municipalities had urbanization rates well below the average for the state of Piauí.

In 2010, the average urbanization rate for the state of Piauí was 65.8%, while the urbanization rate of ADI municipalities varied between 20 and 30% of the population.

**Evolution of the Urbanization Rate of the Municipalities of ADI and Piauí State from 1991 to 2010.**




*Fonte: Brazilian National Institute of Statistics (IBGE), 2010 e 2016. Organized by: Arcadis, 2016.*

As for the population composition of the ADI, there is a predominance of the young population, that is, most people are between 5 and 19 years of age (IBGE, 2010). Although it has a relatively young population, evaluating the variation between the years 2000 and 2010, it can be seen that the municipalities of the ADI and the state of Piauí showed a very similar evolution, with a growing trend for the adult and elderly population.

Regarding the division by sex the smaller municipalities of Campo Alegre do Fidalgo, Capitão Gervásio Oliveira and Dom Inocêncio present a slight predominance of the male population up to 70 years old, whereas for older than 70 the situation is reversed with the female population being the majority in these municipalities. In São João do Piauí and in the state of Piauí the situation is different, with the female population being the majority in almost all age groups (IBGE, 2010).

# Economy

According to the survey carried out by **IBGE**, in **2013** the economies of the municipalities of the **ADI** presented three different levels with Campo Alegre do Fidalgo and Capitão Gervásio Oliveira presenting GDPs (**Gross Domestic Product**) of **R$ 27.7 million** and **R$ 25.4 million**, respectively; Dom Inocêncio showing higher values, composing a GDP of **R$ 44 million**; and São João do Piauí in turn presented a more thriving economy, which translated into a GDP of **R$ 172 million**.

However, the municipalities of the ADI have little representation in the economy of the state of Piauí, since Campo Alegre do Fidalgo, Capitão Gervásio Oliveira and Dom Inocêncio contribute only **0.1%** to the state's GDP.

São João do Piauí also has a small contribution to the total production of the state (even with a more dynamic and larger economy than the others), contributing **0.5%** of the State's GDP.

### Did you know?

Added Value (VA) is the value that different activities add to the goods and services consumed in their production process. Thus, through the VA, one can analyze the performance of each productive sector in the economy.

### Did you know?

The Gross Domestic Product (GDP) represents the sum of everything that is produced. In other words, it is a way of measuring the economic activity of a region, municipality, state or country.

In the municipalities Campo Alegre do Fidalgo, Capitão Gervásio Oliveira and Dom Inocêncio the dependence of the public administration sector is expressed by the great weight of this sector in the **Added Value (VA)** of their economies, which jumped from about 60% in 2003 to more than 70% % in 2013.

In the same period there was also an increase in the participation of the services sector, especially in Campo Alegre do Fidalgo and Capitão Gervásio Oliveira, where the sector almost doubled its weight in the VA. It is worth noting that in several cases this increase in the service sector occurs as a complement to the growth of public administration.

In São João do Piauí although public administration is also the sector with the highest weight in the VA, it has less economic importance considering in 2013 it represented 46% of the total VA, practically the same weight as the service sector that contributed 45% of the VA. It is important to highlight that the service sector, especially commerce, in São João do Piauí is a reference for neighboring municipalities.

# Public Finances

The analysis of public finances is very important, as it helps to understand municipal socioeconomic realities. This indicator points to the level of spending that the municipalities are able to practice, according to their budget revenue, which considers the multiple sources of available resources; and it also allows evaluation of its order of magnitude and distribution.

The municipality of São João do Piauí, due to its larger population and economic size, presented the highest budget revenue among the municipalities of the ADI, **R$ 38.9 million**, which positioned it as the 27th revenue among municipalities in the state of Piauí. The other municipalities of the ADI have smaller sizes, with revenues of **R$ 13.2 million** in Campo Alegre do Fidalgo, **R$ 11.3 million** in Capitão Gervásio Oliveira and **R$ 18.6 million** in Dom Inocêncio.

With regard to tax revenues, it can be seen that the municipalities of the ADI in 2015 present a very low collection capacity. In this respect, Campo Alegre do Fidalgo stood out among the municipalities of the ADI with **3.3%** of its revenues coming from its own collection, a percentage only below that of São João do Piauí (**5.2%**).

With regard to the main items of federal transfers, there is the Municipality Participation Fund (FPM), which final value to be destined to each municipality is mainly affected and determined by its population size. This transfer represented the largest source for the municipalities of the ADI, being **29.3%** in São João do Piauí, **32.4%** in Dom Inocêncio, **43.2%** in Campo Alegre do Fidalgo and **53.2%** in Capitão Gervásio Oliveira .

**Did you know?**

Municipal budget revenue is formed of two main components: i) the first is tax revenue, comprising by municipal taxes and fees; ii) the second consists of a set of transfers from other spheres of government, that is, federal and state.

# Jobs and Income

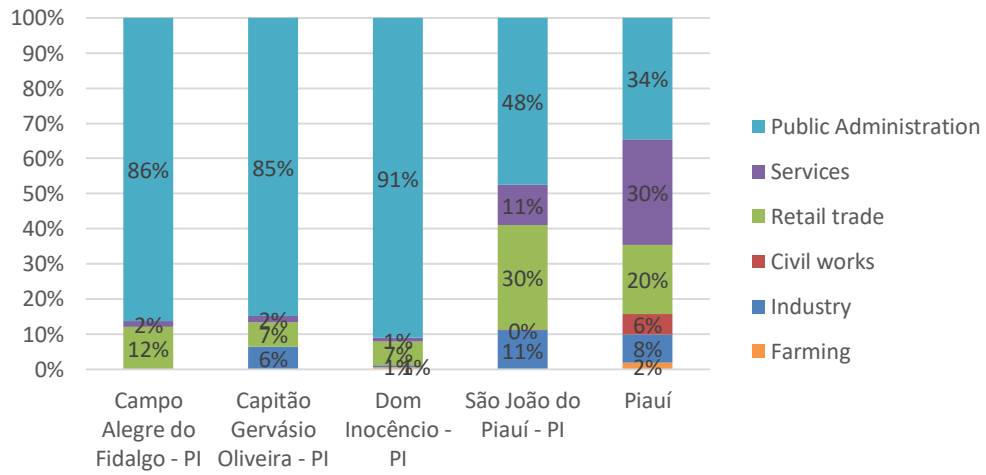
Formal jobs, or employment relationships, are the employment relationships established whenever paid work occurs. Formal employment relationships are considered to be the employment relationships of workers hired according to the CLT (Brazilian Consolidation of Labour Laws), statutory workers, workers governed by temporary contracts, for a fixed term, and individual employees, when hired by unions (IBGE, 2010).

In **2015** the job formality rate was **22%** in Campo Alegre do Fidalgo, **18%** in Capitão Gervásio Oliveira and São João do Piauí and only **9%** in Dom Inocêncio, all well below the average **37%** for the State of Piauí.

In regards to the agricultural sector in the municipalities of the ADI, it was observed a total degree of informality in the working relations in the year 2015 (no formally employed workers).

The graph below shows the distribution of formal jobs in the ADI, in the major sectors of the economy.

**Formal Employment by Major Sectors - Municipalities of the ADI and Piauí State- 2015.**




*Fonte: National Labour Departament (MTE), 2016. Organized: Arcadis, 2016.*

Regarding the average monthly income (**wages**) of formal workers in the municipalities of the ADI, in 2015, the average values recorded ranged between **R$ 1,453** (São João do Piauí) and **R$ 1,898** (Campo Alegre do Fidalgo ). These average income values are below the average for the state of Piauí, which in 2015 was **R$ 1,952**.

# Education

In the municipalities of the ADI there was a reduction in the illiteracy rate between 1991 and 2010 in all age groups, following the trend in the state of Piauí.

Illiteracy rates presented a bigger reduction in the 15 to 17 age group. It is in this age group that the lowest illiteracy rate is found, being, in 2010, just over **4%** in the municipalities of the ADI, with the exception of **Dom Inocêncio** who presented an even lower index of **1.5%**.

Another important fact about education in these municipalities is the level of education of the population, since it influences different social and economic aspects, like the level of knowledge of rights and duties as citizens and work productivity.

In 2010 in the municipalities of Campo Alegre do Fidalgo, Capitão Gervásio Oliveira, and Dom Inocêncio less than **30%** of the population completed one of the education levels. In São João do Piauí this number is more than double (**65%)**, although still slightly below the average for the state of Piauí, which was 67%.

According to data from 2015 (IBGE), the municipalities of the ADI had schools in the three levels of basic education (pre-school, elementary and high school), so students from the municipalities do not need to travel to others in search of care at these levels.

With regard to the number of teachers, it is observed that between 2005 and 2015, according to data from IBGE, the ratio of students to each teacher was reduced in all the ADI municipalities, that is, better teaching conditions with fewer students per teacher. The exception is pre-school education in **Capitão Gervásio Oliveira**, which showed a worsening in the student / teacher ratio in the analyzed period.

According to information from the Secretaries of Education of the municipalities of the ADI, collected in fieldwork (2016), school transportation is offered to students who live far from schools, satisfying all the demand, even in rural areas of the municipalities. However, it was noted that students from more distant areas spend a lot of time in commuting which ends up hampering the students' learning process.

Also according to the secretaries' report, the municipalities of Campo Alegre do Fidalgo and Dom Inocêncio have technical education offered by the state government.

The municipality of São João do Piauí, as a local hub, has in its territory a campus of the Federal Institute of Piauí - IFPI that also offers technical level courses.

*IFPI campus at São João do Piauí.*

# Health

The municipalities of Campo Alegre do Fidalgo, Capitão Gervásio Oliveira and Dom Inocêncio, have a very weak service network with only **primary care or emergency services**, according to data from the Ministry of Health (2016). In these municipalities, all health equipment available to the population is public.

In São João do Piauí, given the size of the municipality, the service network is broader, making it the center of first reference for municipalities in the region, including Campo Alegre do Fidalgo and Capitão Gervásio Oliveira.

Among the structure present in the municipality, we highlight the existence of a regional hospital, which is run by the state government, of a maternity hospital, which, although it is a municipal hospital, is also a regional reference, of a dental service center, and of two units of the Mobile Emergency Service - SAMU.

In this municipality, in addition to the public assistance structures, there are also some private initiative equipment (doctor's offices, diagnostic unit and specialized clinic).

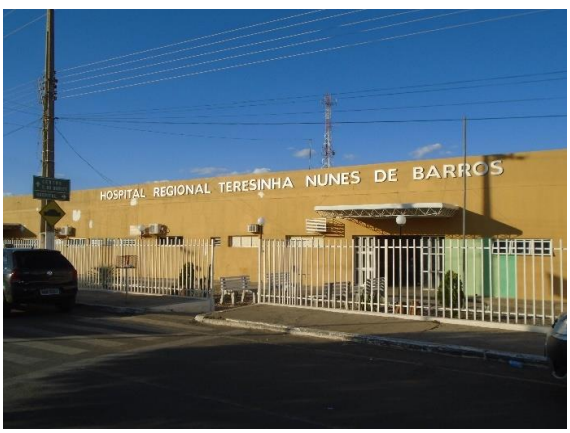
Analyzing the number of health centers / basic health units, according to data from the Ministry of Health (2016), present in the municipalities of the ADI in relation to their respective populations, there is an adequate service as recommended by the Ministry of Health (2012), of having a family health UBS (first aid medical center) for up to 12,000 inhabitants in urban centers.

However, according to SUS's assistance parameters, which characterizes as a reference for the good medical care of the population being one doctor for every 1,000 inhabitants, it is observed that in the municipalities of the ADI the number of doctors is much lower than recommended, being the worst situation in Campo Alegre do Fidalgo, where according to the data there is only one doctor to serve the entire population.

With regard to preventive health, one of the main strategies adopted by SUS is related to the Family Health Program - FHP, which aims at a more dynamic and closer service to the population.

In the municipalities of Dom Inocêncio and São João do Piauí, according to the report of the respective Secretaries of Health, during fieldwork carried out in 2016, the FHP is successful with a sufficient number of teams serving both urban and rural areas.

In turn, in the municipality of Capitão Gervásio Oliveira, according to the report of the Secretaries interviewed, the FHP has only two teams, which is insufficient to serve the entire population, especially due to the large proportion of rural areas.




*Regional Hospital in São João do Piauí.*

# Basic Sanitation Infrastructure

## Sewer

According to data from IBGE (2010), only **4%** of the households of Capitão Gervásio Oliveira and São João do Piauí, and **5%** in Dom Inocêncio, **have an adequate sewage network**, since they are discarded through septic tanks that avoid contamination of soil and groundwater. In Campo Alegre do Fidalgo, this modality was identified in only two households, which is practically zero.

Thus, it appears that practically all sewage from the DIA households is improperly disposed. In the DIA municipalities, the use of **rudimentary pits** as a control system predominates, especially in urban areas, **46%** in Campo Alegre do Fidalgo, **40%** in Capitão Gervásio Oliveira and Dom Inocêncio, and **74%** in São João do Piauí. In rural areas, disposal in **ditches and streams** is more prevalent, and **many households are without access to bathrooms or toilets**.

## Water Supply

Water supply services are very poor for the households in the municipalities of the ADI, with the exception of São João do Piauí, where **78%** of households are supplied via the general network (IBGE, 2010).

In the other municipalities the situation is different, since the general network supplies only **27%** of households in Campo Alegre do Fidalgo, **34%** in Capitão Gervásio Oliveira, and **12%** in Dom Inocêncio.

In these municipalities, most households are supplied by wells and water trucks.

It is important to highlight that even where there is a water supply service through the general network, according to residents heard in the field survey interviews, the population suffers from problems, and there is a routine **lack of water** for supply.

## Garbage Collection

The households in the municipalities of the ADI, according to IBGE data (2010), have a low percentage of garbage collection, **26%** in Campo Alegre do Fidalgo, **31%** in Capitão Gervásio Oliveira, **22%** in Dom Inocêncio, and **66%** in São João do Piauí.

The **rural areas** practically don´t have any garbage collection services available, where about **70 to 80%** of households **have their waste burned within the properties**, the rest being disposed of in other inappropriate ways (buried, thrown in wasteland, thrown into the river ).

## Eletricity Supply

According to data from the 2010 Census, the municipalities of the ADI, with the exception of São João do Piauí, had a **high rate of households without electricity coverage**, **32%** in Campo Alegre do Fidalgo, **54%** in Capitão Gervásio Oliveira and **55%** in Dom Inocêncio, all well above the state average, which is only 6.9%. **São João do Piauí** in turn has a much lower index of only **4.1%**.

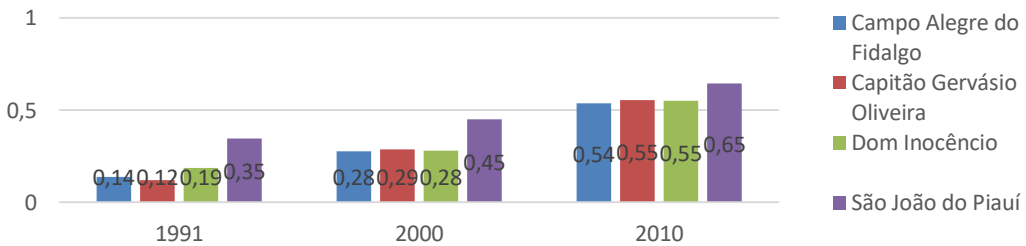
## Public Security

In Capitão Gervásio Oliveira and Dom Inocêncio it was reported that the number of police officers is small, as well as the number and adequacy of the vehicles they use (only one in each municipality), considering the rural characteristics of the municipalities. Dom Inocêncio also reported problems with theft and robbery. In São João do Piauí, the secretariat interviewed reported there were no significant problems, thefts being the main types of crimes in the municipality.

## Life Condition

The indicator used to assess the quality of life of the population of the ADI was the Municipal Human Development Index (MHDI).

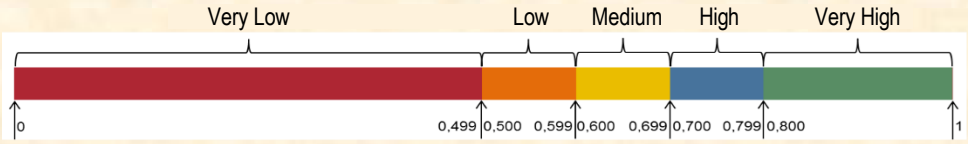
**Municipal Human Development Index (MHDI) in the Municipalities of the ADI, 1991-2010.**




*Fonte: Atlas of Human Development in Brazil 2013 – PNUD, IPEA e FJP. Organized: Arcadis, 2016.*

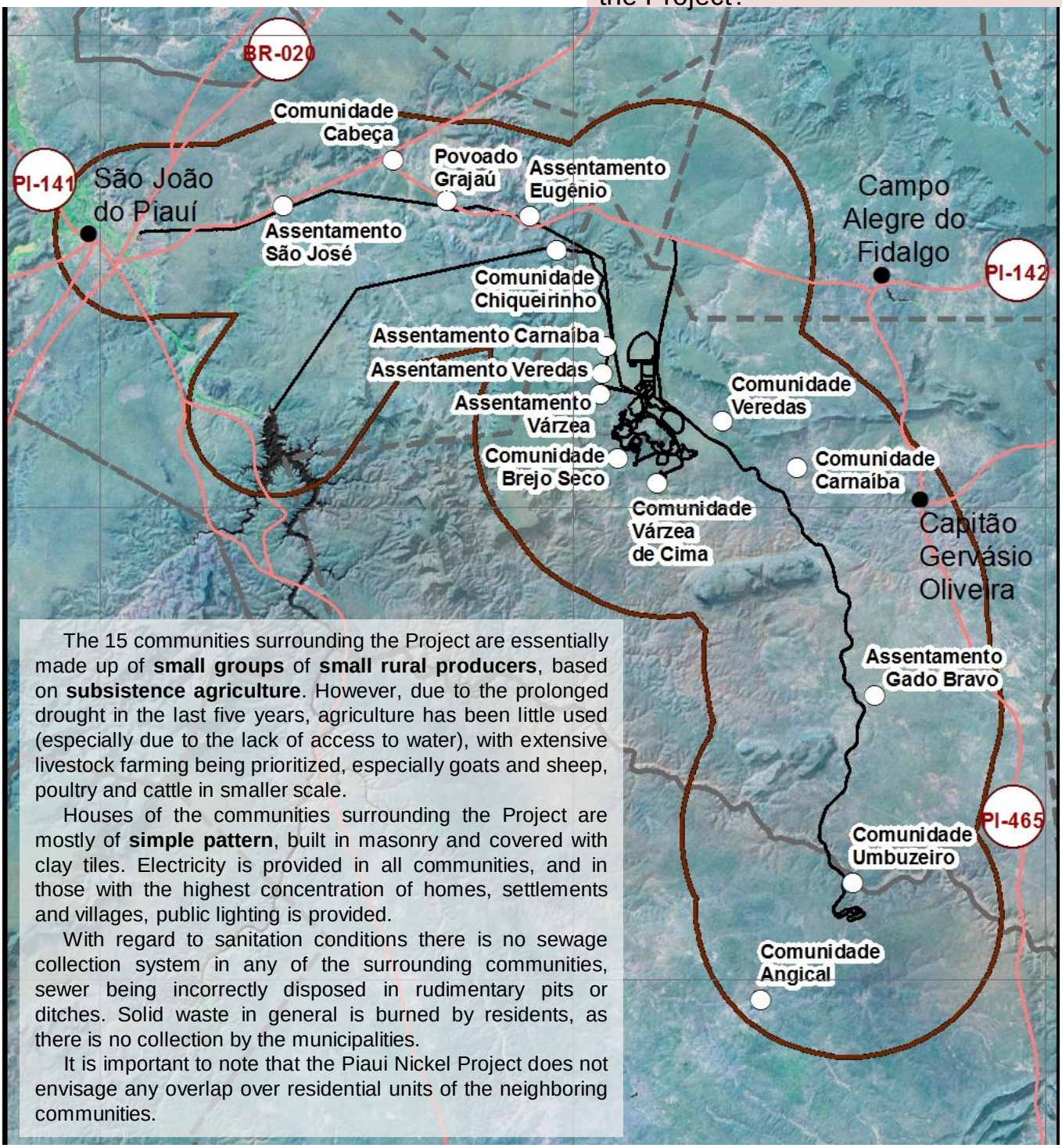
The main component responsible for the evolution of the MHDI in the municipalities was Education, which in the studied period (1991 to 2010) had a significant improvement. However, despite this evolution, the municipalities mentioned are still at a very low level of development with regard to the Education component.

The **HDI** was created by the **United Nations Development Programme (UNDP)** in 1990 with the aim of classifying human development in different countries. Regarding the evaluation of Brazilian municipalities, the UNDP, the Institute of Applied Economic Research (IPEA) and the João Pinheiro Foundation (FJP) adapted the global HDI methodology to the Brazilian context and considering the availability of national indicators, which resulted in the **MHDI**, based on the variables of longevity, education and income. The MHDI considers a numerical range from 0 (zero) to 1 (one), and the closer to 1, the better the population's quality of life is, as shown in the figure below.



# Surrounding communities

What are the closest communities to the Project?




The 15 communities surrounding the Project are essentially made up of **small groups** of **small rural producers**, based on **subsistence agriculture**. However, due to the prolonged drought in the last five years, agriculture has been little used (especially due to the lack of access to water), with extensive livestock farming being prioritized, especially goats and sheep, poultry and cattle in smaller scale.

Houses of the communities surrounding the Project are mostly of **simple pattern**, built in masonry and covered with clay tiles. Electricity is provided in all communities, and in those with the highest concentration of homes, settlements and villages, public lighting is provided.

With regard to sanitation conditions there is no sewage collection system in any of the surrounding communities, sewer being incorrectly disposed in rudimentary pits or ditches. Solid waste in general is burned by residents, as there is no collection by the municipalities.

It is important to note that the Piaui Nickel Project does not envisage any overlap over residential units of the neighboring communities.

*Residences in the Carnaíba settlement in Capitão Gervásio Oliveira.*

*Interview with the president of the Carnaíba Settlement Association in Capitão Gervásio Oliveira.*

*Residence in the Angical community in Dom Inocêncio.*


*Municipal school of the Angical community in Dom Inocêncio.*

*Interview with residents of the Veredas settlement in Capitão Gervásio Oliveira.*


*Headquarters of the Residents of the Eugenio settlement Association in São João do Piauí.*

# Environmental Perception Survey

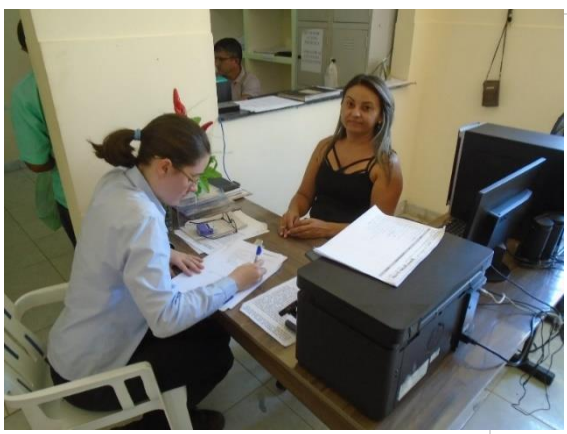
Environmental perception is a survey conducted with the aim of verifying how social actors see, judge and qualify the environment in the region where they live; how do they relate to environmental issues and what are their impressions of the project's implementation and operation forecast. To carry out the research, questionnaires were applied with questions on these themes. The social actors considered in this research were representatives of public institutions and social organizations and also the residents of the communities surrounding the project.

Regarding the region, most respondents consider the region to be good. The main problems pointed out refer to the lack of basic sanitation services, few options for leisure and culture and public safety. Positive aspects were highlighted, such as the tranquility of the place, the welcoming population and the quality of the lands (fertile).

About the enterprise, the survey showed that the Piauí Nickel Project is well known in the region, with over 90% of respondents reporting having some kind of knowledge about it.

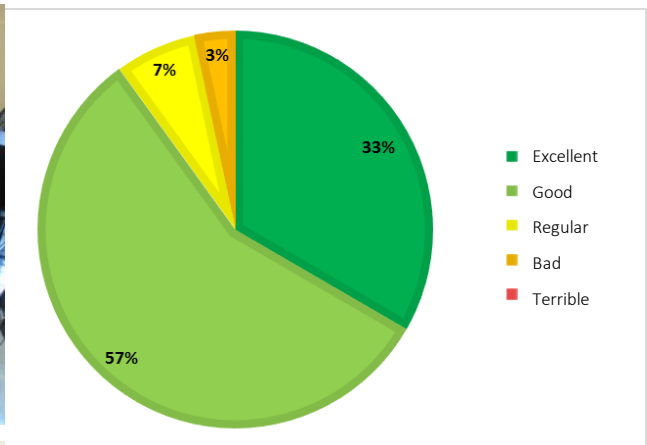
Approximately **90% of the interviewees considered the implementation of the project to be "good" or "excellent"**.

The **positive aspects mentioned** in the interviews as an expected result of the installation of the enterprise in the region are related to the **generation of jobs**. As possible **negative aspects**, **environmental degradation** was mentioned, especially related to deforestation.



*Interview conducted at the Union of Rural Workers of the Municipality of Dom Inocêncio.*

**Evaluation on the Possibility of Implementation of the Piaui Nickel Project.**




*Elaboration: Arcadis, 2016.*

# Cultural and Archaeological Heritage

The archaeological heritage studies related to the environmental permitting process for the Piaui Nickel Project were initiated in 2008 when the project was still owned by Vale do Rio Doce Company, with archaeological surveys carried out by the Museum of American Man Foundation (FUMDHAM), which carried out archaeological prospecting and rescue throughout the entire project's area of influence.

With the resumption of the project by Piauí Níquel Metais S/A, FUMDHAM was then again hired to carry out a survey to update the situation of the archaeological sites identified and rescued in 2008, and prepared a technical report that was submitted for evaluation by the National Historical and Artistic Heritage Institute (IPHAN). Thus, the project has already complied with the legal requirements in relation to the studies and actions necessary to ensure the preservation of archaeological heritage, awaiting formal acceptance from the competent body (IPHAN).

### Did you know?

What is archeology? Archeology is a science that seeks to unravel the history of man through time, relying on material remaining from the past. Rather than relying solely on documents, archeology seeks to base itself on evidence left over from the past, such as pots, work tools, house scraps, altered land for planting, housing, mining, etc.

Let's get to know the archaeological occurrences and sites identified and already rescued in the study area?

*Archaeological site survey (I2). Source: FUMDHAM, 2008.*

*Lytic material (L1 site). Source: FUMDHAM, 2008.*

*Lytic material (I2 site). Source: FUMDHAM, 2008.*

*Survey in archaeological site (L1), shelter without paintings. Source: FUMDHAM, 2008.*

*Survey carried out in 2016. Source: FUMDHAM, 2016.*

*Survey carried out in 2016. Source: FUMDHAM, 2016.*

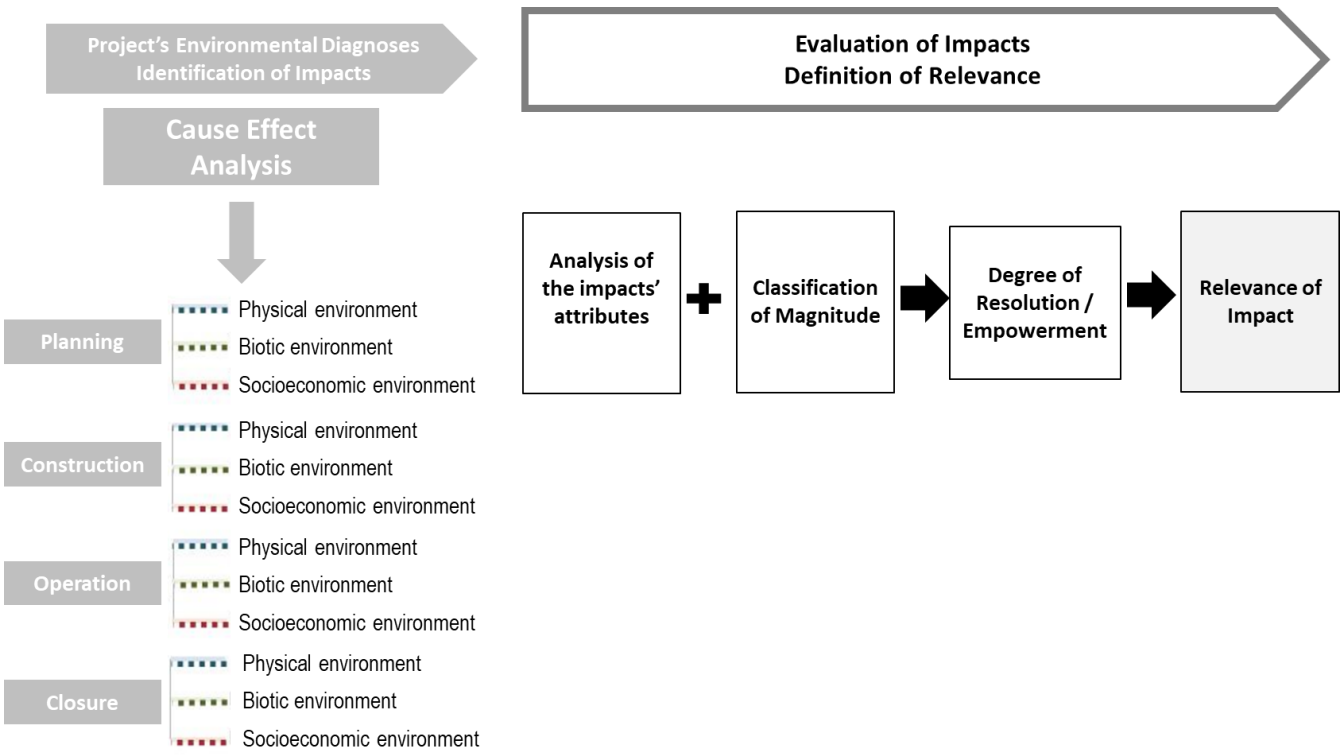
# Impacts Assessment

## What are socio-environmental impacts?

Socio-environmental impacts are the changes, good and bad, that the Project's implementation can cause in its areas of influence considering the existing conditions in the physical, biotic and socioeconomic environments of the region, surveyed by the Environmental Assessment.

The environmental legislation determines the identification of impacts in the various phases of the project: planning (to define where and how the project will be), installation (construction of the project), operation (period when the project will be operating) and closure (when the project no longer produces and its activities cease).

**Synthesis of the Environmental Impact Assessment Methodology**



How are the assessed impacts distributed among the environments and phases of the Project?

## Physical Environment

Low Relevance Negative Nature 15 | Medium Relevance Negative Nature 7 | Total 22

| Phase | Impact | Nature | Relevance Degree |
|---|---|---|---|
| Construction | Deterioration of Soil and Groundwater Quality - Due to the presence of contaminating substances | N | M |
| | Soil Degradation - Due to the generation of surplus materials and promotion of erosion processes | N | L |
| | Deterioration of Air Quality - Due to the resuspension of particulates and the emission of air pollutants | N | M |
| | Degradation of Speleological Heritage - Due to the modification of the original topography and other related aspects | N | L |
| | Deterioration of Surface Water Quality and Silting of the Drainage Network - Due to the generation and transport of sediments | N | L |
| | Deterioration of Surface Water Quality by Effluents and Solid Waste - Due to the generation of liquid and oily effluents and solid waste | N | L |
| | Alteration of the Water Network Configuration - Due to the implementation of project structures | N | L |
| | Environmental Discomfort - Sound Overpressure - Due to mobile and fixed equipment | N | L |
| Operation | Environmental Discomfort - Topographic Change - Due to the change in the original land topography | N | M |
| | Deterioration of Soil and Groundwater Quality - Due to the deposition of dry tailings and ore processing, and the presence of contaminating substances | N | M |
| | Deterioration of Air Quality - Due to the resuspension of particulates and the emission of air pollutants | N | M |
| | Change in Underground Water Availability - Due to the collection of groundwater for the implementation of the project and the lowering of the water table in the Umbuzeiro area. | N | M |
| | Environmental Discomfort - Vibration Level - Due to the vibration level generated by the rock dismantling by explosives | N | M |
| | Environmental Discomfort - Acoustic Overpressure - Due to mobile and fixed equipment | N | L |
| | Soil Degradation - Due to the generation of surplus materials and promotion of erosion processes | N | L |
| | Deterioration of Surface Water Quality and Silting of the Drainage Network - Due to the generation and transport of sediments | N | L |
| | Deterioration of Surface Water Quality by Effluents and Solid Waste - Due to the generation of liquid and oily effluents and solid waste | N | L |
| | Alteration of Surface Water Availability - Due to water consumption | N | L |
| Closure | Soil degradation - Due to the onset of surface dynamic processes | N | L |
| | Deterioration of Air Quality - Due to the resuspension of particulates and the emission of air pollutants | N | L |
| | Deterioration of Soil and Groundwater Quality - Due to the presence of contaminating substances | N | L |
| | Deterioration of Surface Water Quality and Silting of the Drainage Network - Due to the generation and transport of sediments | N | L |

## Biotic Environment

Low Relevance Negative Nature 8 | Medium Relevance Negative Nature 1 | Total 9

| Phase | Impact | Nature | Relevance Degree |
|---|---|---|---|
| Construction | Loss of habitats | N | L |
| | Loss of specimens from the native flora | N | L |
| | Dispersion and loss of terrestrial fauna specimens | N | L |
| | Deterioration of the quality of aquatic habitats - Due to the generation and transport of sediments | N | L |
| | Deterioration of the quality of aquatic habitats - Due to the generation of liquid and oily effluents and solid waste | N | L |
| Operation | Deterioration of the quality of aquatic habitats - Due to the generation and transport of sediments | N | L |
| | Deterioration of the quality of aquatic habitats - Due to the generation of liquid and oily effluents and solid waste | N | L |
| | Loss and disturbance of fauna | N | M |
| Closure | Deterioration of the quality of aquatic habitats - Due to the generation and transport of sediments | N | L |

## Socioeconomic Environment

Low Relevance Negative Nature 3 | Medium Relevance Negative Nature 6 | High Relevance Negative Nature 4

Low Relevance Positive Nature 1 | High Relevance Positive Nature 5

Total 19

| Phase | Impact | Nature | Relevance Degree |
|---|---|---|---|
| Planning | Creation of Positive Expectations | P | L |
| | Creation of Negative Expectations | N | L |
| Construction | Increase in economic activity | P | H |
| | Increase in the demand for housing and prices' elevation | N | M |
| | Increase in the demand for public services | N | H |
| | Increase in prostitution / sexual exploitation | N | H |
| | Increase in government budget revenues | P | H |
| | Increase in social conflicts | N | M |
| | Increase in discomfort to the population | N | H |
| | Increase in the number of employed workers and the population's income | P | H |
| | Decrease in jobs, income and economic activity (demobilization) | N | M |
| | Increase in the incidence of diseases (by vectors, endemic, STD / AIDs, cardiovascular, respiratory, etc.) | N | M |
| | Loss of productive areas (farming) | N | L |
| Operation | Increase in jobs, income and economic activity | P | H |
| | Increase in government budget revenues | P | H |
| | Increase in discomfort to the population | N | M |
| Closure | Increase in discomfort to the population | N | L |
| | Decrease in jobs, income and economic activity | N | M |
| | Reduction of Government Budget Revenues | N | H |

# Socio-Environmental Programs

## What are socio-environmental programs?

The socio-environmental programs are actions and measures proposed in the Environmental and Social Impact Study to **enhance the positive effects** and **minimize the negative effects** of the implementation of the Piaui Nickel Project.

Below are the **21 programs** proposed in this study (and their objectives):

- Environmental Management Program (*coordinate the execution of all the programs*)
- Solid Waste Management Program (*ensure correct disposal of waste*)
- Prevention and Control of Erosion Processes and Water Bodies Sedimentation Program (*prevent, monitor and correct erosions*)
- Air Quality Monitoring Program (*ensure good quality*)
- Noise and Vibration Monitoring Program (*ensure good quality*)
- Effluent Monitoring Program (*ensuring good quality*)
- Surface Water Quality Monitoring Program (*ensure good quality*)
- Groundwater Monitoring Program (*ensure good quality and quantity*)
- Flora Suppression and Rescue Control Program (*ensure correct vegetation clearing*)
- Fauna Chase Away and Management Program (*minimize damage and being run over*)
- Degraded Areas Recovery Program - PRAD (*recover areas*)
- Compensation for intervention in APPs Program (recover APPs)
- Social Communication Program - SCP *(ensure continuous, transparent and two-way communication with all stakeholders*)
- Workforce Management Program (*train and value the workforce*)
- Local Suppliers Development Program (*encourage and train local suppliers*)
- Environmental Education Program – EEP (*disseminate and educate*)
- Public Services' Interference Monitoring and Support Program (*offer support*)
- Land Negotiation Program (*ensure fair negotiations*)
- Self-Sustainable Development Program for Local Communities (*empower communities in other activities when mining is coming to an end*)
- Environmental Compensation Program (*allocate financial resources to the Serra da Capivara National Park*)
- Preliminary Mines Closure Plan (*plan and ensure actions to properly end the project*)

# Final Considerations

This Environmental and Social Impact Study presents and analyzes the main characteristics and the environmental and socioeconomic dynamics of the area where the Piaui Nickel Project is located, aiming to identify and evaluate the impacts that may be caused by its implementation, in order to establish the conditions so the implementation and operation of this project achieves its socio-environmental feasibility.

This project aims to mine and process nickel lateritic ore for the production of Nickel Hydroxide Product (NHP) and another Cobalt product, thus exploring the Nickel and Limestone deposits existing in the DNPM processes nº 804.290/70 and 803.144/2002, respectively, consisting of 5 main structures that will be implemented and will operate in an integrated manner, namely: Nickel Mine and Industrial Plant (Brejo Seco Complex), 69kV Power Line, Water Supply (Jenipapo Dam), Limestone Mine (Umbuzeiro) and Access Roads.

The final design of these structures went through a study of locational and technological alternatives in order to allow their implementation and operation with the best cost/benefit ratio and with the least possible socio-environmental impacts.

The assessment of the physical and biotic environments did not indicate the presence of any particular and/or restrictive aspect for the implementation of the project, so that it does not present the risk of making the survival of any species of flora and fauna unviable, nor to those considered as endangered that may have been (or may still be) found in the project's areas of influence.

From a socioeconomic and cultural point of view, the installation and operation of the mining company will offer conditions for attracting labor and generating jobs, income, services and tax collection, but also for pressuring the public services in local municipalities, which already are deficient (basic sanitation, water and health). According to the assessment of the consulting team, it is in the socioeconomic environment that the most sensitive issues of the project reside.

However, according to the analysis carried out, measures to prevent, control, monitor, correct or even compensate all negative impacts of the project were presented, which even go beyond the current legal obligations. These actions, in addition to others to enhance the expected positive impacts, are organized in the 21 socio-environmental programs presented and which will be initiated in the implementation phase of the project.

In summary, considering the absence of prohibitive factors related to the physical, biotic, socioeconomic and cultural resources existing within the future project areas, and provided all the mitigating, compensatory and monitoring measures proposed here are put into place, the consulting team concludes that the **Piaui Nickel Project** seeks for **sustainable development**, and therefore its implementation **presents socio-environmental feasibility**.

## Technical Team

| Member | Graduation | Performance | Prof. Council |
|---|---|---|---|
| **Technical Responsibility, Management and Coordination - 2017** | | | |
| Karin Marangoni Ferrara Formigoni | Architect and Urban Planner | Management / Technical Responsibility | CAU: A24660-3 |
| Edison Pires | Civil Engineer | Management / Technical Responsibility | CREA-SP: 5060377261 |
| Denise Tonello | Architect and Urban Planner | Management | CAU: 376949 |
| Sueli Kakinami | Biologist | Management | CRBio: 14.450/01-D |
| Camila Corrêa Ramos | Economist / Sociologist | General Coordination | CORECON SP: 32275 |
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| Pedro Paulo Gonçalves Barbiere | Geographer | Physical Environment Coordination | CREA-SP: 5063308082 |
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| **Specialists - Physical Environment - 2008** | | | |
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| Maria Madalena Los | Biologist | Biotic Environment Coordination | CRBio: 04266-01 |
| Norberto Lopes Hulle | Biologist | Mammals/Birds/ Reptiles&Anphibians | CRBio: 51663/01-D |
| Patrícia Beloto Bertola | Veterinarian | Mammals/Birds/ Reptiles&Anphibians | CRMV-SP: 14568 |
| Cristiano Moreira | Biologist | Fish | CRBio: 29559/02 |
| Délsio Natal | Biologist | Insects | --- |
| Almério de Castro Gomes | Biologist | Insects | --- |
| Artur Macarrão | Biologist | Birds | CRBio: 56530/01-P |
| Mariana B. O. Dixo | Biologist | Reptiles&Anphibians | CRBio: 33455/01D |
| **Specialists - Socioeconomic Environment - 2017** | | | |
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| Fernando A. Soltys | Historian / Archaeologist | Cultural and Archaeological Heritage | --- |
| Vinícius Feres Durante | Historian | Cultural and Archaeological Heritage | --- |
| **Specialists - Socioeconomic Environment - 2008** | | | |
| Luis Biazzi | Economist | Socioeconomic Environment Coordination | CORECON-SP 19435-2 |
| Maria de Fátima de Andrade | Economist | Socioeconomic Environment | |
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| Jamille Santos Conceição | Geography Student | General Support (2017) | --- |
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