THE TOWNHALL OF SALVADOR

SPECIAL PROJECTS COORDINATION - CPE

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AND ENVIRONMENTAL IMPACT REPORT (RIMA) FOR THE IMPLEMENTATION OF AN INTEGRATED TRANSPORTATION SYSTEM - THE SALVADOR METRO.
METRO SYSTEM
GENERAL LOCALIZATION
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1. PRESENTATION

HIGESA Ingeniería presents in this document an overview of the Environmental Impact Assessment on the Integrated Transportation System of Salvador - the Salvador Metro, on its first phase of implementation, the Lapa-Pirajá line.

The Environmental Impact Assessment (EIA) aims to respond to the specific Terms of Reference developed and approved by the CRA - Environmental Resource Center of the State of Bahia and CEPRAM - the State Environment Council, in accordance also with the Federal Law which governs such matters, in a similar way.

2. OBJECTIVES

The Environmental Impact Assessment was carried out with the objective of conducting a wide range assessment of the possible environmental impacts resulted from the construction and operation of the Integrated Transportation System of Salvador - the Salvador Metro. There are four objectives to it:

- to describe the system, detailing the major infrastructure and activities involved in its construction and operation which have significant potential environmental implications;
- to predict, describe and evaluate the potential positive and negative environmental impacts arising from the construction and operation of the project;
- to identify practical and cost effective measures which could be employed during the implementation and operation stages of the project in order to remove or mitigate the adverse impacts;
- to identify and define plans and programs for monitoring and auditing requirements which could ensure that impacts are kept within acceptable limits during the implementation and operation of the project.

3. LEGAL BASELINE

In addition to responding to a basic requirement from the Environmental Impact Assessment (EIA) and its respective Environmental Impact Report (RIMA), referred to previously, these studies are based upon guidelines and specific legislative standards of which the several segments are part.

Federal, state and municipal legislative standards for protection of river springs, native woods, appropriation of private properties due to social interest have been surveyed.

Water, air and noise pollution are topics governed by specific legislative standards both at federal and state levels based on international guidelines which are usually internationally adopted, with the possibility of being implemented for the improvement of the environment as a whole, thus increasing the quality of life of the population.

Unfortunately, at municipal level, there is no legal baseline that may be compared to the federal and state instances, except for the present legislative standards for noise pollution, within city limits.

4. METHODOLOGY

Based on the fact that the EIA/RIMA sets out the basis for the administrative decision making process which governs the implementation of any plan, the several phases which constitute the referred study are:

Designing the work team, designing the methodology to be applied to respond to the EIA/RIMA, definition of the Plan, definition of areas of influence, environmental assessment of the area to be affected by the enterprise, study of technological and site alternatives, identification and prediction of environmental
impacts, definition of mitigating, preventive and compensating measures, definition of a Follow-up and Monitoring Plan.

5. THE ENTERPRISE

The Salvador Metro

The rail system planned for the city of Salvador will operate in the final network along two route corridors: the north-south line from Cajazeiras to Lapa, and the east-west from Mussurunga to Calçada including the reorganization of the present bus system which will feed the stations of the Metro network. The east-west line will be built in three stages: The first one will be Rodoviária - Calçada, the second Imbui - Rodoviária and the last one Mussurunga - Imbui.

The north-south line will be the first one to be built and will transport low-income passengers from the central-northern region of Salvador to the Lapa terminal station to be built in the heart of the downtown area next to the already existing bus terminal. This line will be built in three stages: the initial 11.73 km operational segment of the Metro system from Lapa to Pirajá to be extended to Pau da Lima (2.84 km) in a second stage and the last one from Cajazeiras to Pau da Lima.

The proposed alignment for the Initial Operating System will have a minimum radius of 300 m, a maximum gradient of 4%, platform length of 145 m, and it will use a standard gauge track and an overhead current collection.

The line will start at the Lapa terminal and it will run through an 80 m² cross-section of an underground tunnel approximately 35 m below ground level, with an approximate 300 m segment through residual soil. The Stations of Lapa and Campo da Pólvora will both be underground ones, excavated through rock. At the end of the tunnel the route goes along the road level to the end of the Bonocô corridor, with two stations at ground level. The route will then run across elevated concrete sections for another 980 m, including the Rótula do Abacaxi station.

From Rótula do Abacaxi to Pirajá station the route will run on different levels of terrain through cuts and dirt fill or elevated sections with three viaducts one of which will cross the BR 324 freeway. This section will include two elevated stations and the Pirajá terminal. The central maintenance station (200,000 m²) will be in Pirajá whereas a smaller capacity equipment for train parking and the central operating command will both be in Rótula do Abacaxi (45,000 m²).

The 11.73 km will be distributed as follows: 2.2 km through tunnel; 3.7 km through elevated routes; 5.8 km at ground level, totaling eight stations of which three will be for integration and five stop points; two underground stations, three elevated ones and three at ground level.

System Alternatives

The Metro system is the suitable technological alternative for Salvador, responding to the demand for transportation within the scope of the project, resulting in lower emission of pollutants per user-vehicle-kilometer.

Regarding the location alternatives the initial plans which called for a ground level rail system were changed due to the need for preservation of an ecological sensitive area recently recuperated by the State Government (Dique de Tororó), in addition to other system operational circumstances which made the decision to build a 2.2 km underground system prevail.

It will also minimize environmental impacts in a populated area from Lapa to Campo da Pólvora Station.
6. ENVIRONMENTAL ASSESSMENT OF THE AREA

Social Aspects

The city of Salvador, capital of the state of Bahia, has a population of 2.5 million inhabitants, implying in a total of four million journeys a day, of which 50% are taken by means of a public transportation system.

The transportation system proposed for Salvador is multi-modal and it includes suburb trains, buses, ferry boats and the new Metro system to be built along the city's main north-south corridor.

The three initial means of transportation mentioned above connect suburb areas to commercial ones being buses responsible for 98% of the two million journeys taken daily by approximately 400 bus lines. Some of those lines operate through independent routes, i.e., without a central feeder corridor. The number of buses circulating on public corridors is high (up to 370 buses/hour) and that results in serious traffic jams and long journey periods for the buses and other smaller vehicles.

The area contemplated by the enterprise (see map) covers a large and heterogeneous stretch of Salvador, from its old downtown area to the urban sites recently occupied.

One of its extreme points, Lapa station, is situated in the old downtown area, where there is an intense and diversified form of residential and economic occupation.

From this point the route runs across some of the city valleys to the city exit - the BR 324. Some commercial and industrial business sites may be found in the low areas, whereas a process of dense housing occupation can be found in part of the more sloped areas.

Physical Aspects

As for the existing water resources affected by the Metro system, it is worth mentioning that the Camaragipe river, where the Mata Escura dam is located, the Bonocô brook and the Lucaia river are located, are highly polluted. Those rivers are located in densely populated areas and due to urban pressures they lack protection banks as required by existing legislative standards. In addition, not only are they polluted, but they have also had their flow lines changed due to channeling works (Camaragipe, Lucaia and Bonocô).

The occupation results in deterioration of the water resources and in recurring floods as a consequence of waste accumulation and the paved roads that surround the rivers.

Air Quality. As for air quality, Salvador is located near the sea and is under the action of local air circulation, of sea-earth breeze type, influenced by the South Atlantic subtropical anti-cyclone, which reaches the region with trade winds. The city climate is typical of the warm seacoast, with high temperatures in the summer and a well-defined winter period with rain and pleasant temperatures.

Air circulation in the region is in the quadrant E-SE most of the time. The rainy season is well defined from April through July.

At night there is an inversion in air circulation, giving origin to the earth breeze which is important for the region, since it lowers the high
temperatures reached during the day. At night there may also be periods of doldrums with atmospheric stagnation.

In the urban area, the most sensitive segments to pollution are the regions located in the valleys and along the rivers. The coincidence of doldrums in the morning or early evening with a high number of vehicle circulation, causes an increase in pollution rates, when there may be a cooling of the superficial limit layer, under certain climatic conditions.

The main source of atmospheric emissions is the automobile, although diesel trucks and buses also contribute significantly to the particulate material emissions.

The atmospheric emissions from fixed sources in the vicinity of the Metro route are

### AIR EMISSIONS

<table>
<thead>
<tr>
<th>Station</th>
<th>Factors</th>
<th>Characteristics</th>
<th>Pollutants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lapa Station</td>
<td>Bus terminal, Piedade, Lapa</td>
<td>vehicle emissions</td>
<td>• □ □ □</td>
</tr>
<tr>
<td></td>
<td>Shoppings centers, commerce</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Campo de Poioira</td>
<td>Soccer stadium, Courts of Law, commerce</td>
<td>vehicle emissions</td>
<td>□</td>
</tr>
<tr>
<td>Bonoco</td>
<td>Gas station, commerce, garages</td>
<td>bond &amp; unloading of fuel</td>
<td>□ □</td>
</tr>
<tr>
<td>Bonoco I</td>
<td>Electricity company, commerce</td>
<td>vehicle emissions</td>
<td>□</td>
</tr>
<tr>
<td>Retola do Abacaxi</td>
<td>Industries, Furniture Industry, Concrete Lab, DNOS</td>
<td>vehicle emissions</td>
<td>□ □ □ □</td>
</tr>
<tr>
<td>Rotola</td>
<td>Viação Bonfim, Concreto Engenhia, Depa Madeireira, Tecnotele</td>
<td>vehicle emissions</td>
<td>□ □ □ □</td>
</tr>
<tr>
<td>Mata Escura</td>
<td>BR-354, Gas station</td>
<td>vehicle emissions</td>
<td>□ □</td>
</tr>
<tr>
<td>Piraja</td>
<td>Bus terminal station, Jail House</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table of reference:**
- • significant emissions
- □ non-significant emissions

The urban emissions in the area under influence of the enterprise were classified in two categories: movable sources and fixed sources. The movable sources, represented by vehicles, comprehend the vast majority of urban emissions that contain volatile organic compounds, nitrogen oxides, carbon monoxide and particulate material. The fixed sources, represented by vehicle parking lots, gas stations, characteristic of the urban-industrial segment, involving commercial activities and small and average size industrial operations. Those activities involve emissions resulted from the burning of combustible oil in boilers, storage and transference of inflammable material in gas stations, operations of wood processing, use of thinners by mechanics, painting workshops, small metallurgical activities and activities.
related to construction.

There is no historical register of air quality monitoring in Salvador. The only stations in operation are located in the Petrochemical complex and in the areas near some industries. There is no systematic or oriented evaluation of vehicle pollution.

In order to obtain a reference of air quality in the region where the Metro system will be built two representatives sites were selected: the terminal station of Pirajá and the crossover in Rótula do Abacaxi.

The choice took into consideration the flow of vehicles, the wind direction and the circulation of passengers. In Rótula do Abacaxi and in the Pirajá Terminal, HiVol type monitors of total particulate material were installed. In each station, five 24 hour determinations took place. That evaluation consists of a preliminary exploratory study to determine the nature and the magnitude of pollutants. It was conducted during rainy periods and hence the low rates, due to atmosphere instability and strong winds. Deeper studies must take into consideration longer periods of time and consider the evaluation of other pollutants such as: carbon monoxide, hydrocarbons and photochemical pollutants, mainly at the Lapa station, where there are indicators of considerable pollution.

The following points presented in the table below were considered as the most sensitive regarding air pollution.

Noise. Salvador suffers seriously from noise pollution, being that a component of the local culture. Small and larger vehicles, which circulate intensely in the city center and in the corridor chosen for the Metro route in particular, also contribute to the increasing noise level.

It must be pointed out that only recently, in the 90s, effective, although rather flexible legislative standards in their implementation period, have been introduced for noise control in motor vehicles. The low vegetation density in the city also contributes negatively to the existing rates of pollution.

In the Environmental Impact Assessment some specific determinations were conducted at peak time in locations designated to be the future Metro stations, but on a cloudy and quiet day - therefore favorable to an attenuation of noises. The Sound Pressure Integrator Soundmeter was used in the measuring procedures according to state laws and the technical policy in force.

Several statistical levels of noise were obtained. The Leq levels are presented in the table below. The use of the Leq is particularly useful in the evaluation of disturbance, situations of noise pollution and subjective reactions before noise. It has been observed that some values are already very close to the 85 dB(A) defined by Brazilian Thechnical Standards (ABNT/NBR 13,068) which is the condition of pondered sound pressure for moving wagons in the stations.

On the other hand the Municipal Law (5,354/98) requires that the maximum level from any source be below 70dB(A), a level which was surpassed several times during monitoring.

**PREDICTED LEVELS OF BACKGROUND NOISE POLLUTION**

<table>
<thead>
<tr>
<th>Location</th>
<th>Leq (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lapa</td>
<td>74,2</td>
</tr>
<tr>
<td>C. da Pólvora</td>
<td>75,6</td>
</tr>
<tr>
<td>Bonocó I</td>
<td>75,8</td>
</tr>
<tr>
<td>Bonocó II</td>
<td>77</td>
</tr>
<tr>
<td>R. do Abacaxi</td>
<td>77,2</td>
</tr>
<tr>
<td>Retiro</td>
<td>76,7</td>
</tr>
<tr>
<td>Mata Escura</td>
<td>69,5</td>
</tr>
<tr>
<td>Pirajá</td>
<td>67,7</td>
</tr>
</tbody>
</table>

ABNT• 13.068 • 85 Dba • Lei Municipal 5354188 • 70 dBA
BIOTIC ASPECTS.

The natural vegetation along the intended route is nearly dying out due to urban expansion. There are some remaining areas such as the woods of the botanical gardens of Horto Florestal, of Cabula and Mata Escura Dam.

In the most central area, near the Youth Support Service building, where the rail system is elevated, some native species of *Spondias lute*, *Byrsonimea sericea*, *Cecropia spp* and *Tipirira guianensis* were identified.

There is an implanted vegetation (gardening) close to the Bonocô II Station that spreads along that bus route (1.5 km) on a medium strip of the road, turning the surroundings into quite a harmonious urban landscape. Species such as *Clitorea racemosa*, *Cassia siamica* and *Agave sisalana* can be identified in this site.

KEY SENSITIVE RECEIVERS

The assessment has identified key sensitive areas that are particularly significant. These are:

**The Mata Escura Dam.** The justification to include the Mata Escura dam as a sensitive receiver lies on historical grounds related to basic and environmental sanitation.

The dam's operation started in 1903 and was shut in 1987 due to an artificial eutrophication process that took place in this ecosystem. This once important source of water supply to Salvador, considered by the state government as a Source Protected Area, is now silted up thus clashing with its past ecological and sanitation value.

**Campo da Pólvora Square.**

It is on this square that one of the oldest and most impressive buildings of Salvador is located - the Courts of Law. That on itself defines the importance of the site. The square also presents a marginal architecture style that is compatible with that of the Courts of Law building.

Near the square is the Fonte Nova Stadium, one of the most important leisure facilities in town, which demands a high flow of transportation usage on certain days and times.
The construction of a stop station is being planned for this area in order to serve the Metro rail system.

Lapa Connecting Station

It is one of largest concentrations of people in town due to intense commercial, civic and religious activities located in the area.

In this site several battles for the state independence took place. This station will allow access to Joana Angélica Avenue, one of the most traditional and old roads in town, which in the past was a streetcar route. It became modernized and it grew old fashioned. The rails that once gave support to it are now covered by several layers of asphalt.

Environmental conditions of Lapa and Campo da Polvora stations

POINTS OF PARTICULAR SENSITIVITY:
1. ADMINISTRATION SCHOOL (UFBa)
2. OUR LADY OF PIEDADE CONVENT
3. PORTUGUESE READING CABINET
4. AGUIA SCHOOL
5. GEOGRAPHY AND HISTORY INSTITUTE (IGHB)
6. LAPA SHOPPING CENTER
7. PIEDADE SHOPPING CENTER
8. OUR LADY OF LAPA CONVENT
9. BAHIA STATE SCHOOL
10. RUI BARBOSA COURTS OF LAW
11. BAIAXA DOS SAPATEIROS SHOPPING CENTER
12. OUR LADY OF DESTERRO CONVENT
13. SANTANA CHURCH
It is also a bus terminal, close to two shopping centers and small neighboring streets; with intense informal commerce, posing serious urban problems that may be increased with the construction of the Lapa Integration Station which will also serve the Metro system (see drawing).

7. SYNTHESIS OF IMPACTS

The construction of the Metro system will have a significant impact on the urban setting of Salvador.

The environmental analysis of an urban area comprises necessarily the urban space and its relationship with the population. In this case in urban environmental perspectives a new relationship with the metro, rather than just with its possible users should be considered. The Metro impact over the ordinary citizen will take place in two dimensions: a micro level one specially in stations with high concentration of people with different feelings of comfort or conflict and a sensorial impact in a macro dimension (visual and acoustics) generated by the metro material structure.

The possibility of improving the access of mass transportation to a wider range of the population, thus avoiding the use of individual vehicles, will result in the improvement of users' well being, reducing traffic jams in areas which are perceived today as being problematic, reducing air and noise pollution as well as the number of accidents.

The substitution of a non-renewable source of energy (petroleum) by hydroelectric energy must also be considered as a positive impact resulted from the construction of the Metro system.

In addition, the Metro system may offer a unique opportunity for improving urban traffic, integrating a mass transportation system and generating a structure which can establish a new urban landscape, characterized today by a lack of coherence among its several components.

The negative impacts relate to the construction and operational phases.

The nature of this project, involves intense construction work for a period of approximately three years in the area under assessment, generating a significant impact and concern with environmental problems which will arise.

The long term impacts may be greatly minimized during the planning stages of the project by means of pro-active measures such as recommendations/suggestions, implementation of norms which address not only land use but also specific regulations restricted to urban traffic. These aim to improve the benefits of the new structure which may be achieved naturally by means of a process of users' education (construction and operational phase of the system).

The negative impacts related to the construction of Metro systems refer to noise, vibration, water pollution, air pollution, social and scenic factors.

SOCIAL FEATURES
EXECUTIVE SUMMARY

Landscape and Visual Impacts. These impacts are more significant after conclusion of the project and may be ignored during the construction period due to being transitory.

The Metro system of Salvador will undoubtedly imply changes in the urban landscape of the city. This fact should result in new visual and aesthetic patterns.

Hence the importance of the structure and facility design, especially applied to the stations. The formal effects of the Metro system also reach the topography and morphology of the urban terrain by means of treatment of slopes, brooks, canals and vegetation.

It is therefore important that the Metro structures, mainly in its elevated segments, do not destroy the remaining harmony of what was once the representative landscape of the urban culture of Salvador. Some suggestions related to the type section and the elevated ground level, and underground structures are presented along this report.

On the other hand since the corridors will mostly go at grade will occupy areas the visual intrusion impacts will be kept at a minimum level, even in its elevated segments.

Generic Environmental Disturbance. The setting of construction supporting areas during the building phase will imply several impacts to some of the segments of this study. Even though these facilities are of short duration, the amount of people, equipment, machinery, etc. in such a limited space tend to disturb the environment with noise, dust, mud, solid and liquid waste, in addition to social and economic changes.

Locomotion Disturbance. Urban interference in traffic will occur in the following ways during
construction phase:

- restrictions to the free flow of pedestrians for security reasons due to barriers separating the Metro lines from the rest of the urban traffic;

- inevitable closing of road intersections and shifts in vehicle circulation, causing traffic jams on other
  Six work stages were identified as being the cause of most significant forms of disturbance, such as the segment near Rodolfo Pimentel Street up to the area close to the Northern Access.

Rupture of residents/commerce relationships and difficulty of insertion for the relocated/indemnified population. The buying off or relocation of residential or commercial premises in areas located along the corridor (513 units, comprising approximately 90% of residential) will cause impacts to the population implying a rupture of personal friendships and commercial relationships, generating community disruption.

The relocated population not always finds in their future neighborhood (Baixa de Santo Antônio) the conditions they previously had which may cause dissatisfaction and integration issues regarding the new place of residence, even when all the aspects related to the maintaining of community habits(social relationships, work, etc.). The high number of dissatisfaction and social problems is common when these issues are being addressed.

Relocation is not foreseen for commercial business. Those will be compensated for losses relative to their premises and interruption of activities. This simple substitution of economic activity by monetary compensation not always guarantees the satisfaction of the beneficiary.

The relocation is being addressed in a more specific study hence it will not be detailed in this report.
**EXECUTIVE SUMMARY**

*The arising of new attractive real estate and commerce.* The increase in value of the areas surrounding the Metro system is likely to generate residential and commercial poles, being the latter, particularly the ones located in the neighboring areas, probably incompatible with the standards of modernity and space improvement which the system will try to achieve.

**BIOTIC FEATURES**

*Drainage.* The changes in pre-existing drainage patterns may worsen the lack of balance of water streams regarding their flow capacity thus generating floods. The following points must be carefully considered in the designing of a Metro system project (drainage):

- The canal behind the Traffic Department of Salvador (DETRAN - Saramandaia) - There are pipeline bottlenecks in the canal which cause flooding of the adjacent areas;

- Av. Barros Reis (Pau Miúdo) - Bridges and pipeline bottlenecks on the Camaragipe river canal on an extremely silted up place;

- Low Santo Antônio (São Gonçalo) - Flooding of low areas due to silting up and deficient drainage system;

- Low Camaragipe (São Caetano) - Flooding of the low areas due to insufficient draining sections from the culverts under the BR-324 freeway. Those culverts are clogged and need maintenance.

*Biologic Stress.* The destruction of native and exotic vegetation may have a significant importance in two sites along the corridor, Bonocô and the Mata Escura dam, where native and even exotic vegetation already incorporated to the local landscape was identified in some small areas.

**PHYSICAL FEATURES**

*Water and Water Resources Pollution.* The construction of such a system implies an increasing amount of suspended solid residues which may interfere in the color of the water or the silting up of the stream beds. That may result in possible floods during the rainy season, being Mata Escura, a significant area of concern in this respect, due to presenting this sort of problem nowadays.
Water Table. When submitted just to the natural process of the hydrological cycle, the freatic water tables oscillate on a seasonal basis, increasing during the rainy seasons, or immediately after them, and decreasing in the dry periods to their original level. In an area of high occupation density, such as some strips of Bonocô Ave., the freatic water tables have gradually been decreasing due to inhibiting of infiltration, occupation of the recharging zones or even pumping.

With the construction of the Metro system the drawdown tends to be more intense in the tunnel sections below water level, with the possibility of affecting the stability of some buildings. Quick drawdowns are extremely dangerous especially if one considers the weather changes which take place in the region, requiring prevention through monitoring of the water tables in order to minimize the effects of their lowering. Associated to the quick lowering of the water tables is the fact that the loss of water in the interior of the excavation always leads to soil removal, with the possibility of subsidence.

Vibrations. This impact consists of propagation of sound waves which transmit vibrations to the neighboring buildings, from 'open-air' detonations of rocks. These can eventually generate material damage associated to air shifting with the possibility, in extreme cases, of glass window breaking in buildings located opposite the shifting of the sound wave.

The concern during the phase of opening of tunnels applies only to the initial 15 meters approximately. After that the sound energy resulted from friction with the tunnel walls is reduced to tolerable levels. The buildings located within a radius of approximately 100 meters from the detonation sites may get a slight vibration.

Noise. Construction noise will vary from marginal for a large proportion of time to significant during extended periods of increased activities. There will also be short periods of one to two hours duration when the presence of high level impact and vibrator noise during the pouring of in-situ concrete will create severe noise impacts for receivers near the construction activity, which may reach a 20 m range from the origin of noise.

There may be the following main sources of noise during the operation phase: operational train noise, reverberation from road traffic noise underneath the stations and nearby buildings, noise from the ventilation system, depot noise and track maintenance noise.

A diagnostic assessment revealed that in case the project does not contemplate special structures for the attenuation of noise generated by the moving trains, some stations will end up presenting noise levels above maximum legislative standards.

Air Pollution. The greatest problem during the implementation of the enterprise are particulates, which may arise at sensitive receivers in the station locations and along the length of the route.

The Salvador Metro system will be fed by an electrical system and most probably, during the operational phase, there will not be any problems related to air emissions. It is true to say that the removal of ignition motors from circulation will generate a positive impact. However, in the areas surrounding station locations, there should be an increase in the number of vehicles which will feed them, and that will probably inhibit dispersion of emissions, which added to the background ones may generate a substantial impact.
8. MITIGATING MEASURES

SOCIAL FEATURES

The project will affect a wide part of the community in Salvador, and some groups in particular, during the construction and operational phases, i.e., services which are now conducted in the area (some informal commercial activities) as well as communication will be harmed under the influence of the Metro system.

Problems with accidents may occur during the construction phase during the circulation of heavy vehicles specially in areas where high velocity traffic is common presently such as in the BR-324 and Bonocô corridors. Special attention should be given to these areas in order to minimize the occurrence of accidents.

The most relevant aspect in this segment might occur due to the construction work, when families will be relocated to another area. It is therefore necessary to design a widespread information plan for the population, through social agents, in order to provide orientation on the reasons for relocation of families and their new living conditions. The relocation plan should be carefully planned and performed so that the process is natural.

A similar issue, even though of minor magnitude, refers to indemnification to the owners of commercial businesses, based on monetary transactions (different from the residents' relocation) thus expediting

Suggestions for street level and elevated station on Bonocô Avenue with provision for using the existing bridges
appropriation actions.
A serious control of land use and commercial practices, especially the informal ones, will avoid the generation of a negative association of the Metro system to former chaotic practices of land use for commercial purposes which generates an inadequate behavior on the part of the population. In the Metro systems of Rio de Janeiro and São Paulo one may notice, for instance, collective behavior patterns far higher than those of the same population on the streets, being that a result of order, cleanliness within and around the Metro facilities.

Two station areas Campo da Polvora and Rotula do Abacaxi should receive special attention regarding architectural aspects surrounding the future station (Campo da Pólvora) and limited conditions of public access (Rotula do Abacaxi - see drawing).

A campaign of Environmental Education should be carried out among the population as a whole, the future users of the system, employees, dwellers of neighboring areas, aiming preparation of the community for construction and operation of the new transportation system to be implemented in the city.

**BIOTIC FEATURES**

Due to the fact that the construction of the Metro will take place in an area whose vegetation is already resultant from man's action, the impacts over the biotic media will be light. It must be reinforced nevertheless that the native tree species (Bonocô Avenue and Mata Escura) should, within the possibilities,
be preserved. The incorporation of native and even exotic tree and bush species, with which the population is already familiar, must not be spared in stations and corridors. Those, e.g., Clitoria recemosa, Cassia siamica, Terminalia cattapa (trees); Hibiscus rosa sinensis, Burguenville sp., Lantana camara and Agave sisalana (bushes), will provide beauty and will create small natural oases in urban spaces.

On the other hand, the incorporation of dense aligned vegetation, wherever possible, will soften the visual impact of the presence of the Metro, as it will break the homogeneity of the visual continuum of structures in concrete and it will undoubtedly attenuate the generated noise.

The Mata Escura area, due to the several aspects already mentioned, deserves a differentiated treatment upon the construction of the metro, and remedial (landscape recuperation and improvement of the urban standards), and should be addressed in a later stage with the state government support.

**PHYSICAL FEATURES**

Problems related to noise and vibration are expected mainly during the construction period. It is expected that these impacts will be reasonably controlled due to their transitory nature, the experience that the municipal government has in carrying out works such as this one, and in light of the several works already conducted along the city roads. However it is always worth mentioning the need to keep the population as a whole informed of the future benefits of such interventions, so that they can better accept the temporary discomfort.

The mitigating measures pertaining to the attenuation of noise pressure resulted from explosions, consist basically of the implementation of procedures for vibration and sound wave control inherent to the construction phase, e.g., control of the amount of explosives so as to keep the sound pressure below the 115 dB limit in the buildings nearby the detonation sites. The key procedures in the control and management of risks consist in the use of a secondary cover over the detonation area (narrow path protection cover), in order to attenuate the wave propagation and in keeping the windows open during detonation, so that the shifting of air will be facilitated and windows in the buildings located in the nearby region will not be broken.

The areas of potential risk as far as such impact is concerned are the ones near the tunnel narrow paths and open air disassembly, having the buildings within a radius of 100 meters from detonation sites the possibility of perceiving...
some vibration.

Another factor which must be taken into consideration in terms of sound pressure resulted from explosions refers to stability of certain marginal slopes, specially the ones along Bonocó Avenue and BR-324, which will have to be studied under a greater amount of detail. The vibrations resulted from detonations which are transmitted to rock substrata can, when not controlled, induce tensions which may cause movement of slopes and/or sliding of soil under precarious levels of stability.

The stability of unstable soils and rock blocks, the monitoring of the existing structures for slope contention and above all the program of vibration control are measures, which must be strictly followed, for the control and prevention of accidents in that type of construction work.

The subsidence problems in the foundations of existing buildings and viaducts, are a result of soil excavations (sedimentary or colluvial) or rock excavations, which transmit vibrations to the rock substratum and the adjacent soil inducing tensions which can turn unstable the grounds on which the foundations are supported. In both cases, the rearrangement of the layers is the crucial factor for subsidence. The generation of dust and mud is inherent to the open air and underground excavation operations, in addition to the ones carried out in concrete central stations. Soil excavation, rock perforation, disassembly, loading and transportation of material produce dust. It also comes from truck traffic in the service fronts and from the industrial support sites.

As for the foundations, the assessment recommends the use of in situ molded piling rather than percussive piling which may cause noise problems at the moment of nailing.

There should be occasional noises in the station locations in its several operations, but those must not be considered as significant. On the other hand, the cumulative effect of the main sources of noise will depend mainly on the location of the noises and the proximity to sensitive receivers.

The cumulative effect in the station location is due to traffic noise increase and reverberation. That can be controlled through the use of absorbing materials under the structure and by intense use of vegetation in order to ensure that resulting noises will be within environmental legislative standards. The cumulative effect outside the station location is due to trains moving or undergoing occasional maintenance, and it will probably be significant due to the levels already shown in the assessment area. Once more, the use of dense vegetation barriers or specific structures for attenuation of noises must be stimulated.

Due to the nature of the construction site (within city limits) it will be important to ensure a high standard of caution, minimizing the emission of solid wastes which are generated. It is also important to bear in mind that an adequate drainage system both during the construction and operational phases may prevent impacts over the quality of water. Project parameters with higher factors of security (e.g., duration of rain intensity, draining coefficients) must be used in the sites which were considered as critical ones by this assessment, so that greater drainage may be obtained in those areas. Such recommendations are already being taken in consideration in the engineering project.

9. ENVIRONMENTAL MONITORING

Environmental monitoring schedules have been proposed to:

- ensure that environmental impacts resulting from the construction and operation of the Salvador Metro system are minimized or kept to acceptable levels;
- establish procedures for checking that
mitigation measures have been effectively applied, and that appropriate corrective actions are appropriately undertaken;

- provide a means of checking compliance with environmental objectives, recording any anomalies and documenting necessary corrective action.

Monitoring will be required to measure noise, particulate and gaseous levels, and waste management practices during both the construction and operation of the Salvador Metro system.

A during-project audit (Comissão Técnica de Garantia Ambiental) will be carried out, as per state requirements, with a team formed by technicians employed by the municipal government, who will implement, execute and coordinate the control actions proposed in the EIA/RIMA, ensuring that the environmental entity is duly informed of the steps taken.

It is recommended that periodical auditing is carried out after the system becomes fully operational, in order to systematically ensure that the performance of the organizational structure of environmental management meets the management patterns of the equipment used. The Environmental Impact Assessment will act as a basis for the periodical auditing and will guarantee its correct achievement and updating, making it an essential document for environmental management.

10. COSTS

Since the detected impacts are of minor significance some of the recommendations will be naturally incorporated in order to improve the project in general terms. The expenses regarding mitigation should be included in the engineering costs.

11. CONCLUSIONS AND RECOMMENDATIONS

As mentioned above, the construction of the Salvador Metro system will represent a significant positive impact to the city's urban setting.

The possibility of improving mass transport will result in a decrease in the use of private vehicles, thus implying an improvement of users' well being, reduction of traffic jams and accidents in areas which today are characterized as problematic ones, and attenuation of air and noise pollution.

The mitigation measures have been proposed to minimize the environmental impacts wherever possible. Environmental monitoring will be essential in order to ensure that potential impacts are kept at acceptable levels.

Recommendations have been made and the most important ones are summarized below. In order for the potential environmental impacts of the system to be minimized, it is essential that these recommendations be observed throughout the conclusion of the project.

Key detected environmental impacts and summarized recommendations are presented below:

*Noise/Vibration*: high level impact noise, including vibrator noise, during construction will be significant, and is likely to cause sleep disturbance to sensitive receivers in close proximity to construction activities. It has been recommended that the use of percussive construction methods be kept to a minimum, and that slopes and existing building foundations are carefully evaluated so as to predict and avoid possible damage.

*Air*: results from evaluation of quality modeling have established that the level of air pollution in some specific points (stations) is high. Due
to the short time spent on monitoring, it is recommended that a more detailed and extended campaign be carried out aiming the acquisition of better-defined data even during the construction of the Metro system. The forced ventilation system will have to take into consideration the sensitive situation of the existing stations.

**Landscape and visual impacts:** the development of the Salvador Metro system will create significant visual impacts. The most important ones are associated to the development of stations where the proximity to sensitive receivers is most critical (Campo da Pólvora) as well as in the proximity to the Mata Escura Dam.

The community impacts resulting from the construction of the Salvador Metro system include impact over the traffic, issues related to existing services and general impact over the community activities in the area. The relocation of people and extinction of commercial buildings along the Metro route are permanent impacts of the construction of the Metro system.

Strict control is recommended in terms of the future relationship of use and occupation of neighboring areas to the stations and along the corridor, in order to avoid a negative association of the Metro system to old and inadequate collective habits and/or patterns of conduct related to chaotic land occupation.

Measures to mitigate the impacts are specified, in greater detail in the "Environmental Impact Assessment" and "Environmental Impact Report" which are also parts of this assessment and should be

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**EXECUTIVE SUMMARY**

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Suggestion for Lapa underground Station
in the bidding documents for construction and operating concession.

Finally, with the objective of maximizing the benefits derived from an equipment which will tend to improve life conditions in the urban setting, it is recommended that a campaign of Environmental Education is carried out among the population as a whole, the future users of the system, employees, dwellers of neighboring areas, aiming preparation of the community directly affected or not by the construction and operation of the new transportation system to be implemented.
SECTION FOR ELEVATED STATION ROTULA DO ABACAXI

ELEVATED ACCESS DISTANCE = 330m

ACCESS FROM AV. BARROS REIS

HIGHWAY 324

AV. BONOCO

RA 324

TO GUATEMALA

ACCESS FROM AV. BARROS REIS AND SUPERBOX

SUGGESTED ACCESS FROM AV. BARROS REIS AND SUPERBOX

LIGHT METALLIC ROOF

PASSENGER PLATFORM

ACCESS AND CIRCULAR ELEVATED RAMPS WITH TICKET RATEGES

SELECT FROM AV. ANTONIO CARLOS NABALIARES

ROTULA DO ABACAXI

CAMARASIDE RIVER

STAIRS

ELEVATOR