## 2) Janga STF

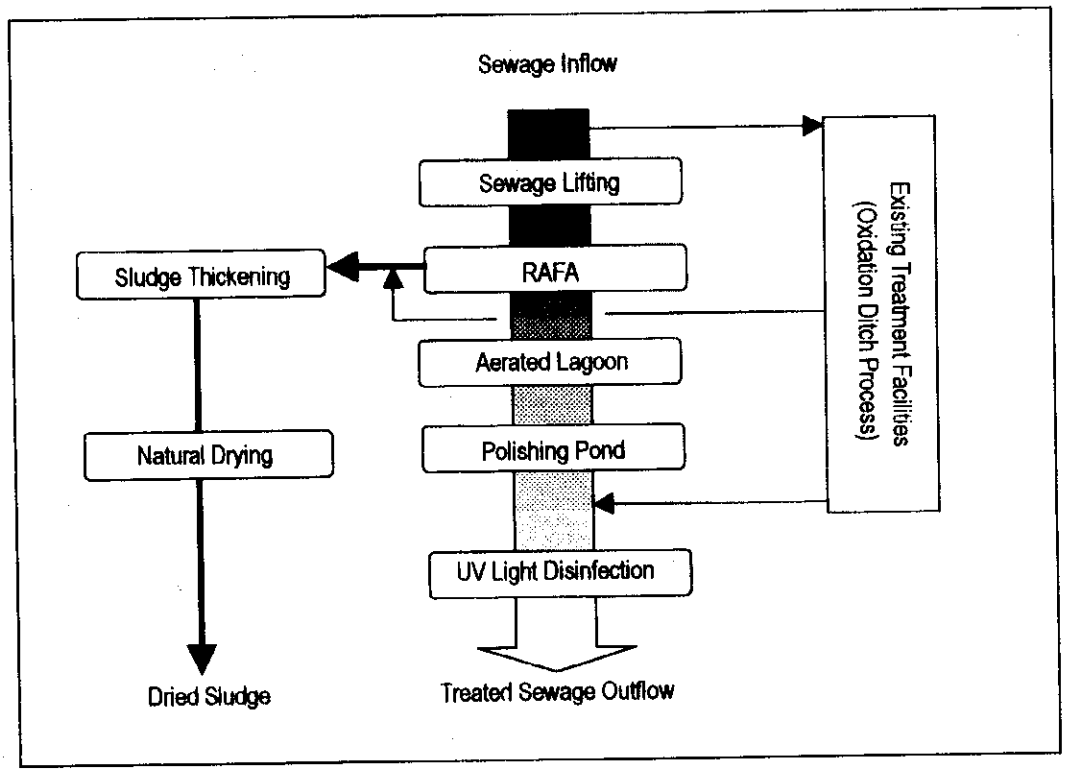
### (a) General

The Janga STF shall be equipped with dual treatment trains. One comprises the existing treatment facilities consisting of oxidation ditches and other related equipment, which are used after the necessary rehabilitation. The other is a newly installed treatment facilities consisting of the following steps: the "RAFA + aerated lagoon + polishing pond" for the biological treatment system and the "natural drying" for the sludge treatment system, as shown below.

The treated sewage and the sludge from the existing facilities will be handled by the newly installed facilities after being mixed together as shown in the following figure.

Treated sewage shall be discharged by gravity into the Timbo River through embedded discharge pipes. This discharge pipe will be installed newly. The sludge generated from the treatment facilities shall be disposed of at landfill sites, being transported after being dried naturally at the STF.

**Treatment Flow of Janga STF**




The layout plan of the facilities is shown in Fig. 4.4-3.

(b) **Construction site**

The site is located at the existing treatment station situated at the locally determined coordinates, 2.96E / 91.22N, in the Municipality of Paulista and lies near the upper reach of the Timbo River and its tributaries. The land belongs to COMPESA.

New series of treatment facilities will be constructed next to the existing ones and certain component facilities will be placed in the area of the existing facilities. The land of 12.3 ha excluding the area occupied by the existing facilities shall be used for the treatment station.

The present ground at the site is undulated from north to south with levels between 25 m and 5 m (+ MSL). It is currently vacant with bushes and trees, and a certain portion of the scheduled area has already been leveled. The STF shall be constructed at ground levels of 8.0 m, 11.0 m, 13.0 m and 16.0 m (+ MSL), which are prepared by grading and reclamation.

(c) **Major facilities and structural works**

Main Specifications of major facilities and structural works for the STF are shown in Table 4.4-2.

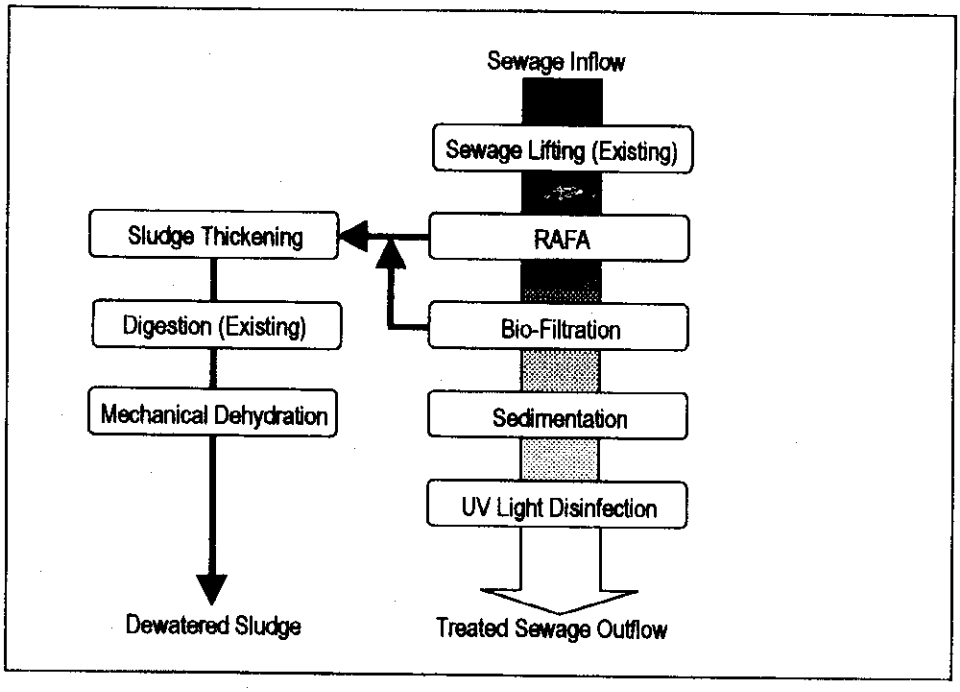
### 3) Cabanga STF

#### (a) General

The Cabanga STF consists of the following steps: the "RAFA + bio-filtration" for the biological treatment system and the "digestion + mechanical dehydration" for the sludge treatment system. Of the existing facilities, influent pumps, grit chambers, sludge digesters and gasholder shall be used after rehabilitation and integrated in the newly installed facilities, as shown below.

Treated sewage shall be discharged by gravity into the Pina Bay through embedded discharge pipes. The sludge generated from the treatment facilities shall be disposed of at landfill sites, after being dehydrated mechanically at the STF site and transported. The layout plan of the facilities is shown in Fig. 4.4-4.

**Treatment Flow of Cabanga STF**




#### (b) Construction site

The facilities will be constructed in the existing treatment station at the locally determined coordinates, 2.91E / 91.07N, in the Municipality of Recife. It is close to the Governador Agamenon Maglhnaes Bridge and belongs to COMPESA.

The ground at the site is almost flat with levels of around 2.5 to 3.0 m (+ MSL) and the STF shall be constructed on the plot at a level of 3.0 m (+ MSL).

The total area of the Station is 3.8 ha without any expansion area outside. The STF shall be constructed in the space, which is used as a football ground and others. The areas for parts of old existing facilities to be demolished will be used also.

### (c) Major facilities and structural works

Main specifications of major facilities and structural works for the STF are shown in Table 4.4-2.

### 4) Boa Viagem STF

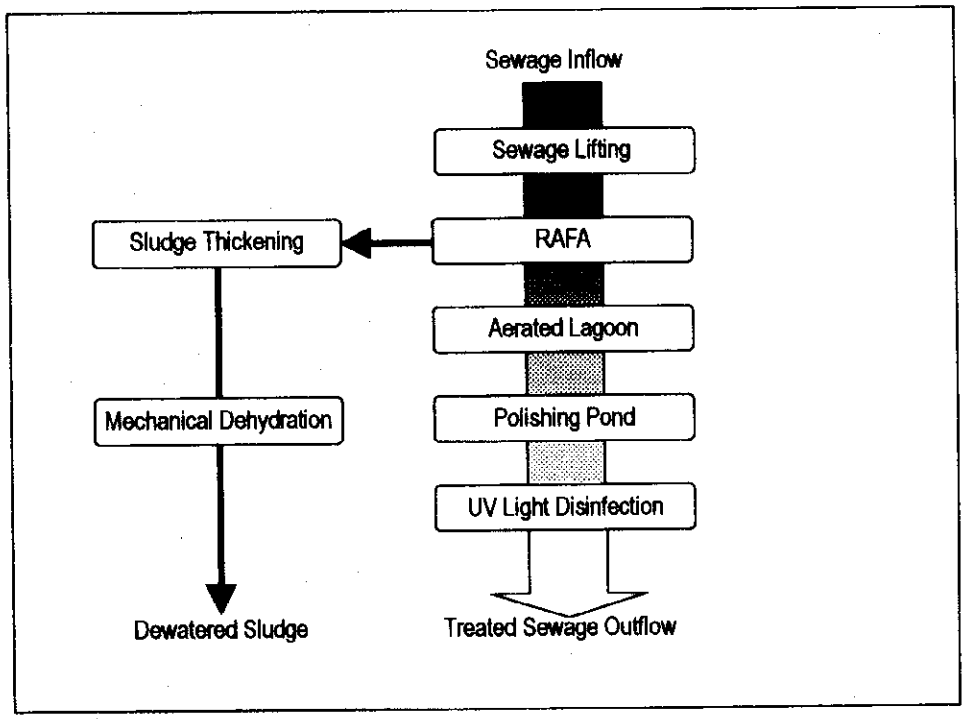
#### (a) General

The Boa Viagem STF consists of the following steps: the "RAFA + aerated lagoon + polishing pond" for the biological treatment system and the "natural drying" for the sludge treatment system, as shown below.

Treated sewage shall be discharged by gravity into the Jordao River through embedded discharge pipes. The generated sludge from the treatment facilities shall be disposed of at a landfill site, after being dehydrated mechanically at the STF site and transported.

The layout plan of the facilities is shown in Fig. 4.4-5.

**Treatment Flow of Boa Viagem STF**




#### (b) Construction site

The site is located at the locally determined coordinates, 2.89E / 91.03N, in the Municipality of Recife. The site with an area of 8.7 ha lies between the Jordao River and a railway and the land belongs to several private citizens.

At present, the land has many high-trees and is being used sporadically as a park. The site faces factories to the south and residential zones to the west beyond a railway. Although a road from the south is the only access way to the site, this is being occupied by illegal settlement. It is requested that these illegal houses are moved to ensure the free flow of

traffic for the construction and the operation.

The land with an area of 8.7 ha shall be used as the STF site. The ground at the site is undulated between 2 m and 4 m (+ MSL). The Station will be constructed on the plot at a level of 4.0 m (+ MSL), which is to be prepared by reclamation and grading.

As a result of the environmental survey in this Study, the mangrove area of some 0.7 ha was identified at the riverside to the east of the land proposed by the Counterpart. Therefore, the utilization of this area for the construction site of the STF was avoided.

### (c) Major facilities and structural works

Main specifications of major facilities and structural works for the STF are shown in Table 4.4-2.

## 5) Cordeiro STF

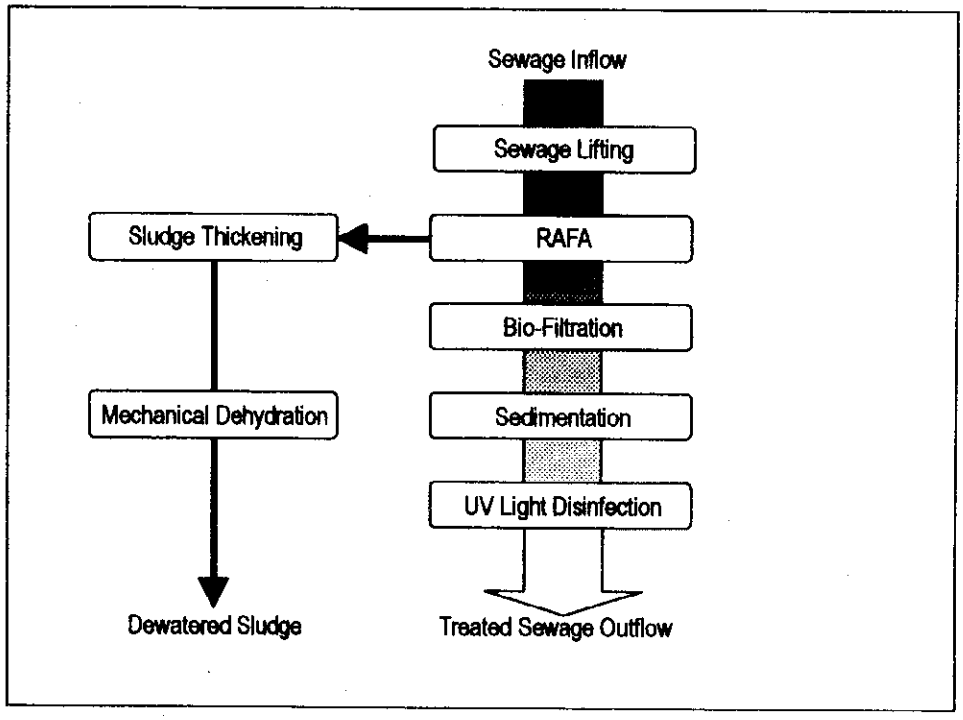
### (a) General

The Cordeiro STF consists of the following steps: the "RAFA + bio-filtration + sedimentation" for the biological treatment system and the "sludge thickening + mechanical dehydration" for the sludge treatment system, as shown below.

Treated sewage shall be discharged by gravity into the Capibaribe River through embedded discharge pipes. The generated sludge from the treatment facilities shall be disposed of at landfill sites, after being dehydrated mechanically at the STF site and transported.

The layout plan of the facilities is shown in Fig. 4.4-6.

**Treatment Flow of Cordeiro Sewage STF**




### (b) Construction site

The site is situated at the locally determined coordinates, 2.87E / 91.11N, in the Municipality of Recife. The site lies alongside the Capibaribe River. The available land area is of 4.0 ha and it belongs to the state of Pernanbuco.

At present, the land is almost vacant with bushes and several abolished buildings. The site faces residential zones to the south and a new road is being planned just outside the site.

The ground at the site is undulated between 2 m and 4 m (+ MSL). The Station will be constructed on the plot at a level of 4.0 m (+ MSL), which is to be prepared by reclamation and grading.

### (c) Major facilities and structural works

Main specifications of major facilities and structural works for the STF are shown in Table 4.4-2.

### 6) Prazeres STF

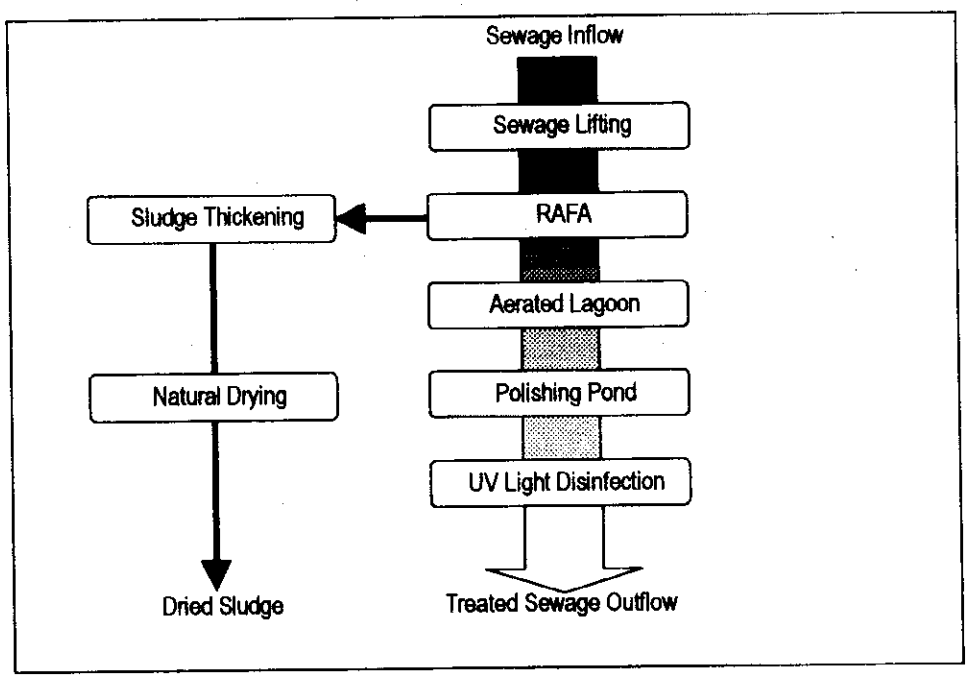
#### (a) General

The Prazeres STF consists of the following steps: the "RAFA + aerated Lagoon + polishing pond" for the biological treatment system and the "natural drying" for the sludge treatment system, as shown below.

Treated sewage shall be discharged by gravity into the Jaboatao River through embedded discharge pipes. The sludge generated from the treatment facilities shall be disposed of at landfill sites, after being dried naturally at the STF site and transported.

The layout plan of the facilities is shown in Fig. 4.4-7.

**Treatment Flow of Prazeres STF**




#### (b) Construction site

The site is situated at the locally determined coordinates, 2.87E / 90.97N, in the Municipality of Jaboatao. The site lies in an industrial zone between the BR-101 highway and a railway. The available land area is of 12.1 ha and it belongs to several private citizens.

At present, the land is almost vacant with bushes and trees. A shallow lagoon occupies a part of the site. The site is surrounded by factory buildings to the south and to the east.

The ground at the site is undulated between 6.5 m and 9 m (+ MSL). The STF shall be constructed on the plot at a level of 5.0 m (+ MSL), which is to be prepared by reclamation and grading to prevent the site from submersion and to discharge treated sewage by gravity.

### (c) Major facilities and structural works

Main specifications of major facilities and structural works for the STF are shown in Table 4.4-2.

### 7) Curcurana STF

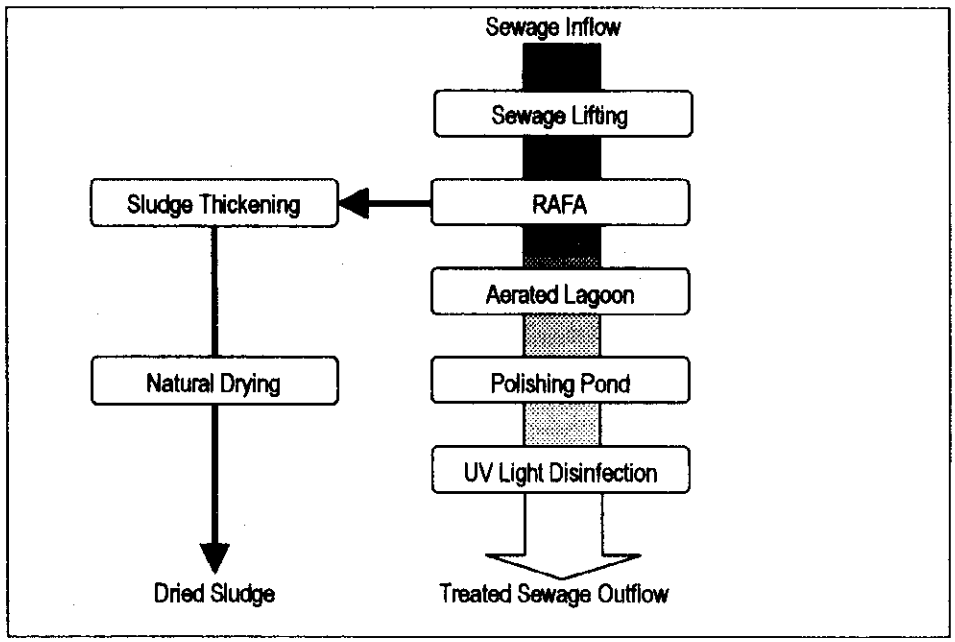
#### (a) General

The Curcurana STF consists of the following steps: the "RAFA + aerated Lagoon + polishing pond" for the biological treatment system and the "natural drying" for the sludge treatment system, as shown below.

Treated sewage shall be discharged by gravity into the Jaboatao River through embedded discharge pipes. The sludge generated from the treatment facilities shall be disposed of at landfill sites, after being dried naturally at the STF site and transported.

The layout plan of the facilities is shown in Fig. 4.4-8.

**Treatment Flow of Curcurana STF**




#### (b) Construction site

The site is situated at the locally determined coordinates, 2.86E / 90.92N, in the Municipality of Jaboatao. The site lies in the low-lying area of the Olho D'Agua Lagoon along the Curcurana Road. The available land area is of 9.5 ha and it belongs to a private citizen.

The land is low-lying and almost vacant at present with bushes and trees and a natural stream flows throughout it. The site faces residential zones to the east.

The ground at the site is undulated between 0.5 m and 1.0 m (+ MSL). The STF shall be constructed on the plot at a level of 3.0 m (+ MSL), which is to be prepared by reclamation to

prevent the site from submersion and to discharge treated sewage by gravity.

As a result of the environmental survey in this Study, a mangrove area and its area of influence with some 5 ha were identified to the north of the land proposed by the Counterpart. Therefore, the utilization of this area as the construction site of the STF was avoided.

### (c) Major facilities and structural works

Main specifications of major facilities and structural works for the STF are shown in Table 4.4-2.

### 4.4.3 Required O&M

#### (1) Operation and maintenance services

##### 1) General

The services of operation and maintenance for sewage treatment facilities may be subdivided into administration, operation, maintenance, water quality control and labor works. Their respective works are described as follows:

##### 2) Administration service

Administrative service includes the management of properties and stock, budgeting and accounting, and personnel management. In addition, security guards, building janitors, and cleaning persons are managed by the administrative unit.

##### 3) Operation service

The operation service is composed of the monitoring of operation parameters and the manipulation of equipment such as pumps, gates, valves, etc. The monitoring of facilities is required continuously without ceasing to command the operation status of the facilities. Therefore, it is proposed that the monitoring takes place by the introduction of a centralized and automatic monitoring system. The operation to manipulate equipment, on the other hand, will be reduced to a minimum, since it requires high construction costs and is not reliable without periodical and precise adjustment/maintenance.

Table 4.4-3 shows major operation parameters for the respective STFs. Of these, some items shall be supervised from the supervision board, if it is possible technically.

##### 4) Maintenance service

To maintain proper and sustainable functions/performance of component facilities over a specified duration, routine and periodical inspections of mechanical and electrical/instrumental equipment are most important. The following table shows required maintenance items in STFs, classified into daily, monthly and yearly activities.

**Required Maintenance Items**

| Frequency | Categories | Maintenance Items |
|---|---|---|
| Daily | Mechanical | Appearance |
| | | Unusual vibration and sound |
| | | Lubricants |
| | Electrical and Instruments | Appearance |
| | | Unusual vibration and sound |
| | | Overheating |
| | | Current |
| Monthly | Mechanical | Gland packing's wear and leakage |
| | | Checking and replacement of lubricants |
| | | Checking of chains and belts |
| | Electrical and Instruments | Checking of insulation |
| | | Adjustment of instruments |
| Yearly | Mechanical | Dredging RAFA Reactor |
| | | Drying up tanks and checking of submersible parts |
| | | Drying up aerated lagoons and polishing ponds, and dredging, if necessary |
| | | Drying up bio-filters and sedimentation tanks, and internal checking |
| | | Overhaul of main equipment |
| | | Replacement of lubricants |
| | | Replacement of gland packings |
| | | Replacement of chains and belts |
| | | Tightening of bolts |
| | Electrical and Instruments | Checking sequential operation |
| | | Checking protective operation |

### 5) Water quality control

Water quality control is one of the most important services, which ensure the treatment performance of STFs. The main task in water quality control is to analyze the operation status from the physical, chemical and biological points of view. Major items to be measured and analyzed are shown in the following table. The results shall be used for the adjustment and resetting the operation conditions of STFs.

### 6) Labor works

Labor works are manual work to assist site works such as the replenishing of chemicals, site cleaning, dismounting of equipment, grit and sludge removal, manual operations of gates, dredging of tanks, etc.

**Required Measurement and Analysis Items for Water Quality**

| Sampling Points | Frequency | Measurement and Analysis Items | Remarks |
|---|---|---|---|
| Influent well | Daily | Appearance, Odor, Water temperature, Turbidity, pH | Incoming sewage |
| | Weekly | SS, COD | |
| | Monthly | BOD, $NH_4$-N | |
| RAFA Outlet | Daily | Appearance, Odor, Water temperature, Turbidity, pH | RAFA outflow |
| | Weekly | SS, COD | |
| | Monthly | BOD, $NH_4$-N | |
| Outlet of aerated Lagoons | Daily | Appearance, Odor, Water temperature, Turbidity, pH, DO | Aerated lagoon outflow |
| Outlet of disinfection tank | Daily | Appearance, Odor, Water temperature, Turbidity, pH | Discharged sewage |
| | Weekly | SS, COD, Total-Coliform | |
| | Monthly | BOD, $NH_4$-N, $NO_3$-N | |
| Outlet of bio-filters | Daily | Appearance, Odor, Water temperature, Turbidity, pH | Bio-filter outflow |
| Outlet of thickener | Daily | Appearance, Odor | Thickened sludge |
| | Weekly | Sludge concentration | |
| Sludge drying beds | Daily | Appearance, Odor | Dried sludge |
| | Weekly | Moisture of dried sludge | |
| Outlet of sludge digester | Daily | Appearance, Odor | Digested sludge |
| | Weekly | Sludge concentration | |
| | Daily | Appearance, Odor | Supernatant |
| | Weekly | SS | |
| Outlet of dehydrators | Daily | Appearance, Odor | Dehydrated sludge |
| | Weekly | Moisture of dried sludge | |

### (2) Equipment for operation and maintenance

Ordinary maintenance vehicles/equipment and tools such as mechanical shovel cars, forklift trucks, welding machines, lathe, lifting hoists, etc. shall be provided in the stations to repair parts and transport goods and sludge. In addition, the following apparatus necessary for the daily and weekly measurement and analysis of water quality shall be provided:

- Temperature meters,
- PH meters,
- Conductivity meters,
- DO meters,
- COD analysis apparatus,
- Turbidity meters,
- Stereo-microscope,
- Digital balance,
- Drying oven,
- Incubator,
- Flocculation test kit,

- Hot plate stirrers,
- Vacuum pumps,
- Water bath,
- Distillation kit,
- Continuous deionizer unit, and
- Miscellaneous instruments, consumables and spares for measurement and analysis.

### 4.4.4 Rehabilitation Plan

#### (1) Existing Sewage Treatment Facilities

Both the Janga and Cabanga sewage treatment facilities have been investigated based on the data and information provided by COMPESA and the GME. This data and the actual sewage flow have been confirmed on site with representatives of COMPESA.

The other sewerage facilities (independent small systems) which have been maintained by the Janga and Cabanga maintenance teams have not been investigated because they will not be used for the sewerage systems in this project.

#### (2) Field Survey and Problems of Existing Sewage Treatment Facilities

To investigate the present condition of the existing sewage treatment facilities, and to obtain basic data for a rehabilitation plan, a field survey has been carried out. It was accompanied by representatives of COMPESA.

The major equipment has been investigated. Unfortunately, the present situation of the sewage treatment facilities looks very serious. The system is almost out of action and needs to be restored. The major problems are highlighted as follows:

#### 1) Janga Sewage Treatment Facilities

All the sewage passing through the pumping stations EEJ-01 to 21 listed in Table 4.4-4 of Article 3.4 "Pumping Stations" are collected at the Janga sewage treatment facilities by way of pressure pipes.

1) The facilities are old and have had either little or no maintenance and need to be restored,

2) The facilities are working at 20% capacity. Much equipment is out of action due to breakage, maintenance problems or missing parts. There appears to be very little possibility of restoring it due to lack of COMPESA funds. It should be noted that the operating pumps include one, which is in very bad condition,

3) There are two inflow steel bend pipes. They are oxidized with big holes and need replacement. Although almost pumping stations connected to the sewage treatment stations, at present, are not functioning, if all of the pumping stations worked normally, the sewage would leak from the pipes into the ground,

4) There is 1 inflow flow meter. It is out of action due to breakage of the measuring system and needs to be restored,

5) There are 2 grit chambers. One of them is out of action due to breakage of the grit collector (scraper) and need to be restored.

6) There are 2 aeration systems. There is only 1 operating aerator (17%) of a total of 6. All others (5 units: 83%) are out of action due to breakage or maintenance problems and remain to be restored,

7) There are 2 sedimentation systems. 1 unit is in functioning but insufficiently. The other is out of action due to breakage and maintenance problems and needs to be restored. The sludge collectors (scrapers: 100%) of both sedimentation units are out of action due to breakage and maintenance problems and need to be restored.

8) There are 2 sludge return pumps. 1 of them is in functioning. The other is in out of action due to breakage and maintenance problems and needs to be restored,

9) There is an electrical control panel located in the site office with the laboratory. The panel is out of action due to breakage, maintenance problems and missing electrical parts. It needs to be restored. The actual operation of the equipment is being managed with a simplified or shortened electrical circuit for the sake of convenience. It should be noted that although the schematic diagram shown on the panel fascia is of the complete sewage treatment facility based on the original plan, in reality a section of the original had not been provided,

10) There is one substation located on site. Although there are electrical boards in the substation, for the time being it is being operated by means of a simplified or shortened electrical circuit for the sake of convenience because of missing of electrical parts due to luck of COMPESA. So it remains to be restored,

11) Some of the gates are out of use and need to be restored,

12) In order to check the updated specifications of equipment, it is suggested that a nameplate of the equipment should be placed on the wall of the equipment house. This is especially needed in the case of submersible pumps.

**2) Cabanga Sewage Treatment Facilities**

All the sewage passing through all the pumping stations of EEC-01 to 20 and 33, excluding EEC-10, 11, 16, listed in Table 4.4-5 of Article 3.4 "Pumping Stations" are collected at the Cabanga sewage treatment facilities by way of pressure pipes.

1) The facilities are old and have had either little or no maintenance and need to be restored,

2) 2)Although there is a grit chamber after the inflow pumping station, no grit chamber is provided before the inflow pumping station. It is better to install one so that the operation of the pumps is not affected by garbage,

3) There are 2 grit chambers after the inflow pumping station. One of them is out of action due to breakage of the grit collector (scraper) and the grit helical pump. They need to be restored,

4) There are 4 sedimentation units. All of them are out of action due to breakage of the mechanical structures and the sludge collectors (scrapers). However they don't need to be restored because they will not be used for the sewerage system in this project,

5) There are 2 recirculation pumps. They are out of action due to breakage and maintenance problems. They need to be restored. The piping around the pumps is very old and needs to be replaced,

6) There are 2 pumps for the crude mud. They are out of action due to breakage and maintenance problems. However they don't need to be restored because they will not be used for the sewerage system in this project,

13) In order to check the updated specifications of equipment, it is suggested that a nameplate of the equipment should be placed on the wall of the equipment house. This is especially needed in the case of submersible pumps.

### 3) Maintenance and Ancillary Systems

Investigating the site of the sewage treatment stations and visiting the maintenance factory of COMPESA (DME = Mechanical Maintenance Division), as well as some maintenance contractors in Recife, It is clear that not only material replacement is required but also that an organization for a better maintenance and support system should be established as soon as the project is carried out. Without this, new system provided for in the project may soon break down due to poor maintenance. The setting up of this organization should also include a budget for training as well as measuring and testing devices to ensure quality control.

## (3) Equipment Powers of Existing Sewage Treatment Facilities

The following items have been investigated:

- Motor: Output (HP), Pole, Phase, Voltage and Hz

The specifications are shown in the following tables:

**Major Motor Powers of Existing Janga Sewage Treatment Facilities**

| No | Items | Quantity | HP | Total Power | Pole | Phase | Voltage | Hz |
|---|---|---|---|---|---|---|---|---|
| 1 | Grit Helical pump | 1 | 3 | 3 | | 3 | | 60 |
| 2 | Aerator | 6 | 125 | 750 | | 3 | 380/440 | 60 |
| 3 | Sedimentation Unit | 2 | 3 | 6 | | 3 | 220/380 | 60 |
| 4 | Sludge Return Helical Pump Unit | 2 | 10 | 20 | | 3 | 380 | 60 |
| | Total | - | - | 779 | - | - | - | - |

**Major Motor Powers of Existing Cabanga Sewage Treatment Facilities**

| No | Items | Quantity | HP | Total Power | Pole | Phase | Voltage | Hz |
|---|---|---|---|---|---|---|---|---|
| 1 | Bar Screen | 2 | 3 | 6 | 6 | 3 | 380 | 60 |
| 2 | Exhaust Fan | 1 | 2 | 2 | | 2 | 220 | 60 |
| 3 | Inflow Pump | 5 | 75 | 375 | 6 | 3 | 380 | 60 |
| 4 | Grit Helical pump for Grit Chamber | 2 | 3 | 6 | 6 | 3 | 380 | 60 |
| 5 | Sedimentation Unit | 4 | 5 | 20 | 6 | 3 | 380 | 60 |
| 6 | Recirculation Pump | 2 | 50 | 100 | 6 | 3 | 380 | 60 |
| 7 | Crude Mud Pump | 2 | 5 | 10 | 4 | 3 | 380 | 60 |
| 8 | | | | | | | | |
| | Total | - | - | 519 | - | - | - | - |

Almost all of the specifications have been recorded on site because COMPESA records are not updated when equipment is repaired, modified and replaced. Output of the motors is shown in HP, being the unit used in Brazil.

### (4) Rehabilitation Plan

Based on the field survey reports, the rehabilitation plans for the existing sewage treatment facilities have been prepared and shown in Table 4.4-4 for Janga Sewage Treatment Facilities and in Table 4.4-5 for Cabanga Swage Treatment Facilities respectively.

**Table 4.4-1 Treatment Process Applied for Priority STFs**

| STFs | Biological Treatment System | | Sludge Treatment System | | |
|---|---|---|---|---|---|
| | RAFA + Bio-Filtration | RAFA + Aerated Lagoon + Polishing Pond | Sludge Digestion | Mechanical Dehydration | Natural Drying |
| Conceicao | | ● | | | ● |
| Janga | | ● | | | ● |
| Cabanga | ● <br> ➢ The land area is very constrained. | | ● <br> ➢ Existing Facilities will be used after rehabilitated. | ● <br> ➢ The land area is very constrained. | |
| Boa Viagem | | ● | <br> ➢ | ● <br> ➢ The site is adjacent to residential zone. | |
| Cordeiro | ● <br> ➢ The available land area is limited due to the road and park construction plan. | | | ● <br> ➢ The site is adjacent to residential zone. | |
| Prazeres | | ● | | | ● |
| Curcurana | | ● | | | ● |

## Table 4.4-2 Major Facilities and Structural Works of Priority STFs (1/3)

| Items | | Conceicao STF | Janga STF | Cabanga STF |
|---|---|---|---|---|
| Influent System | | | | |
| | Grit Chamber | Rectangular concrete tank, 2 units<br>2.0 m wide x 5.0 m long x 0.5 m deep (water) | Rectangular concrete tank, 3 units<br>2.0 m wide x 7.0 m long x 0.8 m deep (water) | Rectangular concrete tank, 2 units (Existing)<br>8.8 m wide x 8.8 m long x 0.6 m deep (water) |
| | Influent Pump | Vertically mixed flow, 3 units including one standby<br>7.2 $m^3$/min x 300 mm-ND x 16 m-Head x 40 CV | Vertically mixed flow, 4 units including one standby<br>11.5 $m^3$/min x 350 mm-ND x 13 m-Head x 50 CV | Vertically cenrifugal, 5 units including one standby (Existing)<br>26.4 $m^3$/min x 75 HP |
| | Transfer Pump | None | None | Vertically mixed flow, 5 units including one standby<br>16.5 $m^3$/min x 50 CV |
| Biological Treatment System | | | | |
| | RAFA Reactor | Rectangular concrete tank, 4 trains<br>5.0 m wide x 5.0 m long x 6.0 m deep x 9 units, 4500 $m^3$ | Rectangular concrete tank, 4 trains<br>5.0 m wide x 5.0 m long x 6.0 m deep x 21 units, 10500 $m^3$ | Rectangular concrete tank, 8 trains<br>5.0 m wide x 5.0 m long x 7.0 m deep x 17 units, 20400 $m^3$ |
| | Aerated Lagoon | Rectangular earth pond, 2 units<br>32 m wide x 100 m long x 4.3 m deep, 14900 $m^3$ | Rectangular earth pond, 4 units<br>50 m wide x 66 m long x 4.3 m deep, 34636 $m^3$ | None |
| | Polishing Pond | Rectangular earth pond, 2 units<br>32 m wide x 152 m long x 4.3 m deep, 22492 $m^3$ | Rectangular earth pond, 4 units<br>50 m wide x 100 m long x 4.3 m deep, 51846 $m^3$ | None |
| | Bio-Filter | None | None | Cylindrical concrete tank, 3 units<br>39 m Dia x 2.5 m deep |
| | Sedimentation Tank | None | None | Rectangular concrete tank, 4 units<br>12 m wide x 60 m long x 3.8 m deep |
| | Recirculation Pump | None | None | Vertically mixed flow, 7 units including one standby<br>16 $m^3$/min x 450 mm-ND x 8 m-Head x 40 CV |
| Desinfection System | | Rectangular concrete tank, 1 unit<br>3.0 m wide x 6.0 m long x 2.5 m deep | Rectangular concrete tank, 1 unit<br>4.0 m wide x 10 m long x 2.5 m deep | Rectangular concrete tank, 1 unit<br>5.0 m wide x 12 m long x 2.5 m deep |
| Treated Sewage Discharge System | | Reinforced concrete pipe, ND 800 mm x 2900 m long | Reinforced concrete pipe, ND 1200 mm x 2300 m long | Reinforced concrete pipe, ND 1000 mm x 50 m long x 2 sets |
| Sludge Treatment System | | | | |
| | Sludge Thickener | Cylindrical concrete tank, 1 unit<br>4.5 m dia. x 5.0 m deep | Cylindrical concrete tank, 1 unit<br>15 m dia. x 5.0 m deep | Cylindrical concrete tank, 1 unit<br>13 m dia. x 5.0 m deep |
| | Sludge Digester | None | None | Cylindrical concrete tank, 2 units<br>25 m dia. x 8.2 m deep, 4115 $m^3$ |
| | Gas Holder | None | None | Cylindrical concrete tank, 1 unit<br>10 m dia. x 5.0 m deep, 780 $m^3$ |
| | Sludge Drying Bed | Rectangular concrete tank, 6 units<br>10 m wide x 15 m long x 1.0 m deep | Rectangular concrete tank, 56 units<br>10 m wide x 15 m long x 1.0 m deep | None |
| | Dehydrator | None | None | Filter-belt press, 2 units<br>2.5 m wide (belt) |
| Electrical and Control System | | Power receiving boards, supervisory boards, etc. | Power receiving boards, supervisory boards, etc. | Power receiving boards, supervisory boards, etc. |
| Building and Civil works | | Administration building and other buildings, Rainwater drainage, guard fence and gates, etc. | Administration building and other buildings, Rainwater drainage, guard fence and gates, etc. | Administration building and other buildings, Rainwater drainage, guard fence and gates, etc |

## Table 4.4-2 Major Facilities and Structural Works of Priority STFs (2/3)

| Items | | Boa Viagem STF | Cordeiro STF |
|---|---|---|---|
| Influent System | | | |
| | Grit Chamber | Rectangular concrete tank, 3 units<br>2.0 m wide x 7.0 m long x 0.8 m deep (water) | Rectangular concrete tank, 2 units<br>2.0 m wide x 6.0 m long x 0.8 m deep (water) |
| | Influent Pump | Vertically mixed flow, 4 units including one standby<br>11 $m^3$/min x 350 mm-ND x 16 m-Head x 60 CV | Vertically mixed flow, 3 units including one standby<br>11.0 $m^3$/min x 350 mm-ND x 16 m-Head x 60 CV |
| | Transfer Pump | None | None |
| Biological Treatment System | | | |
| | RAFA Reactor | Rectangular concrete tank, 4 trains<br>5.0 m wide x 5.0 m long x 6.0 m deep x 20 units, 10000 $m^3$ | Rectangular concrete tank, 4 trains<br>5.0 m wide x 5.0 m long x 6.0 m deep x 13 units, 6500 $m^3$ |
| | Aerated Lagoon | Rectangular earth pond, 3 units<br>49 m wide x 86 m long x 4.3 m deep, 34317 $m^3$ | None |
| | Polishing Pond | Rectangular earth pond, 3 units<br>49 m wide x 125 m long x 4.3 m deep, 48438 $m^3$ | None |
| | Bio-Filter | None | Cylindrical concrete tank, 2 units<br>27 m Dia x 2.5 m deep |
| | Sedimentation Tank | None | Cylindrical concrete tank, 2 units<br>25 m wide x 3.5 m deep |
| | Recirculation Pump | None | Vertically mixed flow, 3 units including one standby<br>16 $m^3$/min x 450 mm-ND x 8 m-Head x 40 CV |
| Desinfection System | | Rectangular concrete tank, 1 unit<br>3.0 m wide x 10 m long x 2.5 m deep | Rectangular concrete tank, 1 unit<br>3.0 m wide x 8.0 m long x 2.5 m deep |
| Treated Sewage Discharge System | | Reinforced concrete pipe, ND 800 mm x 95 m long | Reinforced concrete pipe, ND 800 mm x 50 m long |
| Sludge Treatment System | | | |
| | Sludge Thickener | Cylindrical concrete tank, 1 unit<br>7.5 m dia. x 5.0 m deep | Cylindrical concrete tank, 1 unit<br>8.0 m dia. x 5.0 m deep |
| | Sludge Digester | None | None |
| | Gas Holder | None | None |
| | Sludge Drying Bed | None | None |
| | Dehydrator | Filter-belt press, 2 units<br>1.5 m wide (belt) | Filter-belt press, 2 units<br>1.5 m wide (belt) |
| Electrical and Control System | | Power receiving boards, supervisory boards, etc. | Power receiving boards, supervisory boards, etc. |
| Building and Civil works | | Administration building and other buildings,<br>Rainwater drainage, guard fence and gates, etc. | Administration building and other buildings,<br>Rainwater drainage, guard fence and gates, etc. |

## Table 4.4-2 Major Facilities and Structural Works of Priority STFs (3/3)

| Items | | Prazeres STF | Curcurana STF |
|---|---|---|---|
| Influent System | | | |
| | Grit Chamber | Rectangular concrete tank, 3 units<br>2.0 m wide x 7.0 m long x 1.0 m deep (water) | Rectangular concrete tank, 2 units<br>2.0 m wide x 8.0 m long x 1.0 m deep (water) |
| | Influent Pump | Vertically mixed flow, 4 units including one standby<br>13 $m^3$/min x 400 mm-ND x 16 m-Head x 75 CV | Vertically mixed flow, 3 units including one standby<br>14.5 $m^3$/min x 400 mm-ND x 16 m-Head x 75 CV |
| | Transfer Pump | None | None |
| Biological Treatment System | | | |
| | RAFA Reactor | Rectangular concrete tank, 6 trains<br>5.0 m wide x 5.0 m long x 6.0 m deep x 16 units, 12000 $m^3$ | Rectangular concrete tank, 6 trains<br>5.0 m wide x 5.0 m long x 6.0 m deep x 12 units, 9000 $m^3$ |
| | Aerated Lagoon | Rectangular earth pond, 3 units<br>39 m wide x 130 m long x 4.3 m deep, 40353 $m^3$ | Rectangular earth pond, 2 units<br>50 m wide x 115 m long x 4.3 m deep, 32362 $m^3$ |
| | Polishing Pond | Rectangular earth pond, 3 units<br>39 m wide x 200 m long x 4.3 m deep, 59508 $m^3$ | Rectangular earth pond, 2 units<br>50 m wide x 166 m long x 4.3 m deep, 44928 $m^3$ |
| | Bio-Filter | None | None |
| | Sedimentation Tank | None | None |
| | Recirculation Pump | None | None |
| Desinfection System | | Rectangular concrete tank, 1 unit<br>4.0 m wide x 10 m long x 2.5 m deep | Rectangular concrete tank, 1 unit<br>3.0 m wide x 10 m long x 2.5 m deep |
| Treated Sewage Discharge System | | Reinforced concrete pipe, ND 1200 mm x 2900 m long | Reinforced concrete pipe, ND 1000 mm x 1600 m long |
| Sludge Treatment System | | | |
| | Sludge Thickener | Cylindrical concrete tank, 1 unit<br>9.5 m dia. x 5.0 m deep | Cylindrical concrete tank, 1 unit<br>8.0 m dia. x 5.0 m deep |
| | Sludge Digester | None | None |
| | Gas Holder | None | None |
| | Sludge Drying Bed | Rectangular concrete tank, 24 units<br>10 m wide x 15 m long x 1.0 m deep | Rectangular concrete tank, 14 units<br>10 m wide x 15 m long x 1.0 m deep |
| | Dehydrator | None | None |
| Electrical and Control System | | Power receiving boards, supervisory boards, etc. | Power receiving boards, supervisory boards, etc. |
| Building and Civil works | | Administration building and other buildings,<br>Rainwater drainage, guard fence and gates, etc. | Administration building and other buildings,<br>Rainwater drainage, guard fence and gates, etc. |

## Table 4.4-3 Major Operation Parameters for STFs

| Systems | Component Facilities | Check Parameters | STFs | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Conceicao | Janga | Cabanga | Boa Viagem | Cordeiro | Prazeres | Curcurana |
| Influent System | Coarse Bar Screen | Trapped screenings volume | ● | ● | ● | ● | ● | ● | ● |
| | | Water levels of pre-screen and post-screen | ● | ● | ● | ● | ● | ● | ● |
| | Grit Chamber | Grit collector running | ● | ● | ● | ● | ● | ● | ● |
| | | Settling grit volume | ● | ● | ● | ● | ● | ● | ● |
| | Fine Bar Screen | Trapped screenings volume | ● | ● | ● | ● | ● | ● | ● |
| | | Water levels of pre-screen and post-screen | ● | ● | ● | ● | ● | ● | ● |
| | Influent Pump | Pump running | ● | ● | ● | ● | ● | ● | ● |
| | | Discharged quantity | ● | ● | ● | ● | ● | ● | ● |
| Biological Treatment System | RAFA Distribution Box | Distributed sewage flow | ● | ● | ● | ● | ● | ● | ● |
| | RAFA Reactor | Distributed sewage flow | ● | ● | ● | ● | ● | ● | ● |
| | | Gas generation flow | ● | ● | ● | ● | ● | ● | ● |
| | | Accumulated sludge level | ● | ● | ● | ● | ● | ● | ● |
| | RAFA Sludge Draw-off Pump | Pump running | ● | ● | ● | ● | ● | ● | ● |
| | | Drawn sludge volume | ● | ● | ● | ● | ● | ● | ● |
| | Lagoon Distribution Box | Distributed sewage flow | ● | ● | | ● | | ● | ● |
| | Aerated Lagoon | Aerator running | ● | ● | | ● | | ● | ● |
| | Polishing Pond | Algae growth and scum generation | ● | ● | | ● | | ● | ● |
| | B/F Distribution Box | Distributed sewage flow | | | ● | | ● | | |
| | Bio-Filter | Spray arm running | | | ● | | ● | | |
| | | Odor generation | | | ● | | ● | | |
| | Recirculation Pump | Pump running | | | ● | | ● | | |
| | | Recirculation flow | | | ● | | ● | | |
| | Sedimentation Tank | Sludge collector running | | | ● | | ● | | |
| | | Scum generation | | | ● | | ● | | |
| | S/T Sludge Draw-off Pump | Pump running | | | ● | | ● | | |
| | | Drawn sludge volume | | | ● | | ● | | |
| Disaffection System | UV disinfection Unit | Unit running | ● | ● | ● | ● | ● | ● | ● |
| | Disinfection Tank | Treated sewage flow | ● | ● | ● | ● | ● | ● | ● |
| | Treated Sewage Outfall | Treated sewage flow | ● | ● | ● | ● | ● | ● | ● |
| | | Discharge water appearance | ● | ● | ● | ● | ● | ● | ● |
| Sludge Treatment System | Sludge Thickener | Sludge rake running | ● | ● | ● | ● | ● | ● | ● |
| | | Scum generation | ● | ● | ● | ● | ● | ● | ● |
| | Thickened Sludge Pump | Pump running | | | ● | ● | ● | | |
| | | Drawn sludge volume | ● | ● | ● | ● | ● | ● | ● |
| | | Sludge concentration | ● | ● | ● | ● | ● | ● | ● |
| | Sludge Digester | Sludge recircualtion pump running | | | ● | | | | |
| | | Gas generation | | | ● | | | | |
| | | Drawn sludge volume | | | ● | | | | |
| | | Drawn sludge supernatant | | | ● | | | | |
| | | Drawn sludge concentration | | | ● | | | | |
| | Gas Holder | Generated gas volume | | | ● | | | | |
| | Dehydrator | Dehydrator and related equipment running | | | ● | ● | ● | | |
| | | Dehydrated sludge quantity | | | ● | ● | ● | | |
| | | Sludge moisture | | | ● | ● | ● | | |
| | | Polymer coagulant consumption | | | ● | ● | ● | | |
| | | Polymer coagulant storage volume | | | ● | ● | ● | | |
| | Sludge Drying Bed | Dried sludge quantity | ● | ● | | | | ● | ● |
| | | Dried sludge moisture | ● | ● | | | | ● | ● |

Remark:

(1) Operation parameters necessary for respective STFs are shown by the mark "●".

## Table 4.4-4 Rehabilitation Plan for Existing Cabanga Sewage Treatment Station

| No. | Item | Quantity | | | |
|---|---|---|---|---|---|
| | | A Good in Use | B To be Repaired | C To be Replaced | Total |
| 1 | Inflow Well | 1 | 0 | 0 | 1 |
| 2 | Automatic Bar Screen Unit | 2 | 0 | 2 | 2 |
| 3 | Inflow Pumping Station | 1 | 0 | 0 | 0 |
| | 1) Pumps & Motors | 5 | 0 | 0 | 5 |
| | 2) Valves & Gates | 15 | 0 | 0 | 15 |
| | 3) Operation Panels | 1 | 0 | 0 | 1 |
| | 4) Pipes | 5 | 0 | 0 | 5 |
| 4 | Grit Chamber | - | - | - | - |
| | 1) Gates | 1 | 1 | 0 | 2 |
| | 2) Guide Vanes | 1 | 0 | 1 | 2 |
| | 3) Grit Collector | 1 | 1 | 0 | 2 |
| | 4) Grit Helical Pump | 1 | 1 | 0 | 2 |
| 5 | Distributor | 0 | 1 | 0 | 1 |
| 6 | Sedimentation Unit No.1 & No.2 | 0 | 2 | 0 | 2 |
| | 1) Sludge Collector | 0 | 2 | 0 | 2 |
| | 2) Tuning Unit | 0 | 2 | 0 | 2 |
| 7 | Purifiers No.1 No.2 | 0 | 2 | 0 | 0 |
| | 1) Sludge Collector | 0 | 2 | 0 | 2 |
| | 2) Tuning Unit | 0 | 2 | 0 | 2 |
| 8 | Digester No.1 & No.2 | 2 | 0 | 0 | 2 |
| | 1) Recirculation Pump (Suction & Delivery) | 0 | 2 | 0 | 2 |
| | 2) Motor | 0 | 2 | 0 | 2 |
| | 3) Piping | 0 | 0 | 1 | 1 |
| 9 | Valve 400mmdia | 0 | 0 | 2 | 2 |
| | Valve 450mmdia | 0 | 0 | 2 | 2 |
| | Check Valve 400 mmdia | 0 | 0 | 2 | 2 |
| 10 | Crude Mud Well | 0 | 1 | 0 | 1 |
| | 1) Pumps & Motors | 1 | 0 | 1 | 2 |
| | 2) Unloading Connection | 1 | 0 | 1 | 2 |
| | 3) Supporting Guide Pipes | 1 | 0 | 1 | 2 |
| | 4) W.Level Regulators | 1 | 0 | 1 | 2 |
| 11 | Chain Block | 0 | 0 | 1 | 1 |
| 12 | Steel Tripod for Chain Block | 0 | 0 | 1 | 1 |
| 13 | Operation Control Panel | 0 | 1 | 0 | 0 |
| 14 | Substation | 0 | 3 | 0 | 0 |
| 15 | Adjustment and Cleaning | 0 | 1 | 0 | 0 |
| 16 | Cleaning and repairing for the above items | 0 | 1 | 0 | 1 |
| 17 | Concrete Structureswells for the below | - | - | - | - |
| | 1) Inflow Well | 1 | 0 | 0 | 1 |
| | 2) Automatic Bar Screen Well | 1 | 0 | 0 | 1 |
| | 3) Well & House of Inflow Pumping Station | 1 | 0 | 0 | 1 |
| | 4) Channel: Pumping Station to Grit Chamber | 1 | 0 | 0 | 1 |
| | 5) Grit Chamber Well | 1 | 0 | 0 | 1 |
| | 6) Sedimentation Wells No.1 & No.2 | 2 | 0 | 0 | 2 |
| | 7) Purifier Wells No.1 No.2 | 2 | 0 | 0 | 2 |
| | 8) Tanks & House of Digester No.1 & No.2 | 2 | 1 | 0 | 2 |
| | 9) Crude Mud Well | 1 | 0 | 0 | 1 |
| | 10) Gas Holder | 1 | 0 | 0 | 1 |
| | 11) Waste Gas Burner | 0 | 1 | 0 | 1 |
| | 12) Sludge Drying Bed (Removal) | 0 | 1 | 0 | 1 |
| | 13) Outflow Well | 0 | 1 | 0 | 1 |
| | | 0 | 1 | 0 | 1 |
| | Total | 53 | 32 | 16 | 90 |

**Table 4.4-5 Rehabilitation Plan for Existing Janga Sewage Treatment Station**

| No. | Item | Quantity | | | |
|---|---|---|---|---|---|
| | | A Good in Use | B To be Repaired | C To be Replaced | Total |
| 1 | Inflow Unit | - | - | - | - |
| | 1) Inflow bend pipes 800mmdia | 0 | 0 | 2 | 2 |
| | 2) Bar Screen | 1 | 0 | 0 | 0 |
| 2 | Inflow Meter | 0 | 0 | 1 | 1 |
| 3 | Grit Chamber | - | - | - | - |
| | 1) Grit Collector | 0 | 1 | 0 | 0 |
| | 2) Grit Helical Pump | 0 | 1 | 0 | 0 |
| 4 | Aeration Unit | 0 | 1 | 0 | 0 |
| | 1) Acrator | 1 | 5 | 0 | 0 |
| 5 | Sedimentation Unit | 0 | 1 | 0 | 1 |
| | 1) Sludge Collector | 0 | 2 | 0 | 0 |
| 6 | Sludge Return Helical Pump Unit | 1 | 1 | 0 | 0 |
| 7 | Valves and Gates | 0 | 4 | 6 | 6 |
| 8 | Operation Control Panel | 0 | 1 | 0 | 0 |
| 9 | Substation | 0 | 3 | 0 | 0 |
| 10 | Adjustment and Cleaning | 0 | 1 | 0 | 0 |
| 11 | Adjustment & Cleaning | 0 | 1 | 0 | 1 |
| 12 | Concrete Structureswells for the below | - | - | - | - |
| | 1) Inflow Well | 1 | 0 | 0 | 0 |
| | 2) Inflow Meter Well | 1 | 0 | 0 | 0 |
| | 3) Grit Chamber Well | 1 | 0 | 0 | 0 |
| | 4) Aeration Well | 1 | 0 | 0 | 0 |
| | 5) Sedimentation Well | 1 | 0 | 0 | 0 |
| | 6) Purifier Wells | 1 | 0 | 0 | 0 |
| | 7) Outflow Well | 1 | 0 | 0 | 0 |
| | 8) Control Center House | 1 | 0 | 0 | 0 |

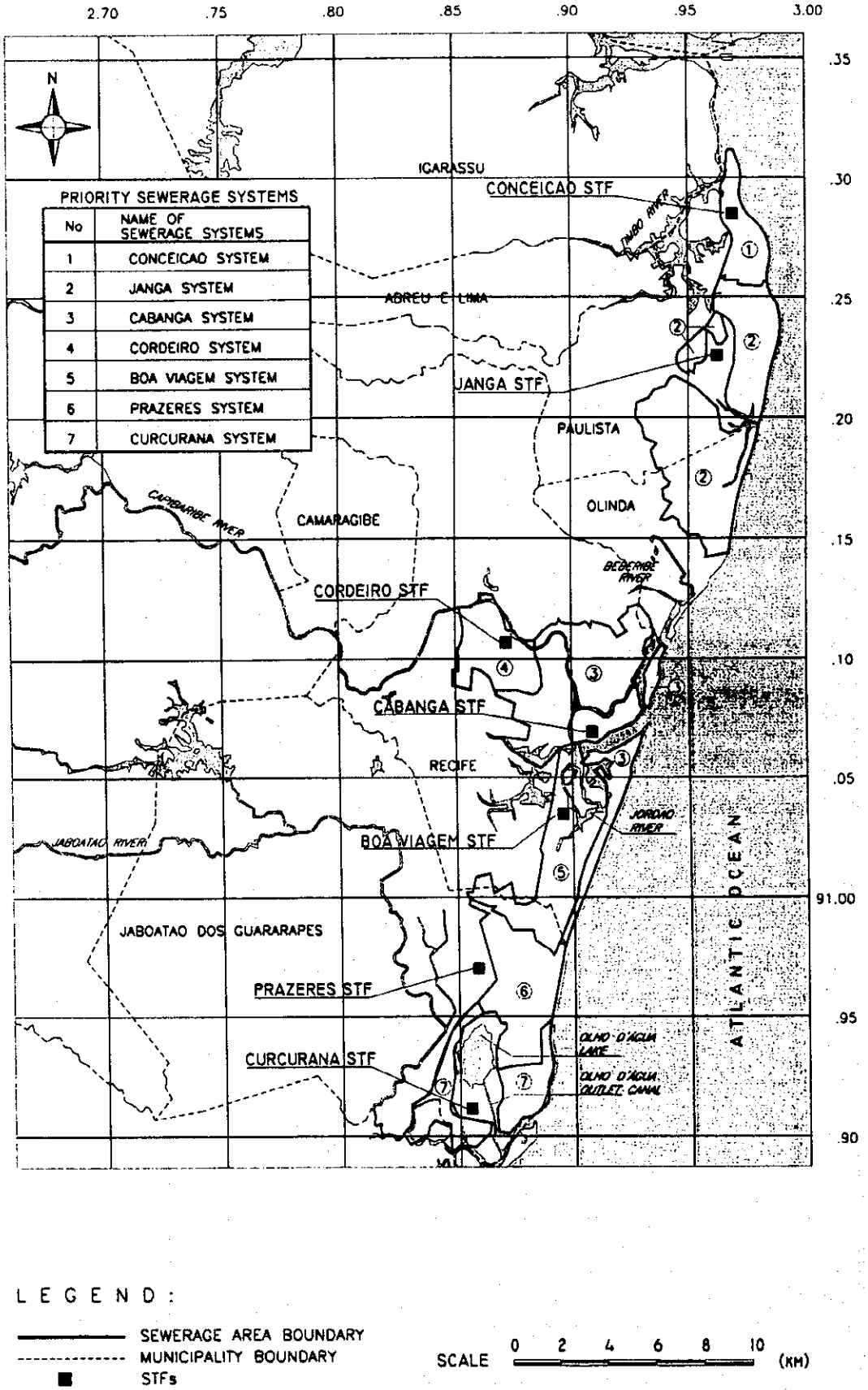
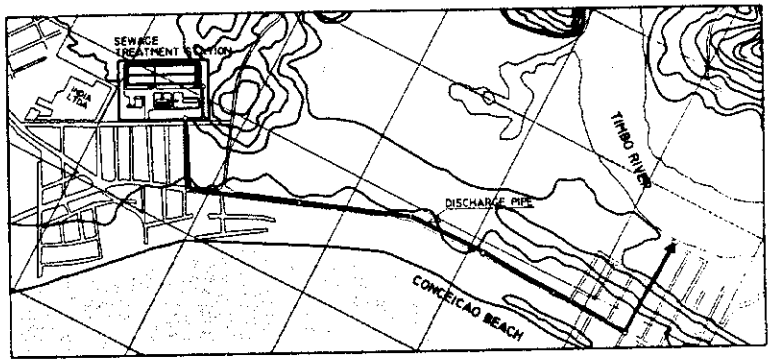



**Fig. 4.4-1** Location of Priority Sewage Treatment Facilities




TREATED SEWAGE DISCHARGE PIPE

SCALE: 1/20,000

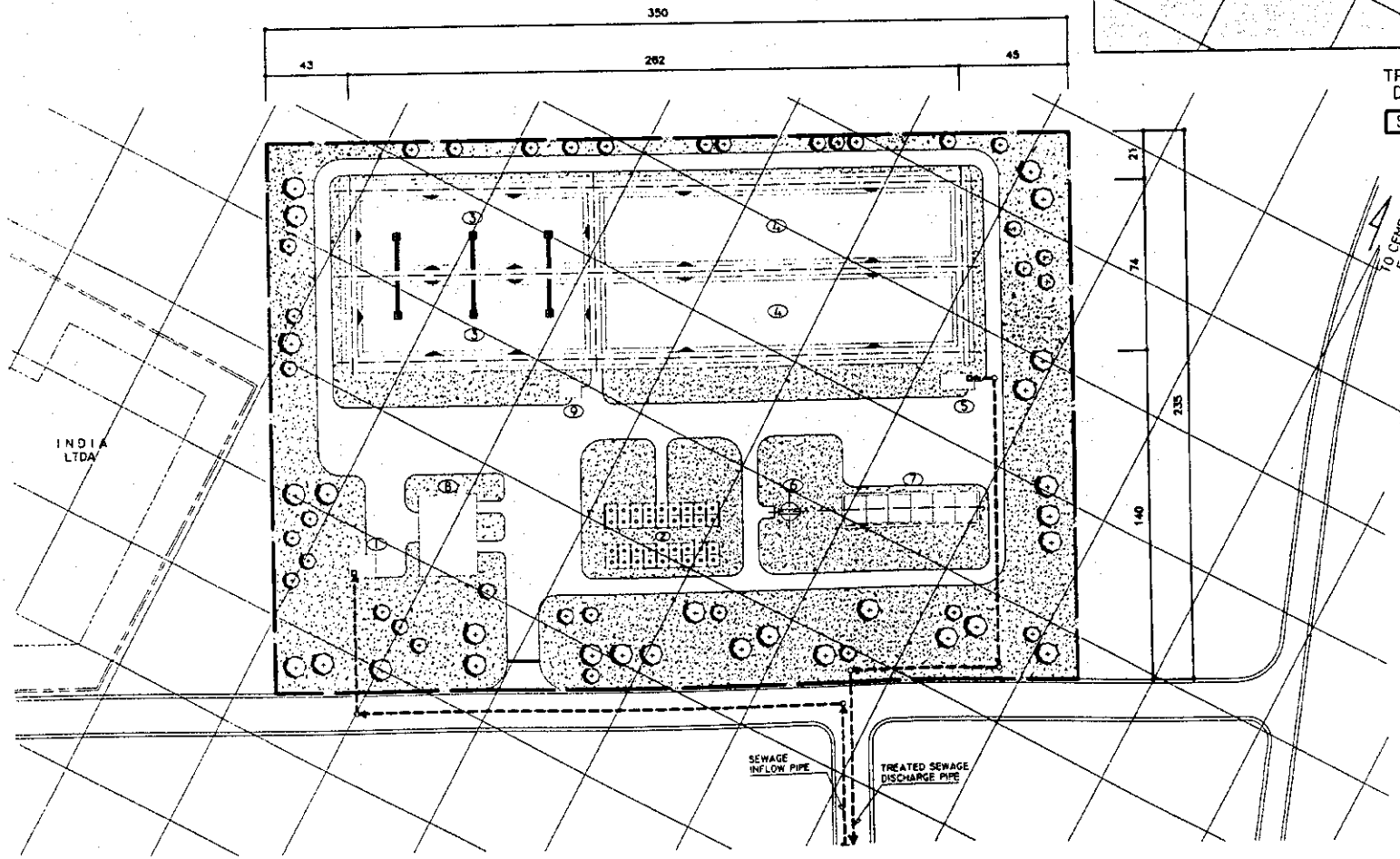



TABLE OF FACILITIES

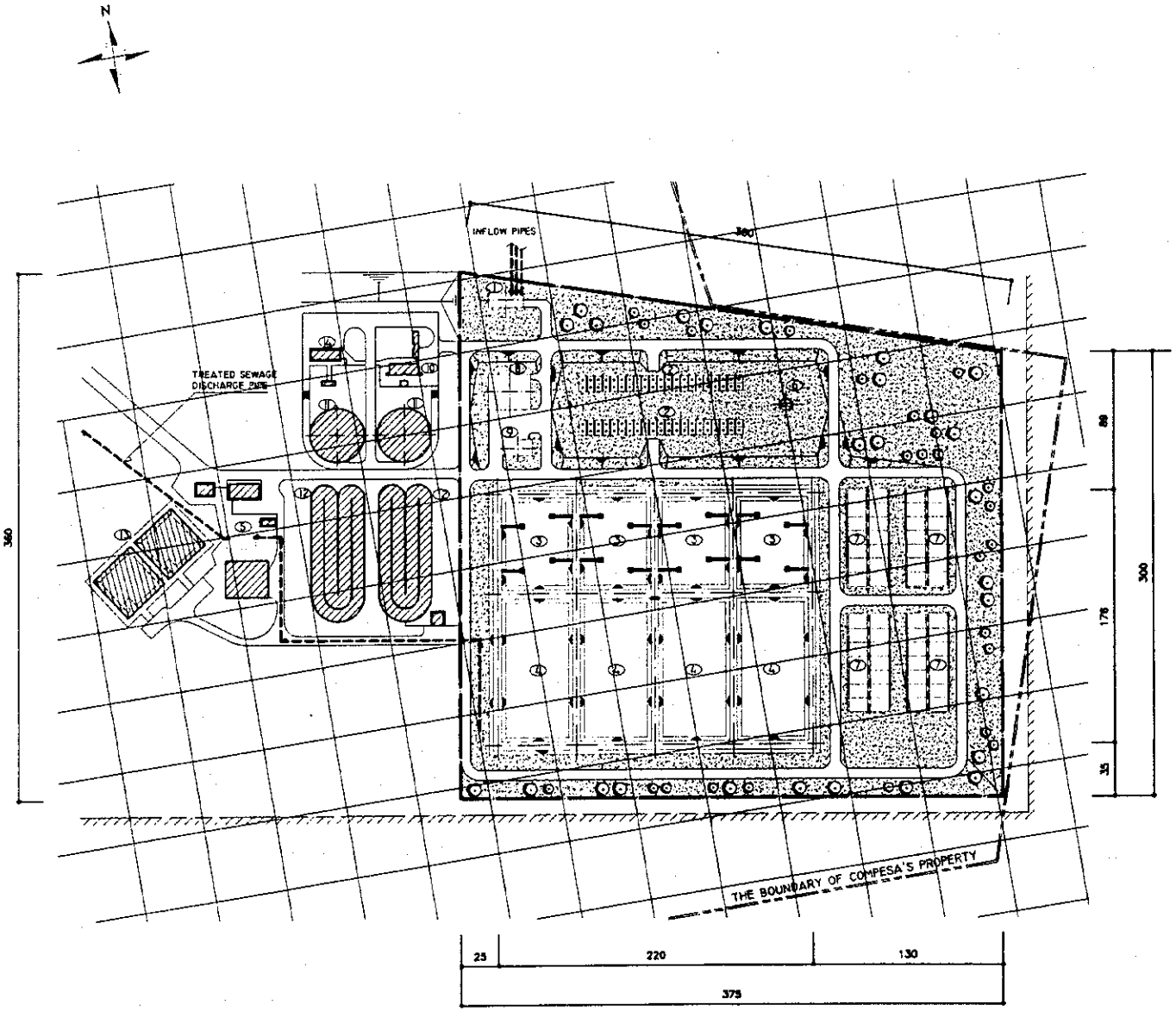
| NUMBER | NAME |
|---|---|
| 1 | GRIT CHAMBERS AND INFLUENT WELL |
| 2 | RAFA REACTORS |
| 3 | AERATED LAGOONS |
| 4 | POLISHING PONDS |
| 5 | DISINFECTION TANK |
| 6 | SLUDGE THICKENER |
| 7 | SLUDGE DRYING BEDS |
| 8 | ADMINISTRATION BUILDING |
| 9 | ELECTRICAL ROOM |

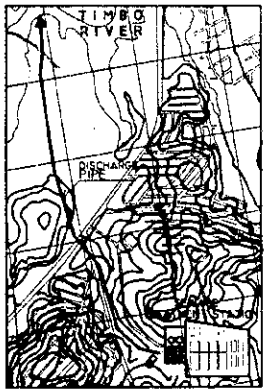
REMARKS:
(1) THE UNIT OF COORDINATE IS 50m.
(2) THE UNIT OF DIMENSIONS IS "METER".

SCALE: 1/2,000

**Fig. 4.4-2** Conceicao Sewage Treatment Facilities Layout Plan

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR




TREATED SEWAGE
DISCHARGE PIPES

SCALE: 1/30,000

TABLE OF FACILITIES

| NUMBER | NAME |
|---|---|
| 1 | GRIT CHAMBERS AND INFLUENT WELL |
| 2 | RAFA REACTORS |
| 3 | AERATED LAGOONS |
| 4 | POLISHING PONDS |
| 5 | DISINFECTION TANK |
| 6 | SLUDGE THICKENER |
| 7 | SLUDGE DRYING BEDS |
| 8 | ADMINISTRATION BUILDING |
| 9 | ELECTRICAL ROOM |
| 10 | GRIT CHAMBERS (EXISTING) |
| 11 | SEDIMENTATION TANKS (EXISTING) |
| 12 | OXIDATION DITCHES (EXISTING) |
| 13 | SLUDGE LAGOON (EXISTING) |
| 14 | ADMINISTRATION ROOM (EXISTING) |

REMARKS:
(1) THE UNIT OF COORDINATE IS 50m.
(2) THE UNIT OF DIMENSIONS IS "METER".
(3) THE FACILITIES MARKED BY HATCHING ARE EXISTING ONES.

SCALE: 1/3,000

**Fig. 4.4-3** Janga Sewage Treatment Facilities Layout Plan

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR

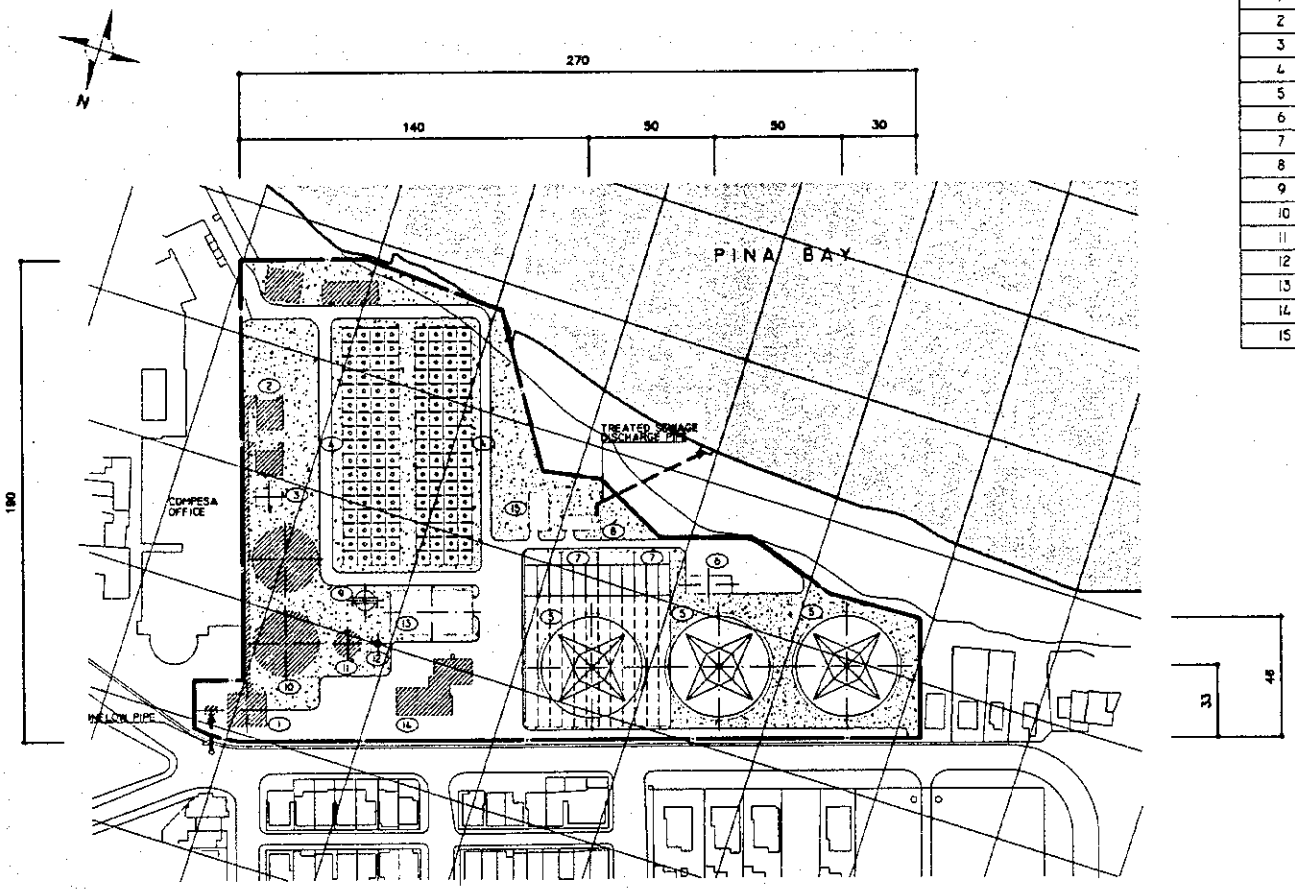



TABLE OF FACILITIES

| NUMBER | NAME |
|---|---|
| 1 | INFLUENT WELL AND INFLUENT PUMPS (EXISTING) |
| 2 | GRIT CHAMBERS |
| 3 | TRANSFER PUMPS |
| 4 | RAFA REACTORS |
| 5 | BIO-FILTERS |
| 6 | RECIRCULATION PUMPS |
| 7 | SEDIMENTATION TANKS |
| 8 | DISINFECTION TANK |
| 9 | SLUDGE THICKENER |
| 10 | SLUDGE DIGESTERS (EXISTING) |
| 11 | GAS HOLDER (EXISTING) |
| 12 | BIO-GAS BURNER |
| 13 | DEHYDRATION ROOM AND CONTROL ROOM |
| 14 | ADMINISTRATION ROOM (EXISTING) |
| 15 | ELECTRICAL ROOM |

REMARKS:
(1) THE UNIT OF COORDINATE IS 50m.
(2) THE UNIT OF DIMENSIONS IS "METER".
(3) THE FACILITIES MARKED BY HATCHING ARE EXISTING ONES.

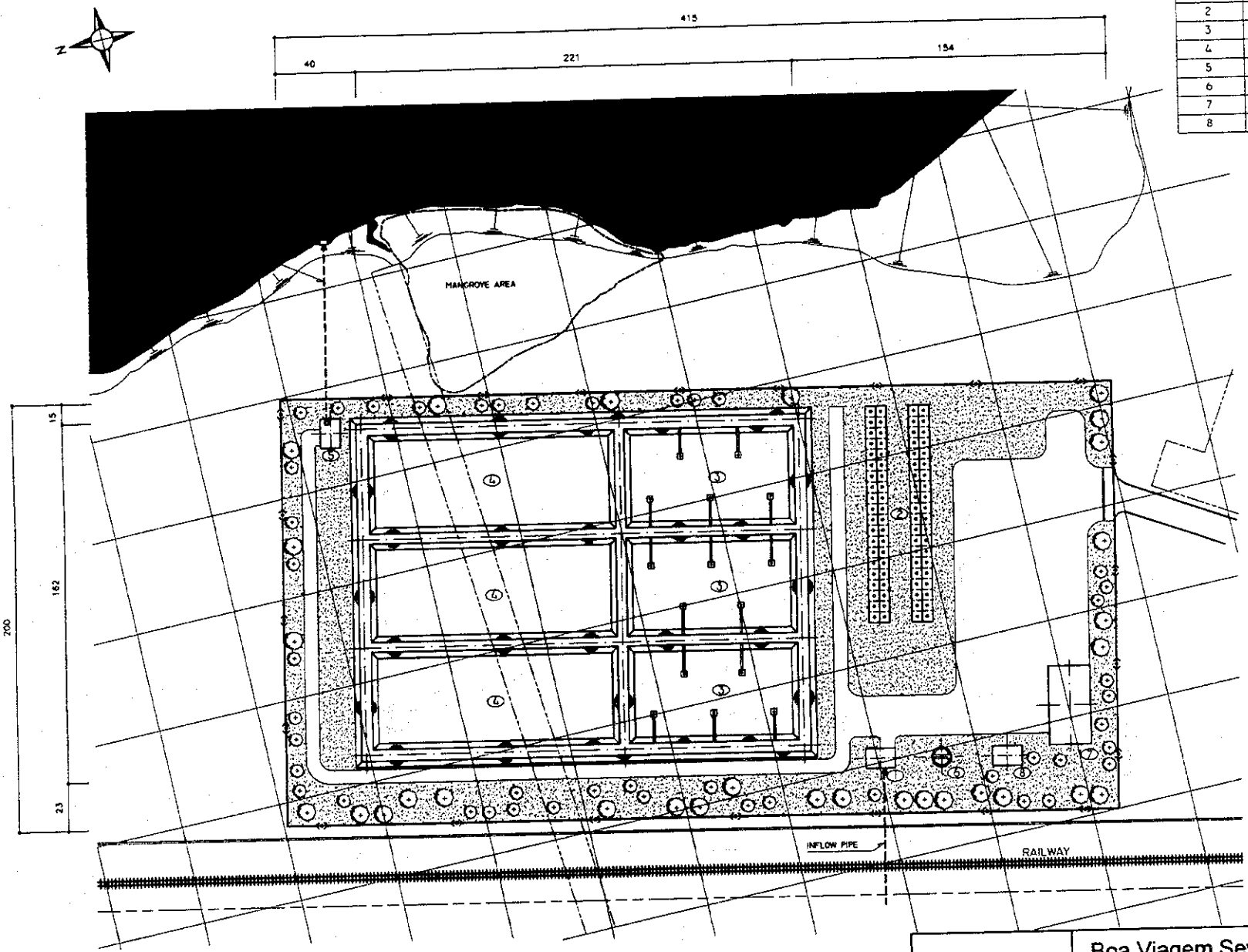
SCALE: 1/2,000

**Fig. 4.4-4** Cabanga Sewage Treatment Facilities Layout Plan

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR

TABLE OF FACILITIES

| NUMBER | NAME |
|---|---|
| 1 | GRIT CHAMBERS AND INFLUENT WELL |
| 2 | RAFA REACTORS |
| 3 | AERATED LAGOONS |
| 4 | POLISHING PONDS |
| 5 | DISINFECTION TANK |
| 6 | SLUDGE THICKENER |
| 7 | ADMINISTRATION BUILDING |
| 8 | ELECTRICAL ROOM |




REMARKS:
(1) THE UNIT OF COORDINATE IS 50M.
(2) THE UNIT OF DIMENSIONS IS "METER".

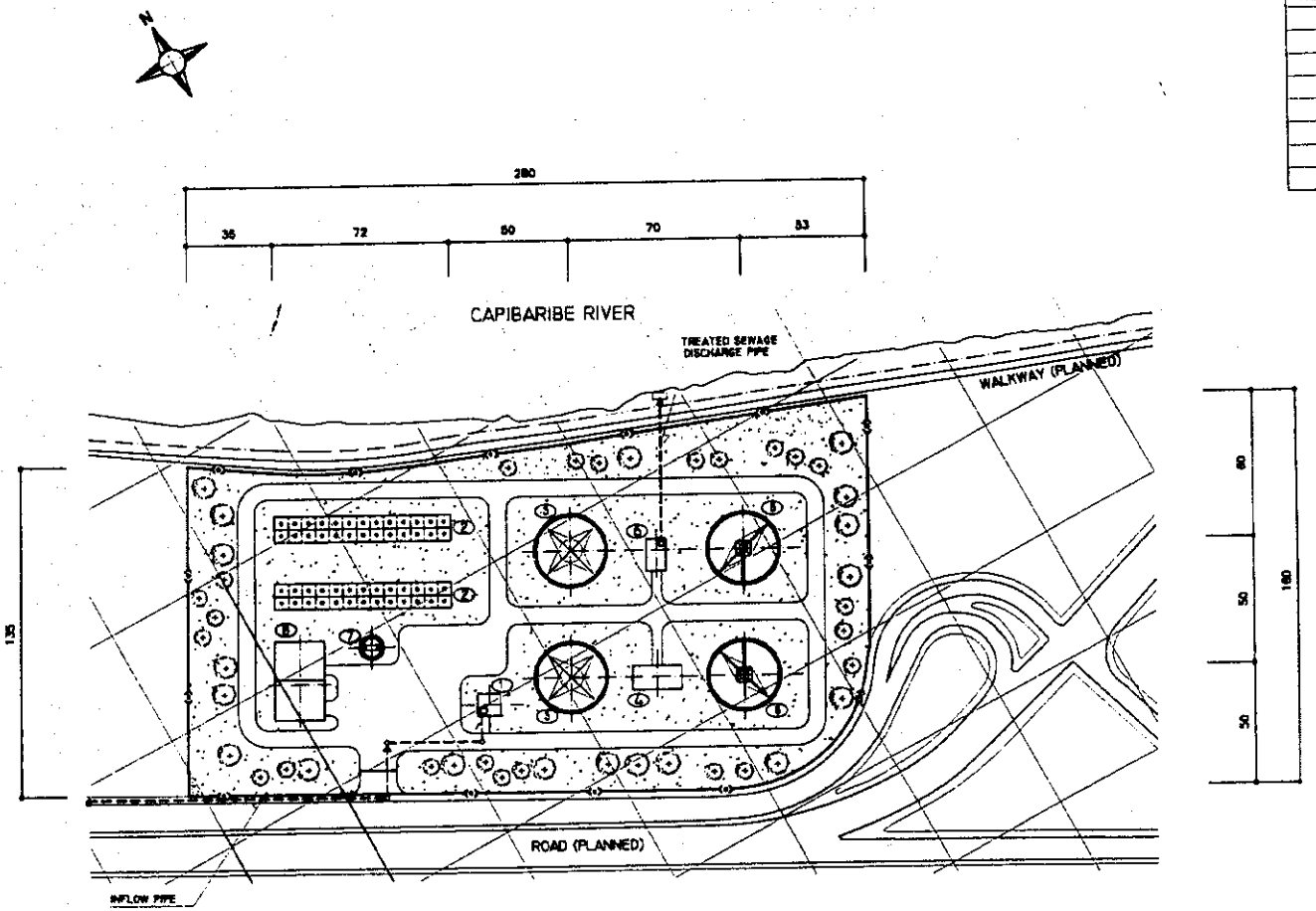
SCALE: 1/2,000

Fig. 4.4-5 Boa Viagem Sewage Treatment Facilities Layout Plan

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR

TABLE OF FACILITIES

| NUMBER | NAME |
|---|---|
| 1 | GRIT CHAMBERS AND INFLUENT WELL |
| 2 | RAFA REACTORS |
| 3 | BIO-FILTERS |
| 4 | TRANSFER TANK |
| 5 | SEDIMENTATION TANKS |
| 6 | DISINFECTION TANK |
| 7 | SLUDGE THICKENER |
| 8 | ADMINISTRATION BUILDING |

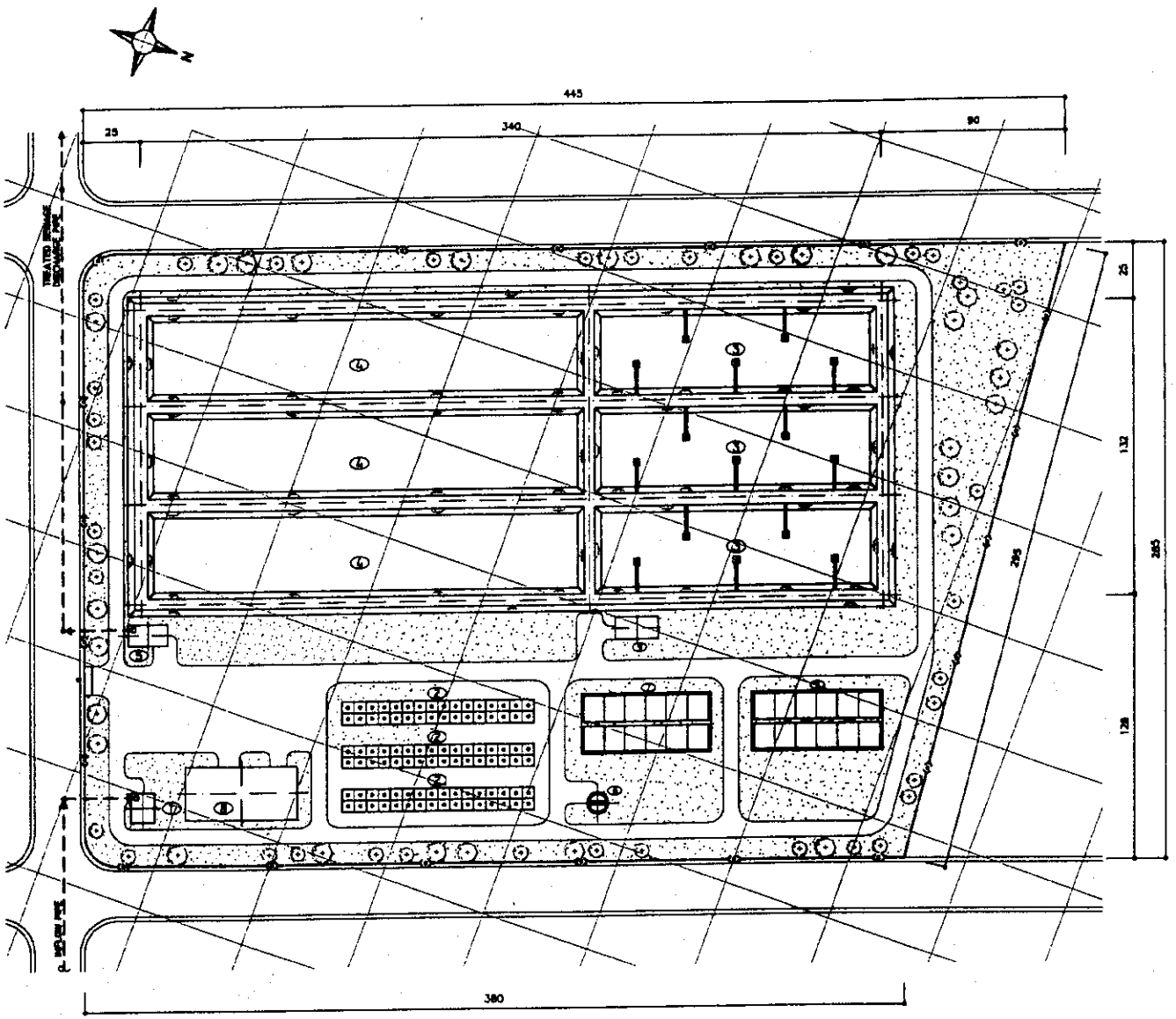



REMARKS:
(1) THE UNIT OF COORDINATE IS 50M.
(2) THE UNIT OF DIMENSIONS IS "METER".

SCALE: 1/2,000

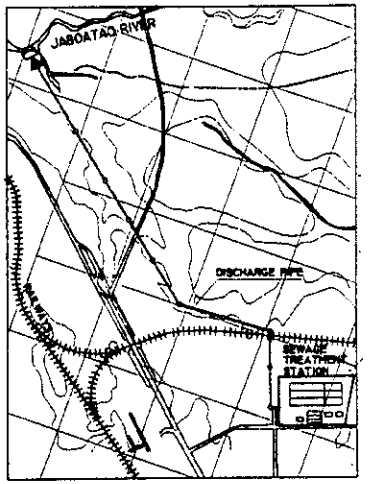
**Fig. 4.4-6** Cordeiro Sewage Treatment Facilities Layout Plan

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR




REMARKS:
(1) THE UNIT OF COORDINATE IS 50m.
(2) THE UNIT OF DIMENSIONS IS "METER".

SCALE: 1/2,000




TREATED SEWAGE DISCHARGE PIPE
SCALE: 1/30,000

TABLE OF FACILITIES

| NUMBER | NAME |
|---|---|
| 1 | GRIT CHAMBERS AND INFLUENT WELL |
| 2 | RAFA REACTORS |
| 3 | AERATED LAGOONS |
| 4 | POLISHING PONDS |
| 5 | DISINFECTION TANK |
| 6 | SLUDGE THICKENER |
| 7 | SLUDGE DRYING BEDS |
| 8 | ADMINISTRATION BUILDING |
| 9 | ELECTRICAL ROOM |

**Fig. 4.4-7** Prazeres Sewage Treatment Facilities Layout Plan

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR

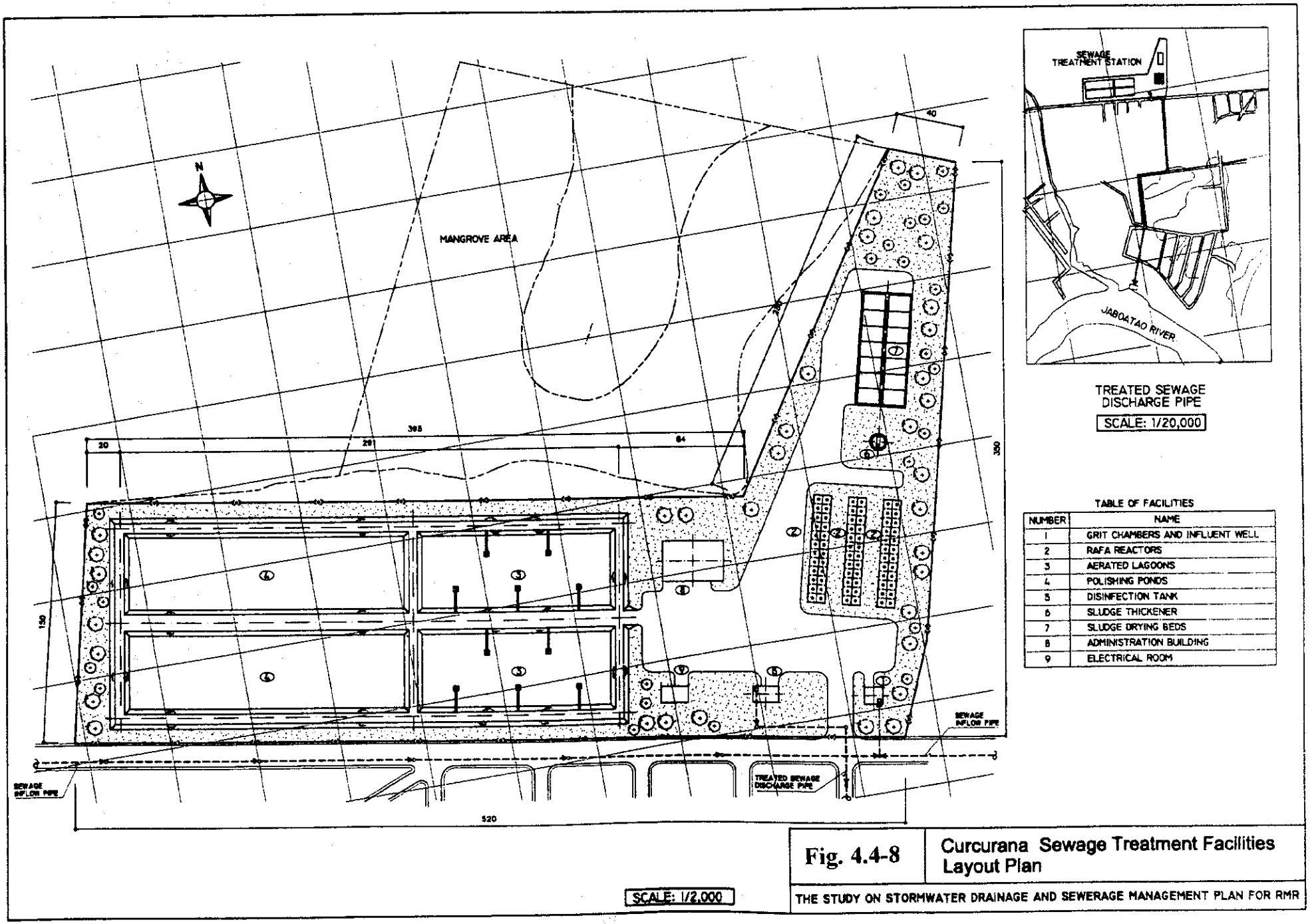



**Fig. 4.4-8** Curcurana Sewage Treatment Facilities Layout Plan

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR

## 4.5 Operation and Maintenance

### 4.5.1 General

After completion of the proposed seven sewerage systems, optimum O&M will be required for the RMR in order to operate the sewerage facilities constructed by the project and to sustain the urban environmental conditions.

In the State of Pernambuco, the sewerage facilities are managed by COMPESA since 1971. However, the existing sewerage facilities are not properly maintained and a lot of facilities are damaged and inactive. The present O&M activities for the sewerage facilities are required to be improved in order to sustain the sewerage facilities after completion.

COMPESA is planned to be the O&M organization for the sewerage systems and the staff of COMPESA should be trained for the required routine O&M activities and also should be provided with required man powers, O&M tools and equipment for the project.

COMPESA should start to prepare the basic data for the proper O&M activities and the routine O&M activities and SEPLANDES should support COMPESA to develop human resources for the future O&M activities.

The required measures for the proper O&M activities for the projects are planned as follows.

### 4.5.2 Basic Concept

**(1) O&M Organization**

COMPESA is planned to be the O&M organization for the project, which are to be implement in Phase 1 (2001-2010). The Metropolitan Sewerage Manager (GME) of the Operation Department of COMPESA, will be reinforced for the required O&M activities.

The present GME is allocated only 6 engineers and 14 technician, but it should be reinforced for the required O&M activities. The total numbers of engineers and staff required for the O&M activities are estimated to be will be 82 in the O&M stage of the project as shown in Table 4.5-1.

**(2) O&M Activities**

The routine O&M activity has not established yet. O&M activities compose of periodical inspections, monitoring and preventive works such as daily inspection, monthly inspection and yearly inspection, of mechanical and electrical/instrumental equipment for all facilities, site investigations, water quality monitoring and pipe cleaning for the sewer pipes and

rehabilitation and overhaul of all facilities.

The routine O&M activities required for the sewerage facilities are explained in the Section 4.4.3, in which required maintenance items, required measurement and analysis are explained. The tasks are as follows:

- To determine the best method of cleaning (flushing, digging up affected sections, etc.) and to carry out removal of blockages.
- To identify and eliminate the cause for malfunction,
- To keep records of causes and solution of problems,
- To conduct overhauls and minor repairs of M/E equipment,
- To provide new staff with on-the-job training and regular training.

### (3) Preparation of O&M tools

Although some drawings of sewer pipes in the central part of Recife have been digitized by COMPESA, basic data and information of the existing sewerage facilities should be prepared to conduct proper O&M activities. The basic data for the proposed sewerage system are planned to be developed in the detailed design stage.

A complete visual inspection, or YV inspection, is planned for the existing sewer networks, to be conducted in the detailed design stage to find out the actual situation of the sewers.

### (4) Equipment and Apparatus

Equipment and apparatus for the O&M activities are planned to be prepared before the O&M stage. The required major equipment such as inspection cars, truck with jet/vacuum, TV camera, etc. and apparatus for monitoring are planned to be procured.

### (5) Human Resources Development

Human resources development is planned through on the job training during the detailed design and supervision stages.

Detailed O&M plan is to be prepared in the detailed design stage. For the time being COMPESA should conduct the routine O&M activities for the existing sewerage facilities.

## Table 4.5-1 O&M Staff Training Schedule

| Sewerage System | Work Item | | | Phase 1 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Total |
| Janga and Cabanga | Operation and Maintenance | | | ← | - | - | - | - | - | - | → | | | |
| | Personnel Requirements | Sewer Pipe Line Networks and Pumping Station | Senior Management Staff | | | | | | | | 2 | 2 | 2 | |
| | | | Engineers and Technician | | | | | | | | 4 | 4 | 4 | |
| | | STF | Senior Management Staff | | | | | | | | 4 | 4 | 4 | |
| | | | Engineers and Technician | | | | | | | | 12 | 16 | 18 | |
| | | Total | | | | | | | | | 22 | 26 | 28 | |
| | Training | | | ← | → | | | | ← | | | → | | |
| | Training | Sewer Pipe Line Networks and Pumping Station | Senior Management Staff | | | | | | 1 | 1 | | | | 2 |
| | | | Engineers and Technician | 1 | 1 | | | | | 2 | | | | 4 |
| | | STF | Senior Management Staff | | | | | | 2 | 2 | | | | 4 |
| | | | Engineers and Technician | | | | | | 6 | 6 | 4 | 2 | | 18 |
| | | Total | | 1 | 1 | 0 | 0 | 0 | 9 | 11 | 4 | 2 | | 28 |
| Conceicao ,Cordeiro and Curcurana | Operation and Maintenance | | | | | | | | | ← | - | - | → | |
| | Personnel Requirements | Sewer Pipe Line Networks and Pumping Station | Senior Management Staff | | | | | | | 3 | 3 | 3 | 3 | |
| | | | Engineers and Technician | | | | | | | 6 | 6 | 6 | 6 | |
| | | STF | Senior Management Staff | | | | | | | 6 | 6 | 6 | 6 | |
| | | | Engineers and Technician | | | | | | | 9 | 12 | 15 | 19 | |
| | | Total | | | | | | | | 24 | 27 | 30 | 34 | |
| | Training | | | ← | → | | | ← | - | - | - | → | | |
| | Training | Sewer Pipe Line Networks and Pumping Station | Senior Management Staff | | | | | 1 | 2 | | | | | 3 |
| | | | Engineers and Technician | 1 | 1 | | | 1 | 3 | | | | | 6 |
| | | STF | Senior Management Staff | | | | | 3 | 3 | | | | | 6 |
| | | | Engineers and Technician | | | | | 3 | 6 | 3 | 3 | 4 | | 19 |
| | | Total | | 1 | 1 | 0 | 0 | 8 | 14 | 3 | 3 | 4 | | 34 |
| Boa Viagem and Prazeres | Operation and Maintenance | | | | | | | | | | ← | - | → | |
| | Personnel Requirements | Sewer Pipe Line Networks and Pumping Station | Senior Management Staff | | | | | | | | 2 | 2 | 2 | |
| | | | Engineers and Technician | | | | | | | | 4 | 4 | 4 | |
| | | STF | Senior Management Staff | | | | | | | | 4 | 4 | 4 | |
| | | | Engineers and Technician | | | | | | | | 8 | 12 | 14 | |
| | | Total | | | | | | | | | 18 | 22 | 24 | |
| | Training | | | ← | → | | | | ← | | | → | | |
| | Training | Sewer Pipe Line Networks and Pumping Station | Senior Management Staff | | | | | | 1 | 1 | | | | 2 |
| | | | Engineers and Technician | 1 | 1 | | | | 1 | 1 | | | | 4 |
| | | STF | Senior Management Staff | | | | | | 2 | 2 | | | | 4 |
| | | | Engineers and Technician | | | | | | 2 | 6 | 4 | 2 | | 14 |
| | | Total | | 1 | 1 | 0 | 0 | 0 | 6 | 10 | 4 | 2 | | 24 |
| **Total Training Number** | | Sewer Pipe Line Networks and Pumping Station | Senior Management Staff | 0 | 0 | 0 | 0 | 1 | 4 | 2 | 0 | 0 | 0 | 7 |
| | | | Engineers and Technician | 3 | 3 | 0 | 0 | 1 | 4 | 3 | 0 | 0 | 0 | 14 |
| | | STF | Senior Management Staff | 0 | 0 | 0 | 0 | 3 | 7 | 4 | 0 | 0 | 0 | 14 |
| | | | Engineers and Technician | 0 | 0 | 0 | 0 | 3 | 14 | 15 | 11 | 8 | 0 | 51 |
| | | Total | | 3 | 3 | 0 | 0 | 8 | 29 | 24 | 11 | 8 | 0 | 86 |

## 4.6 Construction Schedule and Cost Estimate

### 4.6.1 Construction Plan

#### (1) General

The proposed construction works consist of sewer pipe networks, pumping stations, and sewage treatment facilities for the 7 sewerage systems. The construction work will be carried out using conventional construction methods and equipment, which are available in Brazil in principle. Though most of the construction materials are available in local market, specialized equipment and materials are to be procured in overseas markets.

#### (2) Major Construction Works

##### 1) Sewer Pipe-laying

Sewer pipe-laying works are to be carried out for the seven sewerage systems. The new sewer pipes consist of trunk and branch sewers. There are two flow types of trunk sewers, gravity flow and pressured flow. The sewage collected by the branch and trunk sewers, is received by pumping stations, and conveyed to the sewage treatment facilities. Rehabilitation works of the existing sewer pipes are also considered.

The pipe materials to be installed are selected depending on local conditions; proposed sewage discharge, depth of soil cover, flow type of the sewer and constructional conditions.

The following materials are used for sewer pipes.

- Polyvinyl chloride pipe (PVC)
  Diameter (mm): 150, 200, 250, 300, 350 and 400
- Reinforced concrete pipe (RCP)
- Diameter (mm): 500, 600, 700,800, 900, 1000, 1200, 1500
- Cast iron pipe (CIP)
  Diameter (mm): 350,400, 450,500, 600 and 700

The most appropriate methods will be selected taking into account site and soil conditions, economic efficiency and additional construction methods required. Noise, vibration, subsidence and traffic conditions should be considered.

Open Cut Trench Method:

This is the most rapid and technically appropriate method for shallow excavation. During excavation, various alternative side slope cuts are possible depending on the

prevailing soil conditions.

a) Rapid progress can be expected with minimum inconvenience.

b) Better reliability of the finished construction can be also expected.

c) On the other hand, road traffic is temporarily disrupted.

d) Temporary work, such as earth retaining work and protection of underground structures are required.

In order to reduce the ground water level and keep the excavated area dry, the well point method is used, consisting of pipes (or well point) which penetrate the soil. Water coming from the well point is normally drained by a vacuum pump. A pump head of 6 to 8 meters is commonly used.

Cutting Edge Pipe - Jacking Method

The pipe jacking method is one of the pipe-laying methods of pushing-in pipes using the driving force of a jack. In general, this method is limited to use in straight sewer routes. It will be used across the national highways and railroad.

The sewer pipes for the branch and trunk sewers using gravity flow, and trunk sewers using pressured flow, will be installed.

**2) Construction of Pumping Stations**

The open cut method is used with steel sheet piling during the construction of pump pits. At the same time, in order to reduce the underground water level at sites, the well point method is applied to achieve dry working conditions.

The construction should be carried out using the following process.

- Driving the steel sheet piles
- Installation of scaffolding
- Excavation
- Foundation pile driving
- Construction of concrete facilities
- Removal of scaffolding
- Removal of steel sheet piling

For foundation pile driving, pre-cast concrete piles are used to obtain the required foundation strength. The generation of noise and vibration should be taken into account in residential areas.

### 3) Construction of Sewage Treatment Facilities

The major construction works of sewage treatment facilities are the construction of the RAFA reactor, aerated lagoon, bio-filter, sedimentation tank, sludge treatment facilities and administration building, etc.

No special construction method will be applied for the construction of sewage treatment facilities. However, the placement of piling or soil improvement work is required depending on the site conditions to obtain a sufficient foundation strength.

The main civil work items for the sewage treatment facilities are described as follows.

**Main Civil Work Items for Sewage Treatment Facilities**

| Items | Conceicao | Janga | Cabanga | Boa Viagem | Cordeiro | Prazeres | Curcurana |
|---|---|---|---|---|---|---|---|
| Land leveling | ○ | ○ | | | ○ | ○ | ○ |
| Removal of existing facilities | | | ○ | | | | |
| Treatment facilities | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Revetment with boulders | | | ○ | | | | |
| Masonry retaining wall | ○ | ○ | | | | | |
| Access road | ○ | ○ | | ○ | | ○ | ○ |

Note: Construction/rehabilitation of the access roads is required in the following sewage treatment facilities.

Janga:

- Improvement of existing road
- Widening and paving are needed

Boa Viagem:

- Existing road can be used after paving

Prazeres:

-New construction of access road is required

Curcurana:

-Improvement of existing road

-Widening of existing road

Foundation type applied in each treatment facilities is as followed

- Conseicao: Spread foundation
- Janga: Replacement of sand
- Cabanga: Pile foundation (pile length: 25m-29m)
- Boa Viagem: Spread foundation
- Cordeiro: Pile foundation (pile length: 30m-33m)
- Prazeres: Spread foundation
- Curcurana: Pile foundation (Pile length: 14m)

The construction of the sewage treatment facilities should be carried out using the following process.

- Driving the steel sheet piles
- Installation of scaffolding
- Excavation
- Foundation pile driving
- Construction of concrete facilities
- Removal of scaffolding
- Removal of steel sheet piling

In the foundation pile driving, pre-cast concrete piles are used to obtain the required strength of foundations. Generation of noise and vibration in pile driving should be taken into account in residential areas.

### 4.6.2 Construction Schedule

#### (1) Annual Workable Days

Annual workable days are estimated to be 245 days based on the following assumptions:

| | |
|---|---|
| Sundays per annum: | 50 days |
| National and provincial holidays: | 17 days |
| Rainy days per annum: | 53 days (more than 10 mm /day rainfall) |
| Total work suspension days per annum: | 120 days |
| Working days: | 245 days |

#### (2) Workable Time

All the construction works will be carried out during the daytime in principle. The working time is eight hours.

#### (3) Required Construction Period and Sequence of Works

Required construction periods are estimated based on the preliminary designs of the proposed facilities, and the working days and work time assumptions for each type of construction works. The sewerage facilities of the Conceicao, Cordeiro and Curcurana are planned to be constructed during the three years period from 2004 to 2006, while that of Janga, cabanga, Boa Viagem and Prazeres are planned to be constructed during four years period from 2004 to 2007. The required construction schedule for the projects is presented in the following Table.

## Construction Schedule of the project

| System | Work Items | | Periods | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
| Conceisao | Datailed design | | | | | | | |
| | Tendering | | | | | | | |
| | Construction | Trunk sewers, Pumping stations | | | | | | |
| | | Branch sewers | | | | | | |
| | | Treatment facilities | | | | | | |
| Janga | Datailed design | | | | | | | |
| | Tendering | | | | | | | |
| | Construction | Trunk sewers, Pumping stations | | | | | | |
| | | Branch sewers | | | | | | |
| | | Treatment facilities | | | | | | |
| Cabanga | Datailed design | | | | | | | |
| | Tendering | | | | | | | |
| | Construction | Trunk sewers, Pumping stations | | | | | | |
| | | Branch sewers | | | | | | |
| | | Treatment facilities | | | | | | |
| Boa Viagem | Datailed design | | | | | | | |
| | Tendering | | | | | | | |
| | Construction | Trunk sewers, Pumping stations | | | | | | |
| | | Branch sewers | | | | | | |
| | | Treatment facilities | | | | | | |
| Cordeoro | Datailed design | | | | | | | |
| | Tendering | | | | | | | |
| | Construction | Trunk sewers, Pumping stations | | | | | | |
| | | Branch sewers | | | | | | |
| | | Treatment facilities | | | | | | |
| Prazeres | Datailed design | | | | | | | |
| | Tendering | | | | | | | |
| | Construction | Trunk sewers, Pumping stations | | | | | | |
| | | Branch sewers | | | | | | |
| | | Treatment facilities | | | | | | |
| Curcurana | Datailed design | | | | | | | |
| | Tendering | | | | | | | |
| | Construction | Trunk sewers, Pumping stations | | | | | | |
| | | Branch sewers | | | | | | |
| | | Treatment facilities | | | | | | |

### 4.6.3 Cost Estimate

#### (1) Basis of Cost Estimate

The project cost is estimated under the following conditions.

1) All the costs are expressed under the economic conditions that prevailed in July 2000.
2) Exchange rate of currencies is US$1.00=R$1.80=¥110.0
3) Project cost is not classified into foreign and local currency portions.
4) Engineering services and government administration costs are assumed to be 10% and 5% of total construction cost respectivery.
5) Basic construction unit price data are derived from:
   -Service price list - COMPESA, June 2000
   -Construction services costs - PINI, June 2000
6) Price inflation is not taken into account.

#### (2) Component of Project Cost

The construction cost comprises the expansion and rehabilitation works of sewerage systems.

The project cost consists of:

1) Construction cost,
   - Collection sewers
   - Pumping stations
   - Sewage treatment facilities
2) Land acquisition cost,
3) Procurement of O & M equipment
4) Engineering service cost,
5) Government administration cost, and
6) Physical contingencies

The construction cost for civil work, mechanical/electrical equipment and administration building are estimated based on the preliminary engineering design. The cost of civil work and architectural work is estimated by multiplying the quantities of works by unit construction cost. The cost of mechanical/electrical equipment for sewage treatment facilities and pumping stations are determined by the quotation obtained from the manufacturers and experience in Brazil.

### (3) Construction cost

Total construction cost of seven sewerage systems includes the costs of expansion and rehabilitation works of the sewers, pumping stations and sewage treatment facilities. Total construction cost was estimated at R$ 226 million as following Tables.

**Construction Cost of Sewerage System**

Expansion (Unit :R$1000)

| System | Branches, Collectors(1) | | | Trunks(2) | | Pressure pipes (3) | Pumping stations(4) | (5)=(2)+(3)+(4) | Treatment Facilities (6) | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Collectors | Branches | Subtotal | Trunks | Pipe jacking | | | | | |
| Conceisao | 3,572 | 3,493 | 7,065 | 2,458 | 135 | 282 | 503 | 3,378 | 5,618 | 16,061 |
| Janga | 13,736 | 13,432 | 27,168 | 5,969 | 270 | 7582 | 2,102 | 15,923 | 12,547 | 55,638 |
| Cabanga | 6,100 | 5,927 | 12,027 | 1,507 | 180 | 1915 | 1,322 | 4,924 | 13,655 | 30,606 |
| Boa Viagem | 5,460 | 5,305 | 10,765 | 5,836 | 855 | 1580 | 1,789 | 10,060 | 7,094 | 27,919 |
| Cordeoro | 4,247 | 4,167 | 8,414 | 3,676 | 405 | 513 | 910 | 5,504 | 6,928 | 20,846 |
| Prazeres | 6,998 | 6,800 | 13,798 | 6,400 | 315 | 3124 | 1,555 | 11,394 | 10,571 | 35,763 |
| Curcurana | 5,092 | 4,948 | 10,040 | 3,646 | 405 | 1024 | 1,408 | 6,483 | 9,839 | 26,362 |
| Total | 45,205 | 44,072 | 89,277 | 29,492 | 2,565 | 16,020 | 9,589 | 57,666 | 66,252 | 213,195 |

Rehabilitation (Unit :R$1000)

| System | Branch, Collectors(1) | | | Trunks(2) | | Pressure pipe (3) | Pumping stations(4) | (5)=(2)+(3)+(4) | Treatment Facilities (6) | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Collectors | Branches | Subtotal | Trunks | Pipe jacking | | | | | |
| Conceisao | | | | | | | 74 | 74 | | 74 |
| Janga | | | | | | 677 | 1,409 | 2,086 | 959 | 3,045 |
| Cabanga | | | | 2377 | | 237 | 5,067 | 7,681 | 1,478 | 9,159 |
| Boa Viagem | | | | | | | | | | |
| Cordeoro | | | | | | | 210 | 210 | | 210 |
| Prazeres | | | | | | 470 | 267 | 737 | | 737 |
| Curcurana | | | | | | | | | | |
| Total | | | | 2,377 | | 1,384 | 7,027 | 10,788 | 2,437 | 13,225 |

Construction cost (Expansion + Rehabilitation) (Unit : 1000 R$)

| System | Branch, Collectors(1) | | | Trunks(2) | | Pressure pipe (3) | Pumping stations(4) | (5)=(2)+(3)+(4) | Treatment Facilities (6) | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Collectors | Branch | Subtotal | Trunks | Pipe jacking | | | | | |
| Conceisao | 3,572 | 3,493 | 7,065 | 2,458 | 135 | 282 | 577 | 3,452 | 5,618 | 16,135 |
| Janga | 13,736 | 13,432 | 27,168 | 5,969 | 270 | 8,259 | 3,511 | 18,009 | 13,506 | 58,683 |
| Cabanga | 6,100 | 5,927 | 12,027 | 3,884 | 180 | 2,152 | 6,389 | 12,605 | 15,133 | 39,765 |
| Boa Viagem | 5,460 | 5,305 | 10,765 | 5,836 | 855 | 1,580 | 1,789 | 10,060 | 7,094 | 27,919 |
| Cordeoro | 4,247 | 4,167 | 8,414 | 3,676 | 405 | 513 | 1,120 | 5,714 | 6,928 | 21,056 |
| Prazeres | 6,998 | 6,800 | 13,798 | 6,400 | 315 | 3,594 | 1,822 | 12,131 | 10,571 | 36,500 |
| Curcurana | 5,092 | 4,948 | 10,040 | 3,646 | 405 | 1,024 | 1,408 | 6,483 | 9,839 | 26,362 |
| Total | 45,205 | 44,072 | 89,277 | 31,869 | 2,565 | 17,404 | 16,616 | 68,454 | 68,689 | 226,420 |

### (4) Land Acquisition and Compensation Cost

The required land acquisition and compensation of the project consists of the areas of the sewage treatment facilities, pumping stations and access roads. The compensation for house relocations in the area of treatment facilities in Boa Viagem is due required for the implementation of the project. The land acquisition and compensation cost of the project is estimated at R$ 45.5 as following Table.

**Land Acquisition and Compensation Cost**

(Unit: R$1000)

| Systems | Treatment Facilities | Pumping Station | Subtotal | Road | House Relocation | Total |
|---|---|---|---|---|---|---|
| Conceicao | 3,280 | 16 | 3,296 | | | 3,296 |
| Janga | | 48 | 48 | | | 48 |
| Cabanga | | 480 | 480 | | | 480 |
| Boa Viagem | 23,142 | 434 | 23,576 | | 675 | 24,251 |
| Cordeiro | 1,400 | 27 | 1,427 | | | 1,427 |
| Prazeres | 14,520 | 143 | 14,663 | 336 | | 14,999 |
| Curcurana | 950 | 11 | 961 | 63 | | 1,024 |
| Total | 43,292 | 1,159 | 44,451 | 399 | 675 | 45,525 |

### (5) Procurement Cost of O & M Equipment

Required operation and maintenance cost consists of procurement cost of inspection cars, trucks with jet/vacuum and TV camera, etc. Prevailing market prices in Brazil were applied for the procurement of the O & M equipment. The procurement cost of O & M equipment was estimated at R$ 4.7million.

**Procurement Cost of O & M Equipment**

(Unit: R$1000)

| System | | Items of equipment(unit) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Truck | Car Light | Jet | vacuum | TV Camera | Total |
| Unit cost | | 45 | 17 | 100 | 87 | 400 | |
| Conceicao | Unit | 1 | 1 | 1 | 1 | 1 | 5 |
| | Cost | 45 | 17 | 100 | 87 | 400 | 649 |
| Janga | Unit | 2 | 2 | 1 | 1 | 1 | 7 |
| | Cost | 90 | 34 | 100 | 87 | 400 | 711 |
| Cabanga | Unit | 2 | 2 | 1 | 1 | 1 | 7 |
| | Cost | 90 | 34 | 100 | 87 | 400 | 711 |
| Boa Viagem | Unit | 1 | 1 | 1 | 1 | 1 | 5 |
| | Cost | 45 | 17 | 100 | 87 | 400 | 649 |
| Cordeiro | Unit | 1 | 1 | 1 | 1 | 1 | 5 |
| | Cost | 45 | 17 | 100 | 87 | 400 | 649 |
| Prazeres | Unit | 1 | 1 | 1 | 1 | 1 | 5 |
| | Cost | 45 | 17 | 100 | 87 | 400 | 649 |
| Curcurana | Unit | 1 | 1 | 1 | 1 | 1 | 5 |
| | Cost | 45 | 17 | 100 | 87 | 400 | 649 |
| Total(unit) | Unit | 9 | 9 | 7 | 7 | 7 | 39 |
| | Cost | 405 | 153 | 700 | 609 | 2,800 | 4,667 |

## (6) Project Cost

Estimated total project cost is 344 million, and its breakdown is shown as follows. Engineering service cost, government administration cost and physical contingencies are assumed respectively, to be 10%, 5% and 15% of the construction cost based on the experiences of the similar projects. Breakdown of the project cost is shown in the following table.

**Project Cost**

(Unit: R$1000)

| Item | | Conceicao | Janga | Cabanga | Boa Viagem | Cordeiro | Prazeres | Curcurana | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1.Construction | 1)Sewage Treatment facilities | 5,618 | 13,506 | 15,133 | 7,094 | 6,928 | 10,571 | 9,839 | 68,689 |
| | 2)Trunk sewers, pumping stations | 3,452 | 18,009 | 12,605 | 10,060 | 5,714 | 12,131 | 6,483 | 68,454 |
| | 3)Branch, etc. | 7,065 | 27,168 | 12,027 | 10,765 | 8,414 | 13,798 | 10,040 | 89,277 |
| | Subtotal | 16,135 | 58,683 | 39,765 | 27,919 | 21,056 | 36,500 | 26,362 | 226,420 |
| 2. Land acqusition cost | | 3,296 | 48 | 480 | 24,251 | 1,427 | 14,999 | 1,024 | 45,525 |
| 3.Procurement cost of equipment | | 649 | 711 | 711 | 649 | 649 | 649 | 649 | 4,667 |
| 4. Engineering service cost | | 1,614 | 5,868 | 3,977 | 2,792 | 2,106 | 3,650 | 2,636 | 22,643 |
| 5. Government administration cost | | 807 | 2,934 | 1,988 | 1,396 | 1,053 | 1,825 | 1,318 | 11,321 |
| 6. Physical contingencies | | 2,420 | 8,802 | 5,965 | 4,188 | 3,158 | 5,475 | 3,954 | 33,962 |
| Total | | 24,921 | 77,046 | 52,886 | 61,195 | 29,449 | 63,098 | 35,943 | 344,538 |

## (7) Disbursement Schedule

The project will be completed within 6 years from 2002 to 2007. The detailed design will be completed with in 12 months in the year of 2002. The construction work will be commenced in 2004 and be completed in 2007 within a net construction period of 60 month. The annual disbursement schedule and amount of the project is summarized as follows.

| System | Period | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | |
| Conceicao | 3,344 | 2,294 | 4,500 | 8,167 | 6,616 | | 24,921 |
| Janger | 5,796 | 1,980 | 11,639 | 20,807 | 20,807 | 16,017 | 77,046 |
| Cabanga | 4,152 | 1,566 | 9,037 | 9,037 | 16,401 | 12,693 | 52,886 |
| Boa Viagem | 14,872 | 13,055 | 5,537 | 9,900 | 9,900 | 7,931 | 61,195 |
| Cordeiro | 2,924 | 1,555 | 5,874 | 10,659 | 8,437 | | 29,449 |
| Prazeres | 11,092 | 8,716 | 7,240 | 12,941 | 12,941 | 10,168 | 63,098 |
| Curcurana | 3,277 | 1,566 | 7,354 | 13,346 | 10,400 | | 35,943 |
| Total | 45,457 | 30,732 | 51,181 | 84,857 | 85,502 | 46,809 | 344,538 |

Details, see Table 4-6-1.

### (8) O & M Cost

Major portions of O/M cost are electric power charge for the operation of treatment plants and pumping stations, personnel cost and repairing cost. The O/M cost was assumed to be 6% of construction cost based on the data collected in Brazil. The annual O & M cost of the project is estimated at R$ 13.6 million.

### (9) Disbursement Schedule of O & M Cost

The O & M cost of Conceisao, Cordeiro and Curcurana will be disbursed from the year 2007, while other five systems will be disbursed from the year 2008 after construction of expansion sewerage systems. The annual O & M cost in the year of 2007 was estimated at 3.8 million. The annual O & M cost all the systems from the year 2008 was estimated at 13 million. The disbursement schedule and an amount of each O & M system are as follows.

**Disbursement Schedule of O & M Cost**

(Unit: R$1000)

| System | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|
| Conceicao | | | | | | 995 | 995 | → |
| Janga | | | | | | | 3,358 | → |
| Cabanga | | | | | | | 2,450 | → |
| Boa Viagem | | | | | | | 1,715 | → |
| Cordeiro | | | | | | 1,282 | 1,282 | → |
| Prazeres | | | | | | | 2,159 | → |
| Curcurana | | | | | | 1,626 | 1,626 | → |
| Total | | | | | | 3,903 | 13,585 | |

Construction cost 226,421

OM cost(annual) 13,585 (6% of construction cost)

## Tbl 4.6-1 Breakdown of Disbursement Schedule of the Project

**Disbursement Schedule(1/2)**

| System | Work Item | Project cost | Period | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
| Conceicao | 1) Cosntruction | 16,135 | | | 3,667 | 7,334 | 5,134 | |
| | 2)Land acquisition | 3,296 | 1,648 | 1,648 | | | | |
| | 3) Procurement of OM equipment | 649 | | | | | 649 | |
| | 4) Engineering service | 1,614 | 1,050 | | 188 | 188 | 188 | |
| | 5) Government administration | 807 | 162 | 162 | 161 | 161 | 161 | |
| | 6) Physical contingency | 2,420 | 484 | 484 | 484 | 484 | 484 | |
| | Total | 24,921 | 3,344 | 2,294 | 4,500 | 8,167 | 6,616 | |
| Janga | 1) Cosntruction | 58,683 | | | 9,170 | 18,338 | 18,338 | 12,837 |
| | 2)Land acquisition | 48 | 24 | 24 | | | | |
| | 3) Procurement of OM equipment | 711 | | | | | | 711 |
| | 4) Engineering service | 5,868 | 3,816 | | 513 | 513 | 513 | 513 |
| | 5) Government administration | 2,934 | 489 | 489 | 489 | 489 | 489 | 489 |
| | 6) Physical contingency | 8,802 | 1,467 | 1,467 | 1,467 | 1,467 | 1,467 | 1,467 |
| | Total | 77,046 | 5,796 | 1,980 | 11,639 | 20,807 | 20,807 | 16,017 |
| Cabanga | 1) Cosntruction | 39,765 | | | 7,364 | 7,364 | 14,728 | 10,309 |
| | 2)Land acquisition | 480 | 240 | 240 | | | | |
| | 3) Procurement of OM equipment | 711 | | | | | | 711 |
| | 4) Engineering service | 3,977 | 2,585 | | 348 | 348 | 348 | 348 |
| | 5) Government administration | 1,988 | 332 | 332 | 331 | 331 | 331 | 331 |
| | 6) Physical contingency | 5,965 | 995 | 994 | 994 | 994 | 994 | 994 |
| | Total | 52,886 | 4,152 | 1,566 | 9,037 | 9,037 | 16,401 | 12,693 |
| Boa Viage | 1) Cosntruction | 27,919 | | | 4,362 | 8,725 | 8,725 | 6,107 |
| | 2)Land acquisition | 24,251 | 12,126 | 12,125 | | | | |
| | 3) Procurement of OM equipment | 649 | | | | | | 649 |
| | 4) Engineering service | 2,792 | 1,816 | | 244 | 244 | 244 | 244 |
| | 5) Government administration | 1,396 | 232 | 232 | 233 | 233 | 233 | 233 |
| | 6) Physical contingency | 4,188 | 698 | 698 | 698 | 698 | 698 | 698 |
| | Total | 61,195 | 14,871 | 13,055 | 5,537 | 9,900 | 9,900 | 7,931 |

## Tbl 4.6-1 Breakdown of Disbursement Schedule of the Project

**Disbursement Schedule(2/2)**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Cordeiro | 1) Cosntruction | 21,056 | | | 4,785 | 9,571 | 6,700 | |
| | 2)Land acquisition | 1,427 | 714 | 713 | | | | |
| | 3) Procurement of OM equipment | 649 | | | | | 649 | |
| | 4) Engineering service | 2,106 | 1,368 | | 246 | 246 | 246 | |
| | 5) Government administration | 1,053 | 211 | 211 | 211 | 210 | 210 | |
| | 6) Physical contingency | 3,158 | 631 | 631 | 632 | 632 | 632 | |
| | Total | 29,449 | 2,924 | 1,555 | 5,874 | 10,659 | 8,437 | |
| Prazeres | 1) Cosntruction | 36,500 | | | 5,704 | 11,406 | 11,406 | 7,984 |
| | 2)Land acquisition | 14,999 | 7,500 | 7,499 | | | | |
| | 3) Procurement of OM equipment | 649 | | | | | | 649 |
| | 4) Engineering service | 3,650 | 2,374 | | 319 | 319 | 319 | 319 |
| | 5) Government administration | 1,825 | 305 | 304 | 304 | 304 | 304 | 304 |
| | 6) Physical contingency | 5,475 | 913 | 913 | 913 | 912 | 912 | 912 |
| | Total | 63,098 | 11,092 | 8,716 | 7,240 | 12,941 | 12,941 | 10,168 |
| Curcurana | 1) Cosntruction | 26,362 | | | 5,991 | 11,983 | 8,388 | |
| | 2)Land acquisition | 1,024 | 512 | 512 | | | | |
| | 3) Procurement of OM equipment | 649 | | | | | 649 | |
| | 4) Engineering service | 2,636 | 1,712 | | 308 | 308 | 308 | |
| | 5) Government administration | 1,318 | 263 | 263 | 264 | 264 | 264 | |
| | 6) Physical contingency | 3,954 | 790 | 791 | 791 | 791 | 791 | |
| | Total | 35,943 | 3,277 | 1,566 | 7,354 | 13,346 | 10,400 | |
| Total | 1) Cosntruction | 226,420 | | | 41,043 | 74,721 | 73,419 | 37,237 |
| | 2)Land acquisition | 45,525 | 22,764 | 22,761 | | | | |
| | 3) Procurement of OM equipment | 4,667 | | | | | 1,947 | 2,720 |
| | 4) Engineering service | 22,643 | 14,721 | | 2,166 | 2,166 | 2,166 | 1,424 |
| | 5) Government administration | 11,321 | 1,994 | 1,993 | 1,993 | 1,992 | 1,992 | 1,357 |
| | 6) Physical contingency | 33,962 | 5,978 | 5,978 | 5,979 | 5,978 | 5,978 | 4,071 |
| | Total | 344,538 | 45,457 | 30,732 | 51,181 | 84,857 | 85,502 | 46,809 |

## 4.7 Environmental Impact Assessment

### 4.7.1 Introduction

In the Master Plan, the 7 priority sewerage systems were selected for F/S from three points of view, 1) effective reduction of pollution load from the major rivers in the RMR, 2) effective use of existing Sewage Treatment Facility (STF), and 3) giving priority for STF which covers the sewage collection area in the major river basins in the central part of the RMR. The Study assessed the environmental impact caused by the implementation of the proposed 7 STFs.

### 4.7.2 Description of the Priority Projects

#### (1) Location of the Priority Project Sites

The location of the priority project sites and effluent discharging points is shown in Fig. 4.7-1.

#### (2) Proposed Sewerage Improvement Works

The proposed sewage treatment facilities are to be constructed and to be in operation by 2008. The sewage treatment facilities, the volume of the daily sewage treatment, the BOD load of inflow sewage, and the layout of facilities at each site are as shown in the following table.

| Sewage Treatment Plant | Major Sewage Treatment Facilities | Sewage Volume ($m^3$/day) | BOD Load (kg/day) | Layout of Facilities |
|---|---|---|---|---|
| **Conceicao** | RAFA + Lagoon | 11,800 | 2,900 | See Fig. 4.4-2 |
| **Janga** | RAFA + Lagoon | 60,600 | 16,000 | See Fig. 4.4-3 |
| **Cabanga** | RAFA + Bio-filtration | 55,900 | 16,800 | See Fig. 4.4-4 |
| **Boa Viagem** | RAFA + Lagoon | 26,000 | 8,100 | See Fig. 4.4-5 |
| **Cordeiro** | RAFA + Bio-filtration | 18,800 | 5,700 | See Fig.4.4-6 |
| **Prazeres** | RAFA + Lagoon | 30,100 | 11,300 | See Fig. 4.4-7 |
| **Curcurana** | RAFA + Lagoon | 22,600 | 7,200 | See Fig. 4.4-8 |

### 4.7.3 Existing Environmental Conditions of the Project Sites

#### (1) Conceicao

##### 1) The existing conditions of the surroundings of the Conceicao STF project site

This STF project site is located in the north side of Paulista City and it is about 250m distance

from State Road Route 22. The land is owned by a cement company (CIMENTO POTY). There is a residential area of around 150 houses in the East of the STF and Warehouse of mineral water company (Indaia) is located in the south side. The West Side is vacant land, but a mangrove is found in the low land, which is around 100m distance of a southwestern side of the STF. Institutions such as hospital, school, and library do not exist in peripheral within 500m of the STF. An aerial photograph of the surroundings of Conceicao STF is shown in Fig. 4.7-2. The existing conditions are explained in Supporting Report F.

### (2) Janga

The existing conditions of the surroundings of the Janga STF project site are as follows:

The Janga STF project site is located in Paulista City and is about 1.0 km eastward from the State Highway Route 22. The forest area spreads through the East and the south side of the STF project site where no houses are existing. In north side of the site a house of around 15 scatters in about 50m distance and the densely populated residential area is located in several hundred meters away. The Maranguape II estate is located in approximately 200m west which is the closest heavily populated residential area near the site. There are a school and a church in the Maranguape II estate. The existing conditions are explained in Supporting Report F.

### (3) Cabanga

The existing conditions of the surroundings of the Cabanga STF project site are as follows:

The Cabanga STF project site is located in the Cabanga district of Recife City in near the Governor Bridge. The south side of the project site is the Pina Estuary in the Capibaribe River system. There is an office of COMPESA in the East Side. There is Cabanga Yacht Club at a distance of about 300m separated from the site by a road. In the west, there is Office of Ministry of Defense and there is Army Quarter in the north side. Institutions such as hospital, school, library do not exist in peripheral within 500m from the project site. The existing conditions are explained in Supporting Report F.

### (4) Boa Viagem

The existing conditions of the surroundings of the Boa Viagem STF project site are as follows:

The Boa Viagem STF project site is located in Boa Viagem district of Recife city and is located in the north side of railway of Sul street. The Jordan River, in the Tejipio River system, flows to the East of this project site. Mangrove community is well developed in the

swamp between Jordan River and Pina river. The swamp zone around Pina River and Jordan River is designated as a mangrove park by Recife City. The north side is vacant land, but house and factory (Steel tube, Liquor, and Plaster factories) exist in the south side. In the west, some houses are existing, but it is mainly factory occupied area. Institutions such as hospital, school, and library do not exist in peripheral within 500m of the project site. The existing conditions are explained in Supporting Report F.

### (5) Cordeiro

The existing conditions of the surroundings of the Cordeiro STF project site are as follows:

The Cordeiro STF project site is located in Cordeiro district of Recife City and is about 800m in the north side from Caxanga Avenue. The north side of the site faces the Capibaribe River. There is a residential area in the other side of the Capibaribe River. The West Side is a park, where soccer grounds are prepared. The Eastern bloc of the project site is vacant land generally, but about 15 houses exist in the inside. The south side of the project site is a densely populated residential area. The road between the site and the residential area is planned to expand in near future by Recife City. Hospitals do not exist in peripheral within 500m of the project site but there is a school. The existing conditions are explained in Supporting Report F.

### (6) Prazeres

The existing conditions of the surroundings of the Prazeres STF project site are as follows:

This STF project site is located in a Prazeres district of Jaboatao City and is at about 700m westward from the cross section between National Highway No. 101 and Avenue Mascarenhas de Morais. The surroundings of this STF is a factory site, and a residential area does not exist around the site. The north side and the west of this project site are vacant lands broadly, and factories do not exist, either. A drinking water factory and a soccer ground exist in the eastern part of the project site. There are concrete, Coca-Cola, plastic tube, and paint factories in the south side beyond a road. Institutions such as hospital, school, and library do not exist in peripheral within 500m of the site. The existing conditions are explained in Supporting Report F.

### (7) Curcurana

The existing conditions of the surroundings of the Prazeres STF project site are as follows:

This STF project site is located in the low-lying land at the south side of Olho d'Agua Lagoon and is at the east side of Barras Street about 2 km from National Highway No. 101. The north side of this project site is low-lying or swamp and houses are not existing. The West

Side is vacant land and houses are scattered at the distance of around 200m from the site. In the south side, there are several houses and transformer substation. Coconut trees are existing between a residential area and the east side of the project site. Mangrove community exists on north side swamp of the project site, but there is no direct impact by the construction of STF. Institutions such as hospital, school, and library do not exist in peripheral within 500m of the project site. The existing conditions are explained in Supporting Report F.

### 4.7.4 Assessment of Environmental Impacts

#### (1) Methodology

Evaluation of the environmental impact by implementation of the project are studied considering the result of IEE and following the Manual of Guidelines for Evaluation of Environmental Impacts by CPRH (1998) and the Environmental Guidelines by JICA (1994).

##### 1) Extraction of environmental parameters receiving impact

Environment parameters receiving impact by construction and operation of STF are as listed in following table.

**Possible Environmental Parameters which can be affected by the Project**

| Environmental Parameters | Description of the impact |
|---|---|
| 1. Topography and Geology | Modifications caused by earthworks |
| 2. Land Use and Occupation | Changes on the land use and occupation at the work site due to specific legislation |
| 3. Air Quality | Air pollution levels in the neighborhood of the works |
| 4. Noise | Noise level in the area |
| 5. Water Resources | Surface and groundwater, its natural, physical/chemical and bacteriological characteristics |
| 6. Flora and Fauna | This refers to the aspects of local flora and fauna |
| 7. Employment and Income | Demand for labor and services, influence of project on level o income |
| 8. Infrastructure | Availability of basic infrastructure of transport, electricity an sanitation in terms of its coverage and quality |
| 9. Quality of Life | Refer to access to goods and public services (safety, education, health, electricity, sanitation, etc. |
| 10. Local Economy | On the demand for goods and services in the municipality an the metropolitan region |
| 11. Landscape | Areas of scenic value such as, vegetation, water bodies, hills mountains, artificial landscaping elements, etc., and thei appreciation by the population in the project area |
| 12. Political and Institutional Aspects | Refer to the legal aspects involved in the implantation of th project and meeting the demands of the various publi authorities |

### 2) Examination of environmental influencing factors

The factors, which give impacts on the environment by implementation of these Sewerage Projects, are as follows,

**Potential Factors which may cause Environmental Impact by Implementation of the Project**

| | Factors | Description |
|---|---|---|
| I | Delimitation and licensing of the construction areas | Delimitation and licensing of the areas where the company in charge of the construction will execute the works. |
| II | Preliminary work services | Group of services, that precede the works, which aim at preparing the work sites such as: topographic services, land clearance, hedges and timbering or interference reorganization, etc |
| III | Equipment and material transportation | Transport of the equipment and necessary materials to the accomplishment of the works, such as concrete mixers, tractors, cement, sand, stones, etc |
| IV | Work site setting up, operation and deactivation | Activities inherent to the setting up of the support facilities, such as offices, dormitories, toilets and refectory (setting up, personnel's mobilization, operation and demobilization of the work site). |
| V | Earthworks | Excavation activities, cuts and fills, temporary storage and further transport of disposal material. |
| VI | Civil works | Execution of the works, such as, foundations and structures, settling of pipes and components, installation and assembly of equipment, and urbanization. |
| VII | System operation and maintenance | Necessary actions to the operation and maintenance of the wastewater treatment system. |

### 3) Examination of environmental impacts and Measures for the environmental impacts

Impacts on environment were examined from the viewpoint of plus and minus of impact, possibility and period of impact, reversibility of impact, strength of impact, range of impact. Then, environmental protection measures were examined.

Following measures are proposed as environment protection measures during construction and operation of the STFs.

**Environmental Measures during Implementation and operation of the Project**

| | |
|---|---|
| 1. | Request from the competent agencies, the authorizations and licensing for the work execution, including those ones necessary to the intervention in areas of permanen preservation. |
| 2. | Proceed, after the accomplishment of the works, a landscape project and an appropriate drainage system and vegetation cover. The landscape project should promote the aesthetic valorization of the area and the harmonization of the STF with the urban and regional landscape and, also to include a "greenbelt" seeking to reduce occasiona negative effects of odors, aerosols and scum. |
| 3. | Restrict cover vegetation removal to the strictly necessary, providing arrangements immediately after the end of the works, and the reforestation with native species. |
| 4. | Accomplish the earthwork activities preferably during the dry months, avoiding th installation of erosive processes and the interruption of the drainage systems. The projects should minimize the earth movements, looking for the optimization of the relationship cut / fill, in order to avoid the instability of the slopes, the installation o erosive processes and the reduction of the disposed volumes. Furthermore it should be accomplished that the immediate consolidation of the land leveling through planting wit grass covering vegetation and installation of a preliminary system of drainage of th pluvial waters. |
| 5. | Give preference to hiring the local workforce when recruiting for construction. The contracted workers and the ones who possess a low qualification level should have acces to basic training programs. Whenever possible local contractors should be used to the support of the works. |
| 6. | Adopt usual procedures of safety in the civil construction works, not only in works sites but also to prevent accidents in the access roads, such as: (i) install road plates and traffic lights in the access roads; (ii) impose restrictions on the access of automobiles and alien people to the earthworks area and to construction sites; (iii) place traffic controllers in crossings and in one-way roads; (iv) plan the schedules and itineraries of the vehicles, (v use the less impeded access roads and times of less traffic. |
| 7. | Implant sealing strips around the units to avoid the expansion and contraction processes of the soils, as well as discourage the plantation of vegetation with deep roots. |
| 8. | Remove the whole dump and discard material off the work areas and off the licensed areas, disposing them in appropriate places, being hindered the release in depressions ditches, streams and rivers. |
| 9. | Maintain the vehicles used in the services with their engines in good conditions, in wa to minimize the emission of pollutants. The stationary machines should be confine conveniently to avoid the propagation of noises. |
| 10. | Provide the construction site, obligatorily, with sanitary facilities. The residues can not in no hypothesis, be discharged or thrown without control. Installation of septic tanks is advisable. The garbage originated in the facilities shall be conditioned for withdrawal b the collection service. The administration of the works should care for so that the appropriate conditions of hygiene and cleaning are maintained in the facilities. |
| 11. | Provide the frequent sprinkling of water in the public areas, mainly in the hours o heavier movement of vehicles. That providence should also be followed for th earthworks in the area of the stations. The trucks used in the transportation of dump and surplus material of the works shall only be able to move with their buckets covered to avoid dumping material in public areas. In case there is dumping of the transporte |

| | |
|---|---|
| | material in the roads, the responsible for the transportation should provide the immediat cleaning or removal of the dumps. |
| 12. | Seal the bottom of ponds and lagoons to impede infiltration. |
| 13. | Give preference to the purchase of materials for the works from local suppliers, in way t increase the local and regional economy. |
| 14. | Accomplish the appropriate and periodic maintenance of the component equipment of th wastewater treatment plants. |
| 15. | Accomplish the maintenance of the vegetation in the area of the stations, mainly the "green belt." |
| 16. | Implant collection system and treatment or dissipation of the gases. |
| 17. | Plan the schedules of the circulation of vehicles. |
| 18. | Monitor the quality of the effluent of the ETE. |
| 19. | Implant disinfection systems. |
| 20. | Hire and capacitate personnel for the operation and maintenance of the stations. |
| 21. | Direct the sludge generated by the sewerage treatment process, properly conditioned, to sanitary fills or other appropriate destination, besides the re-use, proceeded of the necessary complementary procedures of treatment. |
| 22. | Appropriate compensation should be taken. |
| 23. | Nothing to be done. |

### (2) Environmental Impacts during Construction and Operation

The results of evaluation of the impacts on the environment during construction and operation are compiled in Supporting Report F. The anticipated impacts at each stage are summarized and listed in the following table.

**Pattern of impacts**

| PROJECT STAGE / ENVIRONMENTAL FACTORS CONSIDERED | Delimitation and licensing of the work area<br>I | Preliminary works<br>II | Transport of machines and material<br>III | Work site setting up, operation and deactivation<br>IV | Earthworks<br>V | Civil engineering works<br>VI | O&M of system<br>VII |
|---|---|---|---|---|---|---|---|
| 1. Relief and soil | | - | | - | - | - | |
| 2. Land use and occupation | - | | - | - | | | |
| 3. Air quality | | | | | - | - | - |
| 4. Noise | | | | - | - | - | - |
| 5. Water resources | - | | | | | - | +- |
| 6. Vegetation and fauna | - | - | | - | - | - | |
| 7. Jobs and income | | + | + | +- | + | + | + |
| 8. Infrastructure | | | - | | - | - | - |
| 9. Quality of life | | | - | - | - | - | +- |
| 10. Economy | | | + | | + | + | + |
| 11. Landscape heritage | | | | | | + | |
| 12. Political/institutional aspects | | | | - | | - | |

Among these impacts 1) impact on river water quality and flow pattern, 2) offensive odor, 3) impact on flora and fauna has particular importance and examined in detail as follows.

#### 1) Impacts on river water quality and flow pattern

Because an absolute quantity of organic pollution load (BOD) from a target basin decreases by implementation of the project, improvement of water quality is expected. However, water quality and flow pattern of the river receiving the STF effluent may be impacted

negatively. According to the technical notification effluent from STF should be discharged after 90% removal of BOD after treatment. The amount and quality of the discharged effluent, and the river to be discharged are shown in the following table.

| Sewage treatment Facility | Discharge Volume ($m^3$/day) | Effluent Water Quality (BOD mg/l) | Discharge Points (See Figure 4.7-1) |
|---|---|---|---|
| **Conceicao** | 11,800 | 25 | Timbo River |
| **Janga** | 60,600 | 26 | Timbo River |
| **Cabanga** | 55,900 | 30 | Tejipio River |
| **Boa Viagem** | 26,000 | 31 | Tejipio River |
| **Cordeiro** | 18,800 | 30 | Capibaribe River |
| **Prazeres** | 30,100 | 38 | Jaboatao River |
| **Curcurana** | 22,600 | 32 | Jaboatao River |

Note: Data are planned for Year 2010.

The quality of the river water is studied by using the river monitoring data by the CPRH. Monitoring period and the results of Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), and Fecal Coliforms by CPRH are as shown following table, and the monitoring spots are shown in Fig. 4.7-2.

**Monitoring Period of Water Quality Parameters**

| Parameters | Timbo | Capibaribe | Tejipio | Jaboatao |
|---|---|---|---|---|
| **DO** | 1990 to1999 | 1990 to 1999 | 1991 to 1998 | 1990 to 1999 |
| **BOD** | 1990 to1999 | 1990 to 1999 | 1991 to 1998 | 1990 to 1999 |
| **Coliforms** | 1990 to1999 | 1990 to 1999 | 1991 to 1998 | 1990 to 1999 |

### 1) Water Quality

Water quality indicators of the rivers of interest is as follows:

#### a) Timbo River:

The secular variation of water quality (DO, BOD, and Fecal Coliforms) at 2 monitoring stations (TB2-30 and TB2-35) in the Timbo River are as shown in Fig. 4.7-3. BOD of a TB2-30 station doesn't satisfy Class 2 standard value (5mg/l) except in 1994 and 1995. In addition, DO, which is used as indicator of organic pollution as BOD, doesn't satisfy Class 2 standard (5mg/l) except in 1991. Extremely high numbers of Fecal Coliforms together with high BOD and low DO values are suggesting influence of domestic wastewater discharge to the river.

TB2-35 station satisfies BOD standard of Class 2 in 1993, 1994, 1995, 1997, and 1998. However, the station does not satisfy a standard of Class 2 about DO except 1990. But DO is not extremely low and is more than 3mg/l all the years; therefore, the pollution is not really serious at TB2-35 station. Number of Fecal Coliforms doesn't satisfy the Class2 standard value (1000MNP/100ml).

The water of TB2-35 is better compared with TB2-30; however, pollution by domestic wastewater is still observed. The reason why the water quality of TB2-30 station is inferior to that of TB2-35 is attributable to more heavily populated residential areas around TB2-30 than TB2-35.

**b) Capibaribe River:**

The water quality of the Capibaribe River is as shown in Figure 4.7-4. BOD at CB2-80 station which is located upstream of the Cordeiro STF project site has satisfied the standard of Class 2 until 1997, but go beyond the standard value in 1998 and 1999. DO, which generally shows reverse correlation with BOD, suggests progressive tendency of pollution by domestic wastewater. The influence by drought of last 2 years might contribute the deteriorated water quality of 1998 and 1999. Neither year satisfies a standard of Class 2 about Fecal Coliforms. BOD does not satisfy the Class 2 standard at CB2-90 station except 1994. DO does not satisfy the standard after 1995. Fecal Coliforms doesn't satisfy the Class 2 standard in all years..

Trend in the change of water quality shows progressive pollution by domestic wastewater and influence of drought in recent years. The worse water quality at CB2-90 compared to that of CB2-80 indicates discharge of domestic wastewater between these two stations since CB2-90 is located downstream of CB2-80

**c) Tejipio River:**

Water quality in the Tejipio River and Pina Estuary are shown in Figure 4.7-5. These 2 monitoring stations (TJ3-23 and TJ3-25) are located in the river mouth where influence of seawater could be strong. Because of influence of seawater the water quality of these two stations are similar generally. BOD generally satisfies 10mg/l, which is the standard value of Class 3 except 1991. At TB3-23 station DO doesn't satisfy 4mg/l which is the standard value of Class 3, but measured values are close to the standard.

The DO standard value generally is satisfied at TB3-25 station. Since TB3-25 station is at seaside, the better water quality at TB3-25 is attributable to the stronger influence of seawater at the station. In case of Fecal Coliforms it hardly satisfies the standard at both stations.

### d) Jaboatao:

Water quality of the Jaboatao River is as shown in Figure 4.7-13. The stream near the STF project site is classified as Class 3. At JB3-55 station both BOD and DO don't satisfy the standard values (BOD: 10mg/l, DO: 4mg/l). BOD is about 10mg/l to 60mg /l and DO is almost depleted completely which is showing severe water pollution. The water quality at the monitoring stations of the Jaboatao River is worse compare to that of the Timbo, Capibaribe and Tejipio Rivers. However, decreasing tendency is observed about BOD with years and it decreases almost to a value close to the standard value after 1997.

DO does not satisfy a standard value at JB3-75 station, but BOD satisfies with the standard value generally after 1994. Improvement of water year by year is observed as same as JB3-55 station. The better water quality at JB3-75 than JB3-55 is due to the dilution effect by seawater since JB3-75 is located in tidal area. Fecal Coliforms doesn't satisfy the standard all the years.

## 2) Impact by STF effluent

The impact on river water by discharge of the STF effluent is evaluated as follows.

### a) Conceicao and Janga STFs:

Effluent from Conceicao and Janga STFs is planned to be discharged into the Timbo River. In order to evaluate influence to the river water by effluent discharge, comparison of the BOD loads from the sewage collection project area with and without scenarios of implementation of Conceicao and Janga STFs is done. The BOD loads in 2010 years with and without STFs scenarios are shown in the following table.

**BOD load to Timbo River from Sewage Collection Area in 2010**

| Area | BOD load without Project (Kg/day) | BOD load with Project (Kg/day) |
|---|---|---|
| Conceicao | 811 | 291 |
| Janga | 1,971 | 1,603 |
| Total | 2,782 | 1,894 |

As shown in the table, BOD load from the sewage collected project site to the Timbo River is decreased to 68% after the completion of the Conceicao and Janga STFs. Therefore, there is no significant impact on the water quality. Effluent is planned to be disinfected by ultraviolet rays (UV) before discharge; therefore, improvement of river water quality as for Fecal Coliforms is expected.

Amount of the effluent is about 53,000 $m^3$/day and discharge point is located in the tidal reach where is affected by a big inflow of seawater by tide; therefore, influence to river flow by the effluent discharge is expected to be insignificant.

**b) Boa Viagem STF:**

Effluent from Boa Viagem STFs is planned to be discharged into the Tejipio River system. In order to evaluate influence to the estuary water by the effluent discharge, comparison of the BOD loads from the sewage collection project area with and without project. The BOD loads in 2010 years with and without STFs are shown in following table.

**BOD load to the Tejipio River from Sewage Collection Area in 2010**

| Area | BOD load without Project (Kg/day) | BOD load with Project (Kg/day) |
|---|---|---|
| Boa Viagem | 5,242 | 819 |

As shown in the table, BOD load from the sewage collected project site to the Tejipio River is decreased to 16% after the completion of the Boa Viagem STFs. Therefore, there can be no significant impact on the water quality. Effluent is planned to be disinfected by ultraviolet rays (UV) before discharge; therefore, improvement of river water quality as for Fecal Coliforms is expected. Amount of the effluent is about 26,000 $m^3$/day and discharge point is in the tidal area and there is a big inflow of seawater by tide. Therefore, influence to river flow by the effluent discharge is expected to be insignificant.

**c) Cabanga and Cordeiro STFs:**

Effluent from Cabanga and Cordeiro STFs is planned to be discharged into the Capibaribe River. The discharge point is as shown in figure 4.7-1. In order to evaluate influence to the estuary water by effluent discharge, comparison of the BOD loads from the sewage collection project area with and without scenarios of implementation of Cabanga STF is made. The BOD loads in 2010 years with and without the STF are shown in the following table.

**BOD load to Pina Estuary from Sewage Collection Area in 2010**

| Area | BOD load without Project (Kg/day) | BOD load with Project (Kg/day) |
|---|---|---|
| Cordeiro | 3,456 | 520 |
| Cabanga | 14,635 | 1,672 |
| Total | 18,091 | 2,192 |

As shown in the table, BOD load from the sewage collected project site to the Capibaribe

River is decreased to 12 % after the completion of the Cabanga and Cordeiro STFs. Therefore, there can be no significant impact on the water quality. Effluent is planned to be disinfected by ultraviolet rays (UV) before discharge; therefore, improvement of river water quality as for Fecal Coliforms is expected. Amount of the effluent is about 74,700m$^3$/day and the most the effluent will discharge to the river, therefore, influence to river flow by the effluent discharge is point is expected to be insignificant.

**d) Prazeres and Curcurana STFs:**

Effluent from Prazeres and Curcurana STFs is planned to be discharged into the Jaboatao River. The discharge points are as shown in figure 4.7-1. In order to evaluate influence to the river water by effluent discharge, comparison of the BOD loads from the sewage collection project area with and without scenarios of Prazeres and Curcurana STFs is made. The BOD loads in 2010 years with and without STF scenarios are shown in the following table.

**BOD load to Timbo River from Sewage Collection Area in 2010**

| Area | BOD load without Project (Kg/day) | BOD load with Project (Kg/day) |
|---|---|---|
| Prazeres | 4,726 | 1,132 |
| Curcurana | 2,848 | 722 |
| Total | 7,574 | 1,854 |

As shown in the table, BOD load from the sewage collected project site to the Jaboatao River is decreased to 25% after the completion of the Prazeres and Curcurana STFs. Therefore, there can be no significant impact on the water quality. Effluent is planned to be disinfected by ultraviolet rays (UV) before discharge; therefore, improvement of river water quality as for Fecal Coliforms is expected. Amount of the effluent is about 41,000 m$^3$/day; therefore, influence to river flow by the effluent discharge is expected to be insignificant.

**2) Offensive Odor**

Layout plan of the 7 project sites are as shown in Fig. 4.4-2 to 4.4-8. Influent well, sludge drying beds, lagoons and sedimentation tank are considered to be the major sources of offensive odor in the STFs. The distance and direction of these facilities and surrounding houses are as shown in following table.

| Sewage Treatment Plant | The closest distance from offensive odor source facilities to Residential Area (m) | Direction of Residential Area | Remarks |
|---|---|---|---|
| **Conceicao** | 80 | East | Sludge Drying Bed |
| **Janga** | 100 | North | Sludge Drying Bed |
| **Cabanga** | 50 | North | Influent Well |
| **Boa Viagem** | 150 | South | Lagoon |
| **Cordeiro** | 100 | South | Sedimentation Tank |
| **Prazeres** | - | - | Sludge Drying Bed |
| **Curcurana** | 50 | East | Sludge Drying Bed |

Impact of offensive odor to the surroundings is summarized as follows.

**1) Conceicao:**

In the south and east sides of the Conceicao STF project site there are residential area and factory. Distance to the nearest house is about 80m. Fences at the boundary of the STF is planned to be constructed and a green belt is planted inside of the boundary; therefore, offensive odor from the facilities will be lowered by blocking and enhancement of diffusion by the green belt and the fences. Also in the RMR the wind direction is 80% from southeast and expected to lower the possibility of the diffusion of offensive odor to the direction of the residence. Therefore, influence of offensive odor from the STF to the surrounding area can be insignificant.

**2) Janga:**

In the south and east sides of the Janga STF project site there are no residential area and factories. There are few houses in the north side. Distance to the nearest house is about 100m. There is densely populated residential area (the Maranguape II estate) in the west uphill. However, distance to the area is more than 300m. Fences at the boundary of the STF is planned to be constructed and a green belt is planted inside of the boundary; therefore, offensive odor from the facilities will be lowered by blocking and enhancement of diffusion by the green belt and the fences. Also the wind direction is 80% from southeast in the RMR and expected to lower the possibility of the diffusion of offensive odor to the direction of the residence. Therefore, influence of offensive odor from the STF to the surrounding area can

be insignificant.

**3) Cabanga:**

The south side of the Cabanga STF project site is the Pina estuary. The distance to the other side of the estuary is more than 300m. This project site is located in urban area and there are houses and buildings in the north and west side over 10m wide road. Because of limited site space aerated lagoon will not be installed. At this STF the major sources of offensive odor are sludge drying beds, sedimentation tanks, and inflow wells. The closest distance from these facilities to surrounding residence is about 50m. Fences at the boundary of the STF is planned to be constructed and a green belt will be planted inside of the boundary; therefore, offensive odor from the facilities will be lowered by blocking and enhancement of diffusion by the green belt and the fences.

**4) Boa Viagem:**

The East Side of the Boa Viagem STF project site is a swamp. In south and West Side there are houses and factories. The north side of the site is vacant land. There are almost no houses in northeast direction where is the area of high risk of influence from the point of prevailing wind. Also fences at the boundary of the STF is planned to be constructed and a green belt will be planted inside of the boundary; therefore, offensive odor from the facilities will be lowered by blocking and enhancement of diffusion by the green belt and the fences. Therefore, influence of offensive odor from the STF to the surrounding area can be insignificant.

**5) Cordeiro:**

The north side of the Cordeiro STF project site is the Capibaribe River. The distance from houses at the other side of the river is more than 200m. The West Side of this project site is a parkland. In south and east sides 30m wide road is planned to be constructed by Recife City. There is a distance about 100m from residences in south side. Prevailing wind is form the Southeast and fences at the boundary of the STF is planned to be constructed and a green belt is planted inside of the boundary; therefore, influence of offensive odor from the STF to the surrounding area can be insignificant.

**6) Prazeres:**

There is no residence around the Prazeres STF project site. There are some factories in east and south side. North and west sides of the site are vacant lands. Since there is no residence near the site, there can be no significant influence by offensive odor if appropriate planting of green belt is made.

7) **Curcurana:**

The north side of the Curcurana STF project site is a swamp, which continues to Olho d'Agua lagoon. Therefore, there are no houses in north side of the site. Houses are scattered in west and south sides. In East Side there is a residential area. The closest distance from the STF to residences is about 50m. Prevailing wind is form the Southeast and fences at the boundary of the STF is planned to be constructed and a green belt will be planted inside of the boundary; therefore, influence of offensive odor from the STF to the surrounding area can be insignificant.

## (3) Impact on fauna and flora by implementation of the project

In all 7 selected sites for the STF project, the flora is completely anthropogenic. Most of the species found are invasive plants and many of them are weedy (ruderal) plants, (typical plants that are founded in human settlements), with the predominance of bushes and herbaceous plants. About 26 plant and 22 animal families; 46 plant and 28 animal genera; 44 plant and 25 animal species. The lowest number of flora genera and species was found in ETE Cabanga, which is located in a dense and consolidated urban area. In Boa Viagem and Prazeres areas, the preliminary results reveal a very similar number to the other sites. However, in Prazeres it is expected to be a lower number of plant species since there is a predominance of "*taboa*" (***Typha angustifolia***) because the area is mostly wetland. Except Prazeres area described above, it may be possible asserted that in all other areas where invasive and ruderal species predominate, there are the following species: a) in the wetlands or partially flooded areas "*bredo-d'água*" (***Alternanthera philoxeroides***), "*capim-braquiária*" (***Brachiaria decumbens***), b) in most dry area the species more commun are "*jitirana*" (***Ipomoea asarifolia***), "*relógio*" (***Sida cordifolia***), "*vassourinha-de-botão*" (***Spermacoce verticillata***) and "*chanana*" (***Turnera ulmifolia***). In all selected areas for STFs project sites, there is no species in risk of extinction.

Among animal species the predomination are birds, which are totally adapted to urban environment, and the most commun species in all visited area are: "*bem-te-vi*" (***Pitangus sulphuratus***), "*caga-cebito*" (***Coereba flaveola***), "*anum-preto*" (***Crotophaga ani***), "*lavandeira*" (***Fluvicola nengeta***) and "*rouxinol*" (***Troglodytes aedon***).

None of animal species found in those areas are listed in any official track of extinction risk species.