## 2.6 Environmental Aspects

### 2.6.1 Environmental Administration

#### (1) Related Environmental Organizations

According to the National Constitution of 1988, the responsibility for legislation on the environment is distributed among Federal, State, and Municipal authorities. The Central Government is responsible for aspects of water, energy, quarries, mines and other mineral resources and nuclear activities, while the States have responsibilities for all subjects outside the realms of the Central Government. The Municipalities prepare norms of local interest.

There is the National Environmental System (Sistema Nacional de Meio Ambiente: SISNAMA) composed of the Nation, States, Municipalities, and Public enterprises. In the State of Pernambuco, the Environment Company of Pernambuco (Companhia Pernambucana do Meio Ambiente: CPRH) deals with all environmental affairs. The administrative organization chart of the State Government of Pernambuco is shown in Fig. 2.10-1. The CPRH has four departments, of which responsibilities of each are shown in the following table.

**Areas of responsibility in the Departments of CPRH**

| Dept. | Admin. | Air | Water | Noise & Vibration | Offensive Odor | Soil | Forestry | Waste | Environmental Education |
|---|---|---|---|---|---|---|---|---|---|
| DAF | O | | | | | | | | |
| DHF | | | O | | | O | O | O | |
| DCA | | O | O | O | O | O | | O | O |
| DPI | | O | O | O | O | O | O | O | O |

DAF: Administration and finances
DHF: Water and forestry resources
DCA: Environmental control
DPI: Planning and Integration

#### (2) Environmental Legislation

The principal agency for environmental management of the projects in the State of Pernambuco is the CPRH, which plays major roles in the prevention, control and elimination of environmental pollution as well as in the preservation and control of the environment.

SISNAMA has the overall responsibility for establishing the policies, laws, and standards for the protection of the environment along with the State Governments. This includes water, air, and noise quality standards, and requirements for Environmental Impact Assessment

(EIA) for development projects. These standards are of significance for the proposed projects. Key environmental legislation is listed in the following table.

**Key Environmental Legislation**

| Name | Scope and Objective | Key Areas | Operational Agencies / Key Players |
|---|---|---|---|
| National Environmental Policy, 1981 | To provide a basis for protection and improvement of Environment | Umbrella legislation to supplement pollution laws | Central and State governments |
| The Water Code, 1934 | To prevent and control water pollution and enhance the quality of water | Controls sewage and industrial effluent discharges | Central and State governments |
| The Forest Code, 1965 | To halt deforestation and resulting environmental degradation | Restriction on devastation and using forest for non-forestry purpose | Central and State governments |
| Ecological Stations and Environmental Protection Areas, 1981 | To protect wildlife | Create protected areas (national parks/sanctuaries) and categories of wildlife to be protected | Central and State governments |
| National Water Resources Policy, 1977 | To protect and manage water resources | Prepare usage plans of water resources for various purposes | Central and State governments |
| Regulation of States Law, 1981 | To provide a basis for protection and improvement of environment in Pernambuco | Umbrella legislation to supplement pollution laws | State government |
| Authorization of the Constitution of CPRH, 1976 | To define the functions of CPRH | Environmental Licensing | State government |

### (3) Water Quality Standards

The water quality standards, State Law No. 7269 of 05/06/1981, classify the waters in the state territory on the basis of Directives GM No 13 of 15/01/76 of the Ministry of the Interior according to their predominant uses into classes 1 to 4. One of the conditions for discharging the effluents stipulated in article 29 of the Standard State Law is that the discharging of the effluents must not alter the classification of the receiving body. The CONAMA Resolution 20/6/86 reformulates the existing classification. The classification of water according to its uses under the CONAMA Resolution is as follows.

**Fresh Water:**

Special: Water destined for domestic supply with or without simple disinfection before use and for the preservation of the natural equilibrium of aquatic communities.

Class 1: Water destined for;

- domestic supply after simple purification,
- the protection of aquatic communities,
- irrigation of vegetables which are eaten raw and of fruit which grow at soil level and which are eaten raw without peering,
- immediate recreational contact (swimming, water skiing and diving),
- natural or intensive farming (fish farming) of species destined for human consumption.

Class 2: Water destined for;

- domestic supply after conventional purification,
- the protection of aquatic communities,
- immediate recreation contact (swimming, water skiing and diving),
- irrigation of fruit-bearing plants and vegetables,
- natural or intensive farming ( fish farming) of species destined for human consumption.

Class 3: Water destined for;

- domestic supply after conventional purification,
- irrigation of tree, cereal and forage crops fish farming,
- livestock breeding.

Class 4: Water destined for;

- domestic supply after advanced purification,
- navigation, for scenery harmony,
- industrial supply,
- less demanding uses.

**Seawater:**

Class 5: Water destined for;

- recreation of immediate contact (swimming, water skiing and diving),
- the protection of aquatic communities,
- natural or intensive farming of species destined for human consumption.

Class 6: Water destined for;

- commercial navigation,
- landscaping,
- recreation without immediate contact.

**Brackish Water:**

Class 7: Water destined for;

- recreation of immediate contact (swimming, aquatic ski and diving),

- the protection of aquatic communities,
- natural or intensive farming of species destined for human consumption.

Class 8: Water destined for;

- commercial navigation,
- landscape,
- recreation without primary contact.

Although water is classified as described above, there is no harm in using better quality water for common uses as long as these uses do not affect the quality established for these waters.

The rivers in the State of Pernambuco have been classified in terms of water quality by State Decree No 11.358 of 30/04/86 (Jaboatao and Pirapama river), No 11.515 of 12/06/86 (Capibaribe River), and No 11.760 of 27/08/86 (the rest of the rivers). The waters of the major rivers of the RMR are classified as follows;

Class 1: Water for domestic supplies without purification or simple disinfection,

Class 2: Water for domestic supply after conventional purification for irrigation of farm products consumed without processing and for recreation of immediate contact (swimming, aquatic ski, and diving),

Class 3: Water for domestic supply after conventional purification for preservation of fishes and other wildlife and for livestock breading,

Class 4: Water for domestic supply after advanced purification for navigation, landscaping, industrial supply, irrigation, and other less demanding uses.

The effluents from pollution sources may be discharged directly or indirectly into water bodies, if they meet the following requirement:

(a) PH between 5 and 9,
(b) Temperature below 40°C,
(c) Materials that form sediments at a rate of less than 1 ml/l in one hour Imnhoff cone test,
(d) Discharge conditions with maximum discharge of up to 1.5 times the average daily discharge rate,
(e) Absence of floating material,
(f) Up to 50 mg/l of oils and greases,
(g) Substances in harmful concentrations within the CPRH limits,
(h) Special treatment if they come from hospitals and other establishments where there are wastes infected with pathogenic microorganisms and they are deposited in waters destined for immediate contact recreation or irrigation, no matter what the initial levels of Coliforms were.

The responsibility of the CPRH is to guide, inspect, and punish activities in their area and to set limits for effluent discharge.

The details of the ambient standards and the effluent discharge limits are given in Tables 2.6-1 (1/3)-(3/3).

### 2.6.2 Existing Environmental Conditions (Water)

#### (1) Environmental Monitoring

In the RMR, the CPRH has been monitoring physical and chemical parameters of water in 12 rivers, namely the Beberibe, Botafogo, Capibaribe, Igarassu, Ipojuca, Jaboatao, Paratibe, Pirapama, Sta Cruz, Tapacura, Tejipio, and Timbo Rivers since 1984. The monitored parameters are briefly listed in the following table:

**Parameters Monitored by CPRH.**

| Rivers | Monitoring Period | Parameters | Number of Stations |
|---|---|---|---|
| Beberibe | 1986 - 1999 | Temp., pH, DO, BOD, Coliforms, Potentially harmful substances such as Metals, Organic compounds | 8 - 12 |
| Botafogo | 1991 - 1999 | " | 2 - 9 |
| Capibaribe | 1990 - 1999 | " | 9 - 24 |
| Igarassu | 1991 - 1999 | " | 2 - 11 |
| Ipojuca | 1986 - 1999 | " | 7 - 19 |
| Jaboatao | 1990 - 1999 | " | 4 - 12 |
| Paratibe | 1990 - 1999 | " | 2 - 6 |
| Pirapama | 1984 - 1999 | " | 6 - 24 |
| Sta Cruz | 1990 - 1999 | " | 1 - 8 |
| Tapacura | 1997 - 1998 | " | 9 |
| Tejipio | 1991 - 1998 | " | 2 |
| Timbo | 1990 - 1999 | " | 2 - 7 |

The monitoring stations of the major four (4) rivers (Beberibe, Capibaribe, Jaboatao, and Ipojuca Rivers) and the water classes are shown in Fig. 2.6-1, and the monitoring stations along the coast are shown in Table 2.6-2.

## (2) Results of Analyses

### 1) Items related to living environment

a) Beberibe River

| Items | DO | BOD | Coliforms |
|---|---|---|---|
| Locational variation | DO decreases from upstream to downstream due to increase in organic pollution. DO satisfy the water quality standard only at BE2-11 (upstream). | BOD increases toward river mouth because of increase in organic pollution. BOD satisfies the water quality standard only at BE2-11. | Beberibe River is seriously polluted by Coliforms. At all monitoring stations, number of Coliform is far beyond the water quality standard. |
| Monthly variation (In 1998) | There is no significant variation in DO upstream and DO is almost depleted downstream reach. | From May to September there is a decrease in BOD possibly due to Rain. | There is no noticeable monthly change in the number of Coliforms. |
| Ycarly variation | DO is decreasing but not significantly. | BOD decreases in the downstream reach. | Number of Coliforms varies yearly and tends to increase. |

b) Capibaribe River

| Items | DO | BOD | Coliforms |
|---|---|---|---|
| Locational variation | DO is increasing from upstream to downstream due to increasing influence of seawater. DO satisfies the water quality standard in the downstream reach. | BOD increases toward river mouth because of increasing organic pollution. BOD satisfies the water quality standard only at CB2-55. | Capibaribe River is seriously polluted by Coliforms. At all monitoring stations, the number of Coliforms is far beyond the water quality standard except CB2-60. |
| Monthly variation (In 1998) | DO decreases upstream from January to December. However, there is no obvious trend in DO downstream and it is very variable. | There is no obvious trend in BOD at both upstream and downstream. BOD is always higher in the downstream than in the upstream. | There is no remarkable monthly change in the number of Coliforms upstream, but higher number of Coliforms is observed in July and September. |
| Yearly variation | DO is decreasing but not significantly. | There is almost no yearly change in BOD. | There is almost no yearly change in the number of Coliforms. Downstream, the number of Coliforms is very high compared to upstream. |

c) Ipojuca River

| | DO | BOD | Coliforms |
|---|---|---|---|
| Locational variation | DO decreases from upstream to downstream due to increasing organic pollution. DO does not satisfy the water quality standard at any monitoring stations. | BOD increases toward river mouth because of increasing organic pollution. BOD does not satisfy the water quality standard at any monitoring stations. | Ipojuca River is seriously polluted by Coliforms. At all monitoring stations, the number of Coliform bacteria is far beyond the water quality standard. The coliforms count is higher upstream. |
| Monthly variation (In 1998) | DO is high upstream and downstream from April to September possibly due to increasing rain. | From April to September there is a decrease in BOD possibly due to rain. | There is no noticeable monthly change in the number of Coliforms. |
| Yearly variation | Decrease in DO downstream. But not significant upstream. | There is no obvious change in BOD. | Number of Coliforms increases yearly at both monitoring stations. |

d) Jaboatao River

| | DO | BOD | Coliforms |
|---|---|---|---|
| Locational variation | DO changes from upstream to downstream. DO does not satisfy the water quality standard at any points. | BOD is highly variable from upstream to downstream. BOD satisfies the environmental standard only at JB3-75 possibly due to the influence of seawater. | There is serious pollution by Coliforms. At all monitoring stations, the number of Coliforms is far beyond the water quality standard. The number of Coliforms decreases downstream due to the influence of seawater. |
| Monthly variation (In 1998) | There is no clear trend in DO. But DO is somewhat higher from April to September possibly due to increasing rain. | There is no clear trend in BOD. But BOD rapidly increases from October to December as DO decreases. | There is no noticeable monthly change in the number of Coliforms. |
| Yearly variation | DO is decreasing upstream. | BOD is increasing upstream. | There is no clear yearly change in the number of Coliforms. |

c) Timbo River

| | DO | BOD | Coliforms |
|---|---|---|---|
| Locational variation | There are only 2 operational monitoring stations in the Timbo River. These two stations are not in the same stream, therefore, no locational evaluation in the same river can be made. However, TB2-35 observed better quality water compared to TB2-30 from the viewpoints of DO, BOD and Coliforms. | It is the same with the case of DO. | It is the same with the case of DO. |
| Monthly variation (In 1998) | There is no clear change in DO. At station TB-30, DO is always lower than the water quality standard. At TB-35 the situation is better than TB-30, however, it is not clear the ambient standard all the time. | There is no clear monthly change in BOD. Although BOD always exceeds the water quality standard at TB2-30, it is almost satisfied at TB2-35 station. | There is no noticeable monthly change in the number of Coliforms. |
| Yearly variation | There is a decreasing trend in DO at these stations. | There is no noticeable change in BOD at these stations. | There is an increasing yearly trend in the number of Coliforms at these stations. |

### 2) Potentially harmful substances

For these five (5) rivers the levels of harmful substances such as metals and organic compounds have been monitored since 1992. The analytical results are tabulated in Table 2.6-2. In these 5 rivers almost no inorganic harmful substances were observed except ammonia and chloride ions. High concentration of Chloride ion was measured at the monitoring stations near the river mouths, which apparently indicates the influence of seawater. In almost all cases, ammonia and phosphate ions exceed the water quality standards. Taking the high values in fecal Coliforms into consideration in these rivers these high values of ammonia and phosphate concentrations are attributable to the influence of human and farming activities.

## Table 2.6 – 1 Water Quality Standards (1/3)

| PARAMETERS OF WATER QUALITY | UNIT | WATER QUALITY STANDARDS CONAMA RESOLUTION NO. 20/1986 | | | | | | | | | WATER QUALITY STANDARDS PERNAMBUCO, 1981 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FRESH WATER | | | | | SALTY WATER | | BRACKISH WATER | | | | | |
| | | Special Class | Class 1 | Class 2 | Class 3 | Class 4 | Class 5 | Class 6 | Class 7 | Class 8 | Class 1 | Class 2 | Class 3 | Class 4 |
| pH | - | - | 6.0-9.0 | 6.0-9.0 | 6.0-9.0 | 6.0-9.0 | 6.5-8.5 | 6.5-8.5 | 6.5-8.5 | 5.0-9.0 | - | 5.0-9.0 | 5.0-9.0 | 5.0-9.0 |
| DO | mg/l | - | > 6 | > 5 | > 4 | > 2 | > 6 | > 4 | > 5 | > 3 | - | > 5 | > 4 | > 0.5 |
| BOD | mg/l | - | < 3 | < 5 | < 10 | - | < 5 | < 10 | < 5 | - | - | < 5 | < 10 | - |
| Turbidity | NTU | - | < 40 | < 100 | < 100 | - | - | - | - | - | - | - | - | - |
| Color | mg Pt/l | - | Natural | < 75 | < 75 | - | - | - | - | - | - | - | - | - |
| Floating material including non-natural foam | - | - | V.A. | V.A. | V.A. | V.A. | V.A. | V.A. | V.A. | V.A. | - | V.A. | V.A. | V.A. |
| Oil and Grease | - | - | V.A. | V.A. | V.A. | I.T. | V.A. | I.T. | V.A | I.T. | - | V.A. | V.A. | V.A. |
| Substances which have a taste or smell | - | - | V.A. | V.A. | V.A. | N.O. | V.A. | V.A. | V.A. | V.A. | - | V.A. | V.A. | N.O. |
| Artificial dye | - | - | V.A. | V.A. | V.A. | - | V.A. | V.A. | V.A. | V.A. | - | - | - | - |
| Material which can form sediments | - | - | V.A. | V.A. | V.A. | V.A. | V.A. | V.A. | V.A. | V.A. | - | V.A. | V.A. | - |
| Potentially harmful substances | | | | | | | | | | | | | | |
| Al | mg/l | - | 0.1 | 0.1 | 0.1 | - | 1.5 | - | - | - | - | - | - | - |
| Ag | mg/l | - | 0.01 | 0.01 | 0.05 | - | 0.005 | - | - | - | - | - | - | - |
| As | mg/l | - | 0.1 | 0.05 | 0.1 | - | 0.05 | - | 0.05 | - | - | 0.1 | 0.1 | - |
| B | mg/l | - | 0.75 | 0.75 | 0.75 | - | 5.0 | - | - | - | - | - | - | - |
| Ba | mg/l | - | 1.0 | 1.0 | 1.0 | - | 1.0 | - | - | - | - | 1.0 | 1.0 | - |
| Be | mg/l | - | 0.1 | 0.1 | 0.1 | - | 1.5 | - | - | - | - | - | - | - |
| Cd | mg/l | - | 0.001 | 0.001 | 0.01 | - | 0.005 | - | 0.005 | - | - | 0.01 | 0.01 | - |
| Cl | mg/l | - | 250 | 250 | 250 | - | - | - | - | - | - | - | - | - |
| $Cl_2$ | mg/l | - | 0.01 | 0.01 | 0.01 | - | 0.01 | - | - | - | - | - | - | - |
| CN | mg/l | - | 0.01 | 0.01 | 0.2 | - | 0.005 | - | 0.005 | - | - | 0.2 | 0.2 | - |
| Co | mg/l | - | 0.2 | 0.2 | 0.2 | - | - | - | - | - | - | - | - | - |
| $Cr^{3+}$ | mg/l | - | 0.5 | 0.5 | 0.5 | - | - | - | - | - | - | - | - | - |
| $Cr^{6+}$ | mg/l | - | 0.05 | 0.05 | 0.05 | - | 0.05 | - | 0.05 | - | - | - | - | - |
| Cu | mg/l | - | 0.02 | 0.02 | 0.5 | - | 0.05 | - | 0.05 | - | - | 1.0 | 1.0 | - |
| F | mg/l | - | 1.4 | 1.4 | 1.4 | - | 1.4 | - | 1.4 | - | - | 1.4 | 1.4 | - |
| Fe | mg/l | - | 0.3 | 0.3 | 5 | - | 0.3 | - | - | - | - | - | - | - |
| Hg | mg/l | - | 0.0002 | 0.0002 | 0.002 | - | 0.0001 | - | 0.0001 | - | - | 0.002 | 0.002 | - |
| Li | mg/l | - | 2.5 | 2.5 | 2.5 | - | - | - | - | - | - | - | - | - |

**Table 2.6 – 1 Water Quality Standards (2/3)**

| PARAMETERS OF WATER QUALITY | UNIT | WATER QUALITY STANDARDS CONAMA RESOLUTION NO. 20/1986 | | | | | | | | | WATER QUALITY STANDARDS PERNAMBUCO, 1981 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FRESH WATER | | | | | SALTY WATER | | BRACKISH WATER | | | | | |
| | | Special Class | Class 1 | Class 2 | Class 3 | Class 4 | Class 5 | Class 6 | Class 7 | Class 8 | Class 1 | Class 2 | Class 3 | Class 4 |
| Mn | mg/l | - | 0.1 | 0.1 | 0.5 | - | 0.1 | - | - | - | - | - | - | - |
| $NH_3$-N | mg/l | - | 0.02 | 0.02 | 1.0 | - | 0.4 | - | 0.4 | - | - | 0.5 | 0.5 | - |
| Ni | mg/l | - | 0.025 | 0.025 | 0.025 | - | 0.1 | - | 0.1 | - | - | - | - | - |
| $NO_2$-N | mg/l | - | 1.0 | 1.0 | 1.0 | - | 1.0 | - | - | - | - | 1.0 | 1.0 | - |
| $NO_3$-N | mg/l | - | 10.0 | 10.0 | 10.0 | - | 10.0 | - | - | - | - | 10.0 | 10.0 | - |
| P | mg/l | - | 0.025 | 0.025 | 0.025 | - | - | - | - | - | - | - | - | - |
| Pb | mg/l | - | 0.03 | 0.03 | 0.05 | - | 0.01 | - | 0.01 | - | - | 0.1 | 0.1 | - |
| Se | mg/l | - | 0.01 | 0.01 | 0.01 | - | 0.01 | - | - | - | - | 0.01 | 0.01 | - |
| Sn | mg/l | - | 2.0 | 2.0 | 2.0 | - | 2.0 | - | - | - | - | 2.0 | 2.0 | - |
| $SO_4$ | mg/l | - | 250 | 250 | 250 | - | - | - | - | - | - | - | - | - |
| Sulfide | mg/l | - | 0.002 | 0.002 | 0.3 | - | 0.002 | - | 0.002 | - | - | - | - | - |
| Tl | mg/l | - | - | - | - | - | 0.1 | - | - | - | - | - | - | - |
| U | mg/l | - | 0.02 | 0.02 | 0.02 | - | 0.5 | - | - | - | - | - | - | - |
| V | mg/l | - | 0.1 | 0.1 | 0.1 | - | - | - | - | - | - | - | - | - |
| Zn | mg/l | - | 0.18 | 0.18 | 5.0 | - | 0.17 | - | 0.17 | - | - | 5.0 | 5.0 | - |
| Benzen | mg/l | - | 0.01 | 0.01 | 0.01 | - | - | - | - | - | - | - | - | - |
| Benzopyren | mg/l | - | 0.00001 | 0.00001 | 0.00001 | - | - | - | - | - | - | - | - | - |
| Carbon Tetrachloride | mg/l | - | 0.003 | 0.003 | 0.003 | - | - | - | - | - | - | - | - | - |
| Cis-1.2 Dichloro Ethylene | mg/l | - | 0.01 | 0.01 | 0.01 | - | - | - | - | - | - | - | - | - |
| PCB's | ug/l | - | 0.001 | 0.001 | 0.001 | - | - | - | - | - | - | - | - | - |
| Pentachloro Phenol | mg/l | - | 0.01 | 0.01 | 0.01 | - | - | - | - | - | - | - | - | - |
| Phenol | mg/l | - | 0.001 | 0.001 | 0.3 | 1.0 | 0.001 | - | 0.001 | - | - | 0.001 | 0.001 | 1.0 |
| Surfactant | mg/l | - | 0.5 | 0.5 | 0.5 | - | 0.5 | - | - | - | - | - | - | - |
| Tetrachloro Ethylene | mg/l | - | 0.01 | 0.01 | 0.01 | - | - | - | - | - | - | - | - | - |
| Total dissolved solid | mg/l | - | 500 | 500 | 500 | - | - | - | - | - | - | - | - | - |
| Trichloro Ethylene | mg/l | - | 0.03 | 0.03 | 0.03 | - | - | - | - | - | - | - | - | - |
| 1.1 Dichloro Ethylene | mg/l | - | 0.0003 | 0.0003 | 0.0003 | - | - | - | - | - | - | - | - | - |
| 2,4,6 Trichloro Phenol | mg/l | - | 0.01 | 0.01 | 0.01 | - | - | - | - | - | - | - | - | - |
| Aldrin | ug/l | - | 0.01 | 0.01 | 0.03 | - | 0.003 | - | 0.003 | - | - | - | - | - |
| BHC | ug/l | - | 0.02 | 0.02 | 3.0 | - | 0.004 | - | 0.004 | - | - | - | - | - |
| Carbaryl | ug/l | - | 0.02 | 0.02 | 70 | - | - | - | - | - | - | - | - | - |

**Table 2.6 – 1 Water Quality Standards (3/3)**

| PARAMETERS OF WATER QUALITY | UNIT | WATER QUALITY STANDARDS CONAMA RESOLUTION NO. 20/1986 | | | | | | | | | WATER QUALITY STANDARDS PERNAMBUCO, 1981 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FRESH WATER | | | | | SALTY WATER | | BRACKISH WATER | | | | | |
| | | Special Class | Class 1 | Class 2 | Class 3 | Class 4 | Class 5 | Class 6 | Class 7 | Class 8 | Class 1 | Class 2 | Class 3 | Class 4 |
| Chlordane | ug/l | - | 0.04 | 0.04 | 0.3 | - | 0.004 | - | 0.004 | - | - | - | - | - |
| DDT | ug/l | - | 0.002 | 0.002 | 1.0 | - | 0.001 | - | 0.001 | - | - | - | - | - |
| Demeton | ug/l | - | 0.1 | 0.1 | 14.0 | - | 0.1 | - | 0.1 | - | - | - | - | - |
| Dieldrin | ug/l | - | 0.005 | 0.005 | 0.03 | - | 0.003 | - | 0.003 | - | - | - | - | - |
| Dodecachloro + Nonachloro | ug/l | - | 0.001 | 0.001 | 0.001 | - | 0.001 | - | 0.001 | - | - | - | - | - |
| Endosulfan | ug/l | - | 0.056 | 0.056 | 150 | - | 0.034 | - | 0.034 | - | - | - | - | - |
| Endrin | ug/l | - | 0.004 | 0.004 | 0.2 | - | 0.004 | - | 0.004 | - | - | - | - | - |
| Epoxide Heptachlor | ug/l | - | 0.01 | 0.01 | 0.1 | - | 0.001 | - | 0.001 | - | - | - | - | - |
| Gution | ug/l | - | 0.005 | 0.005 | 0.005 | - | 0.01 | - | 0.01 | - | - | - | - | - |
| Heptachlor | ug/l | - | 0.01 | 0.01 | 0.1 | - | 0.001 | - | 0.001 | - | - | - | - | - |
| Malathion | ug/l | - | 0.1 | 0.1 | 100 | - | 0.1 | - | 0.1 | - | - | - | - | - |
| Metoxichloro | ug/l | - | 0.03 | 0.03 | 30 | - | 0.03 | - | 0.03 | - | - | - | - | - |
| Parathion | ug/l | - | 0.04 | 0.04 | 35 | - | 0.04 | - | 0.04 | - | - | - | - | - |
| 2,4,5-T | ug/l | - | 2.0 | 2.0 | 2.0 | - | 10.0 | - | 10.0 | - | - | - | - | - |
| 2,4,5-TP | ug/l | - | 10.0 | 10.0 | 10.0 | - | 10.0 | - | 10.0 | - | - | - | - | - |
| 2,4-D | ug/l | - | 4.0 | 4.0 | 20.0 | - | 10.0 | - | 10.0 | - | - | - | - | - |
| Toxaphene | ug/l | - | 0.01 | 0.01 | 5 | - | 0.005 | - | 0.005 | - | - | - | - | - |
| Total organic pesticide | ug/l as Parathion | - | 10.0 | 10.0 | 100.0 | - | 10.0 | - | 10.0 | - | - | - | - | - |
| Bacteriological Parameters | | | | | | | | | | | | | | |
| Coliforms Total (b) | MPN/100ml | Absent (a) | 1,000 | 5,000 | 20,000 | - | - | 20,000 | 5,000 | 20,000 | - | 5,000 | 20,000 | - |
| Coliforms Fecal (b) | MPN/100ml | - | 200 | 1,000 | 4,000 | - | 1,000 | 4,000 | 1,000 | 4,000 | - | 1,000 | 4,000 | - |

Remarks:

(a) If the water is used without prior disinfection, total Coliforms should be absent.

(b) 80% of the sample need to be below this value.

V.A. - Virtually Absent

N.O. - Not Objectionable

I.T. - Rainbow color on water surface can be acceptable

mg/l = milligrams per liter

ug/l = micrograms per liter

## Table 2.6-2 Harmful Substances Detected over the Limit of Standards

| Locations | Parameters | Year | | | | | | | | Standards (mg/l) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | Class2 | Class3 |
| Beberibe | NO3-N | 0/43 | 0/34 | 0/49 | 0/40 | 0/43 | 0/49 | 0/59 | | 10.0 | 10.0 |
| | NH3-N | 10/43 | 34/34 | 49/49 | 38/40 | 44/44 | 15/15 | | 10/10 | 0.02 | 1 |
| | P | 43/43 | 29/29 | 48/49 | 40/40 | 34/34 | | | 20/20 | 0.025 | 0.025 |
| | Cl | 1/43 | 1/34 | 2/49 | 0/40 | 0/43 | 0/49 | 2/59 | 1/20 | 250 | 250 |
| | Fe | 0/5 | | | | 1/6 | 0/10 | 1/12 | | 0.3 | 5 |
| | Cu | 0/5 | | | | 0/6 | 0/10 | 0/12 | | 0.02 | 0.5 |
| | Pb | 0/5 | | | | 0/6 | 0/10 | 0/12 | | 0.03 | 0.05 |
| | Mn | 0/5 | | | | 0/6 | 0/10 | 0/12 | | 0.1 | 0.5 |
| | Ni | 0/5 | | | | 0/6 | 0/10 | 0/12 | | 0.025 | 0.025 |
| | Cd | 0/5 | | | | 1/6 | 0/10 | 0/12 | | 0.001 | 0.01 |
| | Zn | 0/5 | | | | 0/6 | 0/10 | 0/12 | | 0.18 | 5 |
| | Cr | 0/5 | | | | 0/6 | 0/10 | 0/12 | | 0.5 | 0.5 |
| | Hg | 0/5 | | | | | | | | 0.0002 | 0.002 |
| | Phenol | 0/5 | 0/5 | 0/8 | 0/5 | 0/6 | 0/10 | 0/12 | | 0.001 | 0.3 |
| Capibaribe | NO3-N | | | | | | 0/83 | 0/63 | | 10.0 | - |
| | NH3-N | | | | | | 26/26 | | 14/16 | 0.02 | - |
| | P | | | | | | | | 28/28 | 0.025 | - |
| | Cl | | | | | | 45/92 | 55/77 | 12/28 | 250 | - |
| | Fe | | | | | | 8/8 | 3/3 | 3/4 | 0.3 | - |
| | Cu | | | | | | 0/8 | 0/3 | 1/4 | 0.02 | - |
| | Pb | | | | | | 0/8 | 1/3 | 0/4 | 0.03 | - |
| | Mn | | | | | | 6/8 | 3/3 | 1/4 | 0.1 | - |
| | Ni | | | | | | | 0/3 | 0/4 | 0.025 | - |
| | Cd | | | | | | 0/8 | 0/3 | 0/4 | 0.001 | - |
| | Zn | | | | | | 0/8 | 0/3 | 0/4 | 0.18 | - |
| | Cr | | | | | | 0/8 | 0/3 | 0/4 | 0.5 | - |
| | Hg | | | | | | | | | 0.0002 | - |
| | Phenol | | | | | | | | | 0.001 | - |
| Ipojuca | NO3-N | | | | | | 0/75 | 0/55 | | 10.0 | - |
| | NH3-N | | | | | 73/73 | 20/20 | | 9/9 | 0.02 | - |
| | P | | | | | | | | 9/9 | 0.025 | - |
| | Cl | | | | | | 42/78 | 20/60 | 5/13 | 250 | - |
| | Fe | | | | | | 8/8 | 3/3 | 1/1 | 0.3 | - |
| | Cu | | | | | | 0/8 | 0/3 | 0/1 | 0.02 | - |
| | Pb | | | | | | 0/8 | 0/3 | 0/1 | 0.03 | - |
| | Mn | | | | | | 2/8 | 2/3 | 0/1 | 0.1 | - |
| | Ni | | | | | | 1/8 | 0/3 | 0/1 | 0.025 | - |
| | Cd | | | | | | 0/8 | 0/3 | 0/1 | 0.001 | - |
| | Zn | | | | | | 0/8 | 0/3 | 0/1 | 0.18 | - |
| | Cr | | | | | | 0/8 | 0/3 | 0/1 | 0.5 | - |
| | Hg | | | | | | | | | 0.0002 | - |
| | Phenol | | | | | | 0/6 | 0/2 | | 0.001 | - |
| Jaboatao | NO3-N | | | | | | 0/53 | 0/85 | 0/13 | 10.0 | 10.0 |
| | NH3-N | | | | | | 16/21 | | 17/17 | 0.02 | 1 |
| | P | | | | | | 8/8 | | 26/26 | 0.025 | 0.025 |
| | Cl | | | | | | | 8/87 | 1/27 | 250 | 250 |
| | Fe | | | | | | 0/6 | 1/12 | | 0.3 | 5 |
| | Cu | | | | | | 0/6 | 0/12 | | 0.02 | 0.5 |
| | Pb | | | | | | 0/6 | 0/12 | | 0.03 | 0.05 |
| | Mn | | | | | | 0/6 | 0/12 | | 0.1 | 0.5 |
| | Ni | | | | | | 0/6 | 1/12 | | 0.025 | 0.025 |
| | Cd | | | | | | 0/6 | 1/12 | | 0.001 | 0.01 |
| | Zn | | | | | | 0/6 | 0/12 | | 0.18 | 5 |
| | Cr | | | | | | 0/6 | 0/12 | | 0.5 | 0.5 |
| | Hg | | | | | | | | | 0.0002 | 0.002 |
| | Phenol | | | | | | 0/5 | 1/12 | | 0.001 | 0.3 |
| Timbo | NO3-N | 0/16 | 0/10 | 0/12 | 0/10 | 0/11 | 0/5 | 0/3 | | 10.0 | 10.0 |
| | NH3-N | 10/16 | 9/10 | 12/12 | 10/10 | 11/11 | 2/2 | | 1/1 | 0.02 | 1 |
| | P | 16/16 | 8/8 | 12/12 | 10/10 | 9/9 | | | 2/2 | 0.025 | 0.025 |
| | Cl | 0/16 | 0/10 | 0/12 | 0/10 | 0/11 | 0/6 | 0/5 | 0/3 | 250 | 250 |
| | Fe | 5/5 | | | | 6/6 | 6/6 | 5/5 | 1/1 | 0.3 | 5 |
| | Cu | 2/5 | | | | 1/6 | 0/6 | 1/5 | 0/1 | 0.02 | 0.5 |
| | Pb | 0/5 | | | | 0/6 | 0/6 | 0/5 | 0/1 | 0.03 | 0.05 |
| | Mn | 0/5 | | | | 0/6 | 0/6 | 0/5 | 0/1 | 0.1 | 0.5 |
| | Ni | 0/5 | | | | 0/6 | 1/6 | 0/5 | 0/1 | 0.025 | 0.025 |
| | Cd | 0/5 | | | | 0/6 | 0/6 | 0/5 | 0/1 | 0.001 | 0.01 |
| | Zn | 0/5 | | | | 0/6 | 0/6 | 0/5 | 0/1 | 0.18 | 5 |
| | Cr | 0/5 | | | | 0/6 | 0/6 | 0/5 | 0/1 | 0.5 | 0.5 |
| | Hg | 0/5 | | | | 0/6 | 0/6 | 0/5 | 0/1 | 0.0002 | 0.002 |
| | Phenol | 0/5 | | 1/6 | 4/8 | 2/5 | 1/5 | 1/4 | | 0.001 | 0.3 |

Remarks : x/y x = number of samples which did not satisfy the criteria
y = total number of samples

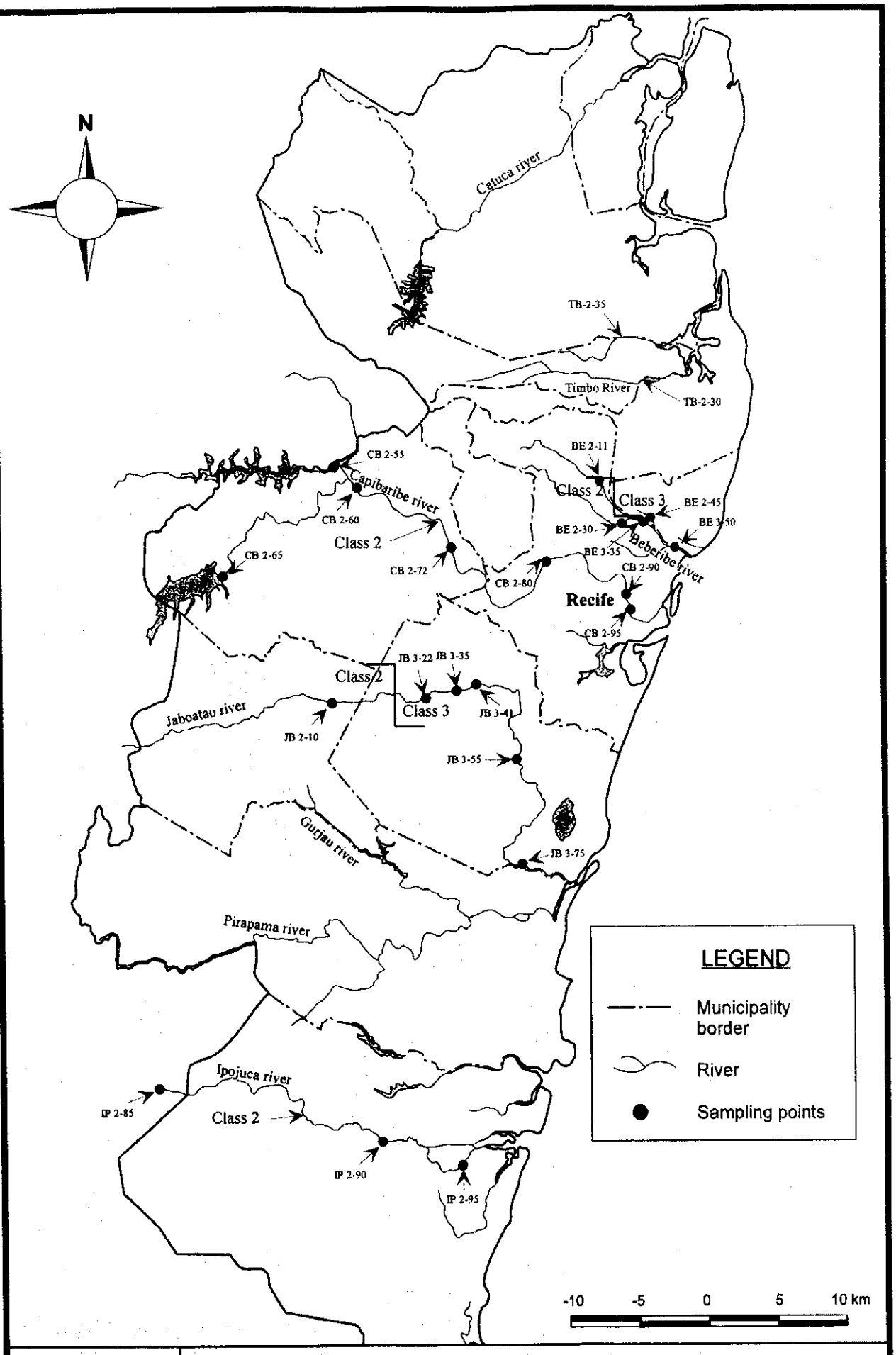


**Fig. 2.6-1** **Monitoring Stations (the Beberibe, Capibaribe, Jaboatao, Ipojuca rivers)**

THE STUDY ON STORMWATER DRAINAGE AND WASTEWATER MANAGEMENT PLAN FOR RMR

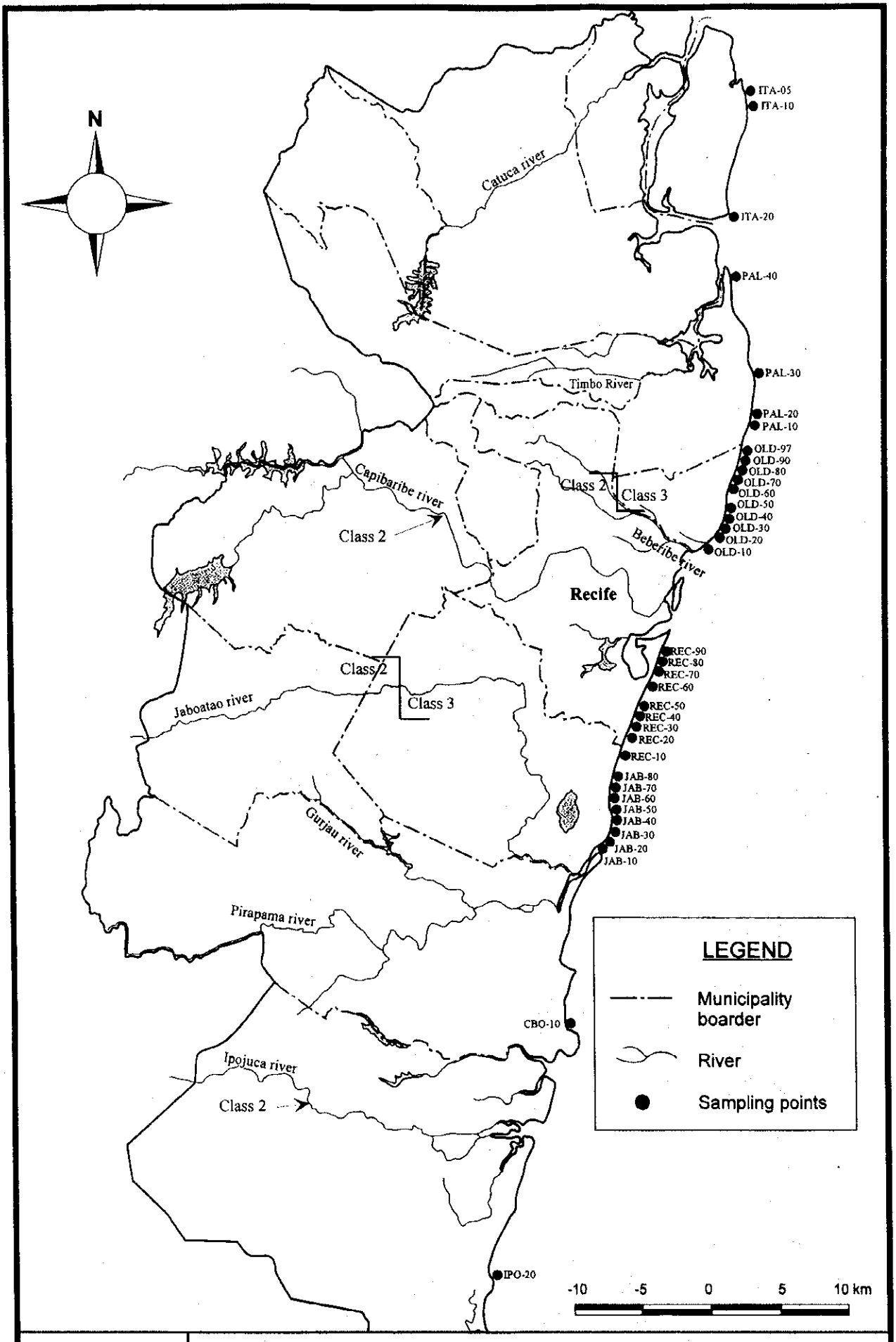


**Figure 2.6-2:** **Seawater Monitoring Stations**

THE STUDY ON STORMWATER DRAINAGE AND WASTEWATER MANAGEMENT PLAN FOR RMR

## 2.7 Sewerage

### 2.7.1 General

Most of the sewerage facilities in the RMR were constructed before 1980s, except for a limited number of small-scale systems. Sanitation Company of Pernambuco (Companhia Pernambucana de Saneamento: COMPESA) is responsible to manage most of the sewerage facilities, parts of which were transferred from the municipalities to COMPESA in the 1970s, along with the inauguration of the national sewerage and sanitation policy in Brazil.

The existing sewerage systems are divided into two categories: the four major sewerage systems located in the central part of the RMR and many small scale independent sewerage systems located in housing estates and condominial sewerage systems located mainly in the poverty areas, scattered through out the urban area. However, there are many damaged and inactive sewerage facilities, which require rehabilitation.

In the RMR the sewerage service households are estimated to be 36 % and the sewage treated households are 21 % according to the census in 1996. Considering the situation of many inactive sewage treatment facilities, more than 80 % of the urban households are directly or indirectly discharging the sewage into rivers and water bodies without proper treatment.

There are still a large number of households relying on onsite facilities such as an individual septic tank or a pit latrine to dispose of wastewater. In the poverty area a large number of households are not equipped with any kind of proper facilities and discharges their wastewater into the ground or water bodies.

The expansion of the sewage treatment service area would be urgent measures for the RMR to improve the urban environmental and sanitary conditions. The existing conditions are to be discussed below.

### 2.7.2 Water Consumption

The water supply system in the RMR consists of seven (7) systems, namely, Tapacura, Gurjau, Suape, Botafago, Alto Do Seu, Pacos and Caixa Agua. The total volume of water supplied by COMPESA was estimated to be 292 million $m^3$ in 1997 based on the capacities of purification plants. However, the actual volume of water supplied to the consumer was supposed to be around 52 % of the estimated volume due to leakage and other losses in the water supply system.

Monthly water consumption per household in recent years measured by COMPESA is shown

in the table below. It is noted that the severe drought reduced the monthly water consumption volumes in 1998 and 1999, because COMPESA could not supply enough water.

**Actual Monthly Water Consumption**

| Municipality | Water consumption / household ($m^3$/month) | | |
|---|---|---|---|
| | 1997 | 1998 | 1999 * |
| Abureu e Lima | 18.7 | 15.7 | 11.18 |
| Aracoiaba | 26.3 | 19.9 | 14.27 |
| Cabo | 31.3 | 23.1 | 18.35 |
| Camaragibe | 28.3 | 19.9 | 14.22 |
| Igarassu | 26.8 | 18.9 | 13.92 |
| Ipojuca | 26.0 | 18.7 | 13.73 |
| Itamaraca | 25.9 | 18.7 | 13.78 |
| Ipissuma | 25.6 | 18.7 | 13.82 |
| Jaboatao | 28.5 | 21.5 | 15.07 |
| Moreno | 27.1 | 20.8 | 14.82 |
| Olinda | 27.6 | 21.9 | 15.89 |
| Paulista | 26.2 | 21.3 | 15.62 |
| Recife | 32.1 | 26.2 | 16.80 |
| Sao Lourenco da Mata | 31.9 | 25.9 | 16.59 |

Note: 1999*: Average values for January to September 1999.

### 2.7.3 Pollution Sources and Pollution Load

The pollution sources in the RMR consist of municipal and industrial ones. Distribution of the pollution loads estimated is shown in Table 2.7-1 and Fig. 2.7-1.

#### (1) Municipal pollution load

The municipal organic pollution loads (represented by BOD) in 1997 were calculated for the eleven (11) river basins in the RMR by assuming the following:

- Population of each river basin in 1997 is the same as that described in the PQA RE-1.
- All the existing sewage treatment stations except Cabanga treated wastewater.
- In the poverty area, load reduction rate of 0.4 for households with septic tank and no reduction(rate =0) for households without septic tank
- Unit load of 54 g/person/day

The results are shown in the table below.

**Present Pollution Loads (BOD) Generated by Population in RMR**

| River Basin | Population (1997) | Generated Pollution Load (kg/day) | Population with Sewerage | Load (1) (kg/day) | Population without Sewerage | Load (2) (kg/day) | Total Load (1)+(2) (kg/day) | Rate of Pollution Runoff |
|---|---|---|---|---|---|---|---|---|
| BEBERIBE | 576,643 | 31,268 | 120,368 | 662 | 456,275 | 21,541 | 22,203 | 0.71 |
| BOTAFOGO | 7,221 | 390 | 0 | 0 | 7,221 | 234 | 234 | 0.60 |
| CAPIBARIBE | 667,933 | 37,209 | 28,208 | 275 | 639,725 | 24,701 | 24,976 | 0.67 |
| IGARASSU | 67,966 | 3,670 | 1,297 | 18 | 66,669 | 2,160 | 2,178 | 0.59 |
| IPOJUCA | 58,621 | 3,166 | 0 | 0 | 58,621 | 1,899 | 1,899 | 0.60 |
| JABOATÃO | 501,382 | 27,075 | 3,008 | 32 | 498,374 | 20,226 | 20,259 | 0.75 |
| JAGUARIBE | 8,269 | 447 | 0 | 0 | 8,269 | 268 | 268 | 0.60 |
| PARATIBE | 98,797 | 5,335 | 21,151 | 228 | 77,646 | 2,535 | 2,764 | 0.52 |
| PIRAPAMA | 84,313 | 4,553 | 11,037 | 119 | 73,276 | 2,374 | 2,493 | 0.55 |
| TEJIPIÓ | 493,273 | 26,824 | 13,906 | 75 | 479,367 | 19,585 | 19,660 | 0.73 |
| TIMBÓ | 387,628 | 20,953 | 118,747 | 642 | 268,881 | 8,712 | 9,354 | 0.45 |
| Total | 2,952,046 | 160,889 | 317,722 | 2,052 | 2,634,324 | 104,237 | 106,288 | 0.66 |

Note: 1. Population number in the urban area in 1997,

2. Generated pollution load:
   Unit BOD load (54g/person/day) x population number of each river basin, which uses a converted population number for the large-scale wastewater discharges (over 500 $m^3$/month) from public facilities etc. The converted population numbers for the river basins are as follows:
   - Capibaribe: 21,119
   - Beberibe: 2,393
   - Tejipio: 3,461
   - Timbo: 399

3. BOD load of population served with sewerage:
   Load (1)=served population ×54 g/person/day ×(1−Reduction rate)

4. BOD load of unserved population (population with or without septic tanks):
   - load from population with septic tank = population with septic tank×54 g/person/day ×(1−R1)
     -R1: reduction rate by septic tank is assumed as 0.4
   - load from population without septic tank :
     population without septic tank x 54 g/person/day ×(1− R2)
     -R2: reduction rate is assumed as 0.0

The total load is estimated to be 106,288 kg/day out of the generated load of 160,889 kg/day. The runoff coefficient is 0.66. About 91 % of the pollution loads in the RMR were generated in the five major basins, i.e., the Beberibe, Capibaribe, Tejipio, Jaboatao and Timbo rivers.

### (2) Industrial pollution load

The sewerage systems in the RMR do not receive industrial wastewater, except for negligible discharges from industries located in urban areas. In general industrial wastewater is controlled by the CPRH along with the criteria on effluent water quality. The CPRH authorizes 38 factories in total as shown below:

**Industrial Wastewater from Industries in RMR**

| River Basin | Number of Factories | Generated BOD Loading (ton/day) | Discharged BOD Loading (ton/day) |
|---|---|---|---|
| Beberibe | 5 | 3.36 | 0.5 |
| Capibaribe | 8 | 3.42 | 1.8 |
| Jaboatao | 10 | 21.4 | 7.4 |
| Ipojuca | 4 | 30.6 | 2.1 |
| Pirapama | 11 | 252.7 | 95.8 |
| Total RMR | 38 | 311.5 | 107.6 |

Source: Compiled based on the data provided by the CPRH in 1999.

The factories in the RMR are mostly equipped with their own wastewater treatment systems and could not discharge more than a BOD load of 110 ton/day (equivalent to 65 % removal) into public watercourses after treatment. The industrial pollution loads of industries are shown in Table 2.7-2.

### 2.7.4 Existing Sewerage System

The existing sewerage systems are divided into two categories. The major systems, i.e., the Janga, Peixinhos, Cabanga and the Southern, are located in the central part of the RMR and other small independent systems are located mainly in housing estates scattered in the RMR. Main features of the existing systems are shown in the following table:

**Existing Sewerage System in the RMR**

| System | Length of Pipe (km) | Number of Pumps | | Treatment Capacity ($m^3$/day) | Served Population |
|---|---|---|---|---|---|
| | | Total | Broken | | |
| Major System | | | | | |
| Janga | 441 | 50 | 23 | 54,919 | 265,717 |
| Peixinhos | 185 | 43 | 20 | 34,148 | 330,285 |
| Cabanga | 135 | 51 | 16 | 107,436 | 233,036 |
| Southern | 141 | 23 | 7 | 26,815 | 104,338 |
| Sub-total | 902 | 167 | 66 | 223,318 | 933,376 |
| Other Systems | | | | | 105,943 |
| Total | | | | | 1,038,409 |

**Source:** Diagnosis at the Sewerage System Operated by COMPESA in the RMR

Fig. 2.7-2 and 2.7-3 show the locations of existing sewage treatment stations in the RMR.

#### (1) Four Major Systems

The four major systems are managed under COMPESA. The systems were originally

designed as a separated system to collect only sewage. Sewage, however, diverts into the stormwater drainage system in many places due to the breakdown of pumping facilities and the damage to sewers. They are outlined as follows:

### 1) Janga System

The Janga System serves districts in the municipalities of Olinda, Paulista, Igarassu and Abreu e Lima, which are located in the north of Recife Municipality. The service areas belong to the northern part of the Beberibe River Basin, Timbo River basin and other small river basins along the coast. The system serves about 266,000 people with a sewage treatment capacity of about 55,000 $m^3$/day.

The Janga Treatment Station was built in 1981 and removes over 90 % of BOD by secondary treatment with an oxidation ditch process. The disinfection system is not equipped with the treatment system. The sludge generated in the sewage treatment is disposed of within the treatment plant site having dried naturally in the drying beds. A small portion of the sludge is used for gardening on a private basis.

The other treatment stations rely on aerated lagoons and primitive purification methods such as septic tanks and natural ponds. Of these, Arthur Lundgren Station (ETEJ-02) and Mutirao Station (ETEJ-06) are out of service at present.

### 2) Peixinhos System

The Peixinhos System serves some districts in the municipalities of Olinda and Recife. The served areas belong to the Beberibe River and the Capibaribe River Baisns with a total population of 330,000. The Treatment Station was built in 1967 and the oldest one in the RMR. It employs a low-grade secondary treatment with about 70 % BOD removal by an aerobic biological filtration process discharging into the Beberibe River. The station is equipped with sludge digestion facilities, which have not been operated for a long time.

### 3) Cabanga System

The Cabanga System occupies the central part of the RMR, where include the downstream of the Capibaribe River and Tejipio River basins. The system totally or partially serves the following districts in the Municipality of Recife: Santo Antonio, Sao Jose, Boa Vista, Madalena, Torre, Santo Amaro, Afogados and Boa Viagem. The System serves a population of about 250,000 people and sewage treatment capacity of 107,000 $m^3$/day.

The Cabanga Treatment Station was built in the 1920s and supplemented in 1972. The station has only a primary sedimentation facility and its BOD removal ratio is only around 40 %.

#### 4) Southern System

The Southern System is located in the Tejipio, Jaboatao and Ipojuca Rivers Basins in the southern part of the RMR. The system serves some districts in the Municipality of Recife and some housing estates in the Municipalities of Camaragibe, Sao Lourence da Mata, Jaboatao dos Gurararapes, Moreno and Cabo de Santo Agostinho. The system serves a population of 100,000 and has a total treatment capacity of 27,000 $m^3$/day in seventeen (17) sewage treatment stations.

### (2) Other Sewerage Systems

#### 1) Small Independent Sewerage System

The small independent systems are mostly managed by COMPESA. The systems serve mainly specific groups of buildings such as public condominiums or housing estates. In most cases, both collection pipes and treatment plants were constructed at the time the estates were developed.

There are 31 small independent systems serving around 106,000 people as shown in Table 2.7-3. Although various kinds of treatment facilities are used to treat wastewater, most of them use a simple septic tank. They include a number of small systems developed by the municipalities.

#### 2) Condominial Sewerage System

The Condominial type sewerage system aims to provide an economical solution for the improvement of sanitation with the participation of users and/or communities. The RMR has developed Condominial type sewerage systems, which serve about 117,000 people in 54 poverty areas as shown in Table 2.7-4. The Condominial type sewerage system is characterized as follows:

- Sewer pipes are embedded at a shallow depth (less than 0.9 m earth cover) in the backyard or front yard of individual plots (in some cases, in sidewalks) and are connected to a short and shallow house connection (less than 0.7 m earth covering) at the nearest location,
- The system is designed to implement projects efficiently and economically with user participation.

### 3) Sanitation Facilities in Poverty Areas

Only 7 % of the population in the poverty areas are served by sewerage systems. The others rely on individual septic tanks or pit latrines for the disposal of their waste or they do not have toilets. In such conditions, substandard hygiene may often cause water-borne diseases, and untreated excrement/sewage is the major cause of surface and ground water pollution.
In the RMR, it is considered that the Condominial type sewerage system is one of the solutions for improving sanitary conditions in poverty areas.

### 4) Individual Sanitation Facilities

For small buildings for businesses and institutions, and individual houses, which are not served by a sewerage system, treatment by a septic tank is common in accordance with building regulations and codes. A gravel filter in some cases is attached to a septic tank. Treated water from a septic tank is discharged into watercourses or infiltrated into the ground through a leaching pit.

In such individual treatment systems, the desludging of septic tanks is a serious problem. Although periodic desludging is crucial to operate such a system properly, the system for sludge removal and disposal is rudimentary in the RMR.
Nowadays, there are several private companies that work the sludge removal. Their numbers are still limited and the sludge treatment facilities have not been established yet. Even if sludge is removed from septic tanks, most of it is simply dumped into sewerage manholes, or in some cases, into swamps, vacant lots, etc. This deficient system of sludge disposal causes the malfunctions of septic tanks, and accelerate the serious deterioration of water environment in the RMR.

## 2.7.5 Present O&M Organization

### (1) Organization

COMPESA is in charge of conducting the operation and maintenance for most of the sewerage systems in the RMR and also for some of the sewerage systems, which were constructed by local governments, based on a specific agreement. Meanwhile, a few systems are operated by URB (Municipal Urban Development Company) and EMLURB (Municipal Maintenance and Cleanliness Enterprise of Municipality).

There are four major divisions in COMPESA that are connected with O&M as shown in the following table. The Operations Department of COMPESA manages the water supply and sewerage systems. The sewerage system in the RMR is managed by the Metropolitan

Sewerage Manager (GME), which is a division of the Operations Department.
The GME has been established to control and coordinate the operation of sewerage system, but it has no power to control principal activities such as system planning, budget planning and execution, property management, and public relations activities. In addition to this, the GME has no specific section to deal with water quality control, although it is in charge of managing each treatment plant.

The following table shows the four divisions of COMPESA and their functions related to O&M.

**Organization of COMPESA for Sewerage (1/2)**

| | Organization of COMPESA | | | |
|---|---|---|---|---|
| | Management Director DG | Technical Director DT | Commercial Director DC | Operations Director DO |
| 1. General Affairs, Personnel, Payment, Budgeting, Accounting, Welfare, Public Relations, dealing with complaints | Accountancy<br>Personnel<br>Payment Training<br>Health and safety at work<br>Social Assistance | | | **Adm./Financial Sub-Manager** |
| 2. Budget Execution, Material Procurement, Contracting, | Budgeting and Costs<br>Material and Patrimony<br>General Services | | | |
| 3. Properties Management (including real estate) | Financial Management Division | | | |
| 4. Notifying the public on commencement of services | | Technical Planning Advisory | Rate Collecting | |
| 5. Adjustment of billing rate, Household survey, Bill collection | Financial Management | | Rate Collecting | |
| 6. Supervision of contractors, Inspection of connection, Installation instruction on site | | | | **Cabanga<br>Peixinhos<br>Janga<br>South<br>Caruaru<br>Petrolina** |
| 7. Management of Pipe networks, Regular inspection and cleaning, Planning for repair and improvement, Designing, Construction and Management | | | | **Cabanga<br>Peixinhos<br>Janga<br>South<br>Caruaru<br>Petrolina** |

**Organization of COMPESA for Sewerage (2/2)**

| | Organization of COMPESA | | | |
|---|---|---|---|---|
| | Management Director DG | Technical Director DT | Commercial Director DC | Operations Director DO |
| 8. Facilities Management of Pump Stations Operation, Inspection and repair, Repair and improvement | | Electrical Maintenance Mechanical Maintenance | | **Technical Sub-Manager Operation and Maintenance Sub-Manager** |
| 9. Facilities Management for Treatment Plants Operation, Inspection and repair, Repair and improvement | | Electrical Maintenance Mechanical Maintenance | | **Technical Sub-Manager Operation and Maintenance Sub-Manager** |
| 10. Water Quality Control Water quality test, Preparation of guidelines for operation and management | | Laboratories Control Treatment Control | | ETE Janga ETE Cabanga ETE Peixinhos |
| 11. Inventory Management Facilities, Real estate, Spare parts, machinery, Construction record, operation log | | Operational Control | Consumer Registration Support | |
| 12. Others: public education on sewerage, promoting technical level of employees | | Technical Planning Advisory | Rate Collecting | |

Note: GME divisions are in bold

### (2) Present Employees

The number of employees of COMPESA is 3,520 in July 2000, but the number is 5,606, if it includes the temporary employees from other governmental or public organizations.

Among the 3,520 employees, non-engineering specialists are 131 (3.7 % of the total), high level technical staff called "Engineers" are 92 (2.6 %), low level technical staff called "Technicians" are 383 (10.9 %) and workers with no titles are 3,013 (82.8%). This is because COMPESA is supposed to carry out the entire O&M work by its staff. The heads of the departments of COMPESA are not counted because they are temporary employees.

For O&M of the sewerage systems in the RMR COMPESA allocates only 6 Engineers and 14 Technicians. This number is too small considering the size of the sewerage systems has to deal with.

**Organization and Number of Employees**

| | Manager | Professional | Engineer | Technician | Other | Total |
|---|---|---|---|---|---|---|
| President<br>**PR** | 10<br>(0) | 15<br>(15) | 4<br>(4) | 3<br>(3) | 34<br>(34) | 66<br>(56) |
| Management Department<br>**DG** | 7<br>(0) | 14<br>(14) | 3<br>(3) | 52<br>(52) | 553<br>(208) | 629<br>(277) |
| Technical Department<br>**DT** | 4<br>(0) | 30<br>(30) | 62<br>(62) | 145<br>(145) | 347<br>(193) | 588<br>(330) |
| Commercial Department<br>**DC** | 3<br>(0) | 03<br>(3) | 1<br>(1) | 35<br>(35) | 178<br>(168) | 220<br>(207) |
| Operations Department<br>**DO** | 79<br>(0) | 69<br>(69) | 55<br>(22) | 191<br>(148) | 3,709<br>(2,411) | 4,103<br>(2,650) |
| Total number | 103<br>(0) | 131<br>(131) | 125<br>(92) | 426<br>(383) | 4,821<br>(3,013) | 5,606<br>(3,602) |
| Total number of GME staff | | 3 | 6 | 14 | 196 | 211 |

### 2.7.6 Present O&M Activities

#### (1) Sewer System

The purposes of O&M for the sewer system are as follows:

- Maintaining the designed flow capacities of sewer pipes,
- Preventing damage to sewers due to other construction works,
- Preventing accidents caused by broken facilities,
- Preventing rainwater inflow into sewer pipes,
- Taking measures to restore facilities.

Most of the sewers in the RMR were constructed before 1980s. In terms of the operation and maintenance, periodical inspections of the sewerage facilities have not conducted since the economic crisis in 1980s. Accordingly there are no available information or record on damage and problems in sewers, though the information of the existing conditions is essential for O&M works. Also COMPESA has not any O&M manuals for routine inspection

procedures.

However, for 1998 to 1999 some part of the sewers were surveyed by using a remote controlled TV camera, introduced by the project " PRODETUR" started in 1996 and about 10 % of the sewers were reported to be found damaged and requiring repair. This survey covered a pipe length of 11,658m and cost R$ 570,000 (R$ 49 / m).

### (2) Cleaning and Sediment Removal

COMPESA has carried out cleaning of sewers only in response to complaints from users.

### (3) Repair Work

This is usually done to rehabilitate old facilities for the purpose of extending their life and restoring their original performance. COMPESA has not conducted regular repair works of broken facilities.

As a project of PRODETUR a total of 300m of sewers in the RMR have been replaced and reinforcing the pipes from inside has repaired 7 m.

## 2) Pump Stations

The following O&M items should be checked at pump stations.

- Regular inspection of grit chambers,
- Operation of inflow gates,
- Operation of screens,
- Operation of sand removal devices,
- Operation of pumps,
- Inspection and maintenance of mechanical and electrical devices.

There are no regulations or manuals for the O&M of pump stations. The sand that got into the pump stations was somehow removed and dumped in a corner of the land. Likewise, broken machines are left not repaired.

## 3) Sewage Treatment Facilities

In the sewage treatment plants, the sludge generated during the treatment of sewage as well as the sewage itself has to be treated. The O&M for treatment facilities is conducted to assure proper treatment of both sewage and sludge by the facilities. In addition to the fact that there is no operation manual or measuring instruments, the treatment facilities of COMPESA employ different types of treatment processes depending on their designed capacities and year

of construction. This makes proper operation of these treatment facilities very difficult.

In the Cabanga treatment station, the majority of the facilities are broken and left to decay. In the Janga treatment station, since the activated sludge in the treatment chamber is not properly controlled, plenty of sludge remains suspended even in the terminal sedimentation pond and flows out of the pond into the river.

The sludge treatment system of COMPESA is made up of sludge digestion tanks (used in Cabanga and Peixinhos) and drying beds. Some of the dried sludge is given away to the people who use it as fertilizer but regular, controlled sludge treatment and disposal have not been carried out.

#### 4) Preparation of Inventory

An inventory of facilities is an essential item for the sound management of sewerage facilities. It does not only provide essential technical data for O&M, but also provides useful information in the case of dealing with user complaints, discussions with organizations concerned with sewerage systems, and for emergency rescue activities.

COMPESA is currently digitizing basic information on the pipeline network both for water supply and sewerage. However, more discussions are yet to be held to plan the use of the data for O&M activities as a whole.

### (4) Machinery and Material owned by COMPESA (GME)

The GME owns only a minimal number of machines for O&M works that are only suitable for cleaning and simple repair work, and not adequate for the overhaul of large electrical and mechanical equipment. Not only this, some of these machines for O&M require repair themselves. Further detailed information is compiled in the Supporting Report A.

### (5) Sewerage Charge

The households connected to the sewerage system pay the sewerage rates to COMPESA together with the water rates. COMPESA applies a progressive rate system, under which sewerage rates are calculated as a proportion of the water rates.
The proportion of sewerage rate to water rate is set based on the type of sewage treatment plant and the type of sewage collection. The users of a Condominial-type sewerage system and those connected to simplified treatment stations are given favor in the sewerage charge system as shown in Table 2.7-5.

**Table.2.7-1 Present Pollution Load (BOD) Generated and Remaining after Treatment in the RMR**

| River Basin | Generated Load (kg/day) | | | Reduction Load(kg/day) | | | Dichaged Load (kg/day) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Population | Factory | Total | Population | Factory | Total | Population | Factory | Total |
| BEBERIBE | 31,268 | 3,360 | 34,628 | 9,065 | 2,880 | 11,945 | 22,203 | 480 | 22,683 |
| BOTAFOGO | 390 | 0 | 390 | 156 | 0 | 156 | 234 | 0 | 234 |
| CAPIBARIBE | 37,209 | 3,418 | 40,627 | 12,233 | 1,604 | 13,837 | 24,976 | 1,814 | 26,790 |
| IGARASSU | 3,670 | 0 | 3,670 | 1,493 | 0 | 1,493 | 2,178 | 0 | 2,178 |
| IPOJUCA | 3,166 | 30,643 | 33,809 | 1,266 | 28,594 | 29,860 | 1,899 | 2,049 | 3,948 |
| JABOATÃO | 27,075 | 21,352 | 48,427 | 6,816 | 13,949 | 20,765 | 20,259 | 7,403 | 27,662 |
| JAGUARIBE | 447 | 0 | 447 | 179 | 0 | 179 | 268 | 0 | 268 |
| PARATIBE | 5,335 | 0 | 5,335 | 2,571 | 0 | 2,571 | 2,764 | 0 | 2,764 |
| PIRAPAMA | 4,553 | 252,709 | 257,262 | 2,060 | 156,905 | 158,965 | 2,493 | 95,804 | 98,297 |
| TEJIPIÓ | 26,824 | 0 | 26,824 | 7,164 | 0 | 7,164 | 19,660 | 0 | 19,660 |
| TIMBÓ | 20,953 | 0 | 20,953 | 11,600 | 0 | 11,600 | 9,354 | 0 | 9,354 |
| Total | 160,889 | 311,482 | 472,371 | 54,602 | 203,932 | 258,534 | 106,288 | 107,550 | 213,838 |

**Table 2.7-2 Present Industrial Pollution Load ( BOD) in RMR**

| River Basin | Location No | Name of Factory | Generated Load (BOD kg/ day) | Discharged Load (BOD kg/ day) | Rate of Treatment (%) |
|---|---|---|---|---|---|
| Beberibe | 1 | ANTARTICA | 2,978 | 280 | 91 |
| | 6 | SAO MATEUS | 280 | 149 | 47 |
| | 28 | GRAFFL | 100 | 50 | 50 |
| | 2 | SINTEQUIMICA | 1 | 1 | 0 |
| | 2 | BENZOQUIMICA | 1 | 0 | 100 |
| | | **Sub-Total** | **3,360** | **480** | **86** |
| Capibaribe | 3 | FRIDUSAN | 1,000 | 1,000 | 0 |
| | 7 | YOLAT RECIFE | 524 | 524 | 0 |
| | 6 | LEITE BETANIA | 470 | 174 | 63 |
| | 4 | BRASPEROLA | 48 | 48 | 0 |
| | 4 | NORCOLA | 46 | 46 | 0 |
| | 5 | ACONORTE | 157 | 16 | 90 |
| | 8 | SANTISTA AFOGADOS | 173 | 6 | 97 |
| | 8 | ONDUNORTE I | 1,000 | 0 | 100 |
| | | **Sub-Total** | **3,418** | **1,814** | **47** |
| Jaboatao | 10 | USINA BULHOES | 14,940 | 1,807 | 88 |
| | 11 | PORTELA | 4,971 | 4,971 | 0 |
| | 12 | MATADOURO JABOATAO | 336 | 336 | 0 |
| | 13 | MALHAS JABOATAO | 300 | 45 | 85 |
| | 14 | ALPARGATAS | 250 | 38 | 85 |
| | 14 | REFRESCO GUARARAPES | 241 | 5 | 98 |
| | 14 | BASF/SUVINIL | 126 | 19 | 85 |
| | 9 | ONDUNORTE III | 108 | 107 | 1 |
| | 29 | TECELAGEM PARAHYBA | 68 | 68 | 0 |
| | 15 | TECELAGEM SAO JOSE | 12 | 7 | 42 |
| | | **Sub-Total** | **21,352** | **7,403** | **65** |
| Ipojuca | 30 | USINA SALGADO | 19,058 | 19 | 100 |
| | 31 | USINA IPOJUCA | 10,615 | 1,348 | 87 |
| | 16 | SUAPE TEXTIL | 650 | 650 | 0 |
| | 17 | SANTISTA SUAPE | 320 | 32 | 90 |
| | | **Sub-Total** | **30,643** | **2,049** | **93** |
| Pirapama | 22 | ALCOOLQUIMICA | 967 | 51 | 95 |
| | 22 | PETROFLEX | 32 | 32 | 0 |
| | 21 | RHODIA | 422 | 46 | 89 |
| | 23 | BRAHMA | 8,640 | 29 | 100 |
| | 18 | DESTILARIA SIBERIA | 21,600 | 299 | 99 |
| | 24 | REFINACOES DE MILHO | 1,378 | 1,378 | 0 |
| | 25 | USINA BOM JESUS | 37,125 | 37,125 | 0 |
| | 19 | INEXPORT | 56,545 | 56,545 | 0 |
| | 20 | DESTILARIA JB. | 126,000 | 299 | 100 |
| | 26 | TUBOBRAS | 0 | | |
| | 27 | CERAMICA PORTO RICO | 0 | | |
| | | **Sub-Total** | **252,709** | **95,804** | **62** |
| **TOTAL** | | | **311,482** | **107,550** | **65** |

Source:PQA PE and CPRH data for Pirapama Basin

**Table 2.7-3 Sewerage Systems besides Four Major Systems in the RMR**

| Line No. | Locations | Covered Area (ha) | Number of Connections | Served Population (People) |
|---|---|---|---|---|
| 1 | Morada Capibaribe | 0.74 | 112 | 504 |
| 2 | Felipe Camarao | 11 | 608 | 2,736 |
| 3 | Inez Andreazza | 29.8 | 2464 | 11,088 |
| 4 | Conj. Mal. Castelo Branco | 5.0 | 640 | 2,880 |
| 5 | Vinicius de Moraes | 8.9 | 105 | 472 |
| 6 | Conj.Resid. Bosque da Torre | 2.2 | 400 | 1,800 |
| 7 | Conj.Hab.Lagoa Encantada | 26.7 | 900 | 4,050 |
| 8 | Conj.Res.Vila Coimbra | 0.91 | 126 | 567 |
| 9 | COMAR-Hosp.Aeronautica | 168 | 570 | 2,565 |
| 10 | Residencial Torre/Banorte | 17.5 | 1552 | 6,984 |
| 11 | Conj.Res.Primavera | 15.4 | 400 | 1,800 |
| 12 | IPSEP | 168 | 548 | 2,466 |
| 13 | Jardim Petropolis | 2 | 320 | 1,440 |
| 14 | San Martim | 13.6 | 711 | 3,200 |
| 15 | UR-1 | 27.7 | 1201 | 5,405 |
| 16 | UR-2 | 29.9 | 1072 | 4,824 |
| 17 | UR-3 | 18.8 | 847 | 3,812 |
| 18 | UR-4 | 7.8 | 352 | 1,584 |
| 19 | UR-5 | 21.9 | 905 | 4,073 |
| 20 | UR-7 | 15.8 | 551 | 2,479 |
| 21 | UR-10 | 19 | 1222 | 5,499 |
| 22 | Conj.Res.Universitario | 2.9 | 320 | 1,440 |
| 23 | Conj.Res.Joao Paulo II | 7.1 | 672 | 3,024 |
| 24 | Loteamento Apipucos | 14 | 135 | 608 |
| 26 | Residencial Conj.Portinari | 0.75 | 120 | 540 |
| 27 | Engenho do Meio | 70 | 1744 | 7,848 |
| 28 | Cordeiro | 26 | 515 | 2,318 |
| 29 | Conj.Res.Santa Luzia | 2.0 | 192 | 864 |
| 30 | Areias | 165 | 4005 | 18,023 |
| 31 | Loteamento Ipiranga | 11 | 234 | 1,053 |
| Total | | 635 | 23,543 | 105,943 |

Source: Updated based on the PQA RE-01.

## Table 2.7-4 Condominial Sewerage Systems in the RMR

| Line No. | Locations | Served Area (ha) | Number of Connection | Served Population (people) |
|---|---|---|---|---|
| 1 | Joao Xavier Pedrosa | 2.1 | 91 | 409 |
| 2 | Alderico Pereira Rego | 0.3 | 10 | 45 |
| 3 | Jardim Beberibe | 2.0 | 39 | 175 |
| 4 | Vila Jorge Pimenta | 9.0 | 499 | 2,245 |
| 5 | Nova Trento | 0.6 | 17 | 76 |
| 6 | Cajueiro | 10 | 52 | 234 |
| 7 | Vila Burity | 8.0 | 269 | 1,210 |
| 8 | Abdias de Oliveira | 1.6 | 118 | 531 |
| 9 | Ind. Paulo Alimonda | 1.4 | 25 | 112 |
| 10 | Rio Jiquiá | 0.7 | 31 | 139 |
| 11 | Elpidio Branco | 2.1 | 90 | 405 |
| 12 | Skylab II | 4.2 | 135 | 607 |
| 13 | Brasilandia | 2.2 | 63 | 283 |
| 14 | Ruth Moura | 0.5 | 19 | 85 |
| 15 | Avare/Tupinare | 3.0 | 120 | 540 |
| 16 | Jardim Sao Paulo | 8.0 | 141 | 634 |
| 17 | Olegario Mariano | 2.0 | 39 | 175 |
| 18 | Jose da Bomba | 4.0 | 144 | 648 |
| 19 | Vila Sao Miguel | 21 | 828 | 3,726 |
| 20 | Vila Cardeal Silva | 13 | 423 | 1,903 |
| 21 | Vietnan | 12 | 753 | 3,388 |
| 22 | Vila N.Sra de Fatima | 0.2 | 23 | 103 |
| 23 | Coque 1-Ibipora | 8.0 | 675 | 3,037 |
| 24 | Coque 2-M.Luther King | 9.4 | 1,029 | 4,630 |
| 25 | Coque 3-Realeza | 0.9 | 142 | 639 |
| 26 | Coque 4-Av.Central | 3.5 | 326 | 1,467 |
| 27 | Coelhos | 11.2 | 1,051 | 4,729 |
| 28 | Joao de Barros | 1.8 | 340 | 1,530 |
| 29 | Alto Santa Isabel | 55.2 | 3,120 | 14,040 |
| 30 | Vila Tamarineira | 1.6 | 175 | 787 |
| 31 | Apipucos/Caetes | 4.9 | 345 | 1,552 |
| 32 | Cacimbao | 1.6 | 150 | 675 |
| 33 | Vila Santa Luzia | 38.5 | 2,141 | 9,634 |
| 34 | Barbalho | 12 | 798 | 3,591 |
| 35 | Vila Santa Marta | 1.2 | 218 | 981 |
| 36 | Coronel Fabriciano | 1.9 | 87 | 391 |
| 37 | Entra Apulso | 0.7 | 34 | 153 |
| 38 | Vila Teimosinho | 1.8 | 147 | 661 |
| 39 | Bomba Grande | 5.1 | 219 | 985 |
| 40 | Skylab I | 5.4 | 313 | 1,408 |
| 41 | Poco Alto | 2.7 | 266 | 1,197 |
| 42 | Odete Monteiro | 0.4 | 55 | 247 |
| 43 | Aritana | 0.3 | 38 | 171 |
| 44 | Lot.Mel.Gonçalves da Luz | 0.5 | 55 | 247 |
| 45 | Roda de Fogo | 54 | 3,100 | 13,950 |
| 46 | Conj.27 de Novembro | 90 | 2,465 | 11,092 |
| 47 | Sesi | 11.9 | 642 | 2,889 |
| 48 | Tancredo Neves | 1.4 | 137 | 616 |
| 49 | Ponte do Maduro | 36 | 1,120 | 5,040 |
| 50 | Passarinho | 9.8 | 580 | 2,610 |
| 51 | Burity | 25.6 | 1,562 | 7029 |
| 52 | Ambole | 4.1 | 269 | 1,210 |
| 53 | Brasilit | 4.2 | 397 | 1,786 |
| 54 | Pe.Henrique | 5.8 | 138 | 621 |
| Total | | 519 | 26,063 | 117,283 |

Source: PQA RE-04 (1998)

**Table 2.7-5 Sewerage Charge System of COMPESA**

| **A. Sewerage Tariff System** | |
|---|---|
| Categories of Sewerage | Rates to Water Charges |
| 1. Conventional Treatment Station | (Such as ETEs in Janga, Peixinhos, Cabanga) |
| • Conventional-type Collection System | 100 % of Water Charge |
| • Condominial-type Collection System | 50 % of Water Charge |
| 2. Simplified Treatment Station | Such as ETEs applying Aerated Lagoon, Stabilization Pond, etc. |
| • Conventional-type Collection System | 80 % of Water Charge |
| • Condominial-type Collection System | 40 % of Water Charge |

| **B. Water Charge System** | | |
|---|---|---|
| Categories of Users | Consumption ($m^3$) | Water Charges (R$/$m^3$) |
| Residential | Minimum Charge (up to 10.0) | 4.60 |
| | 0 to 10.0 | 0.75 |
| | 10.001 to 20.0 | 0.87 |
| | 20.001 to 30.0 | 1.03 |
| | 30.001 to 50.0 | 1.41 |
| | 50.001 to 90.0 | 1.68 |
| | Over 90.0 | 3.22 |
| Commercial | Minimum Charge (up to 10.0) | 11.1 |
| | Over 10.0 | 2.2 |
| Industrial | Minimum Charge (up to 10.0) | 13.9 |
| | Over 10.0 | 2.96 |
| Public | Minimum Charge (up to 10.0) | 10.7 |
| | Over 10.0 | 1.63 |

Source: "Water Charge Table issued by COMPESA" (October 14, 1997).

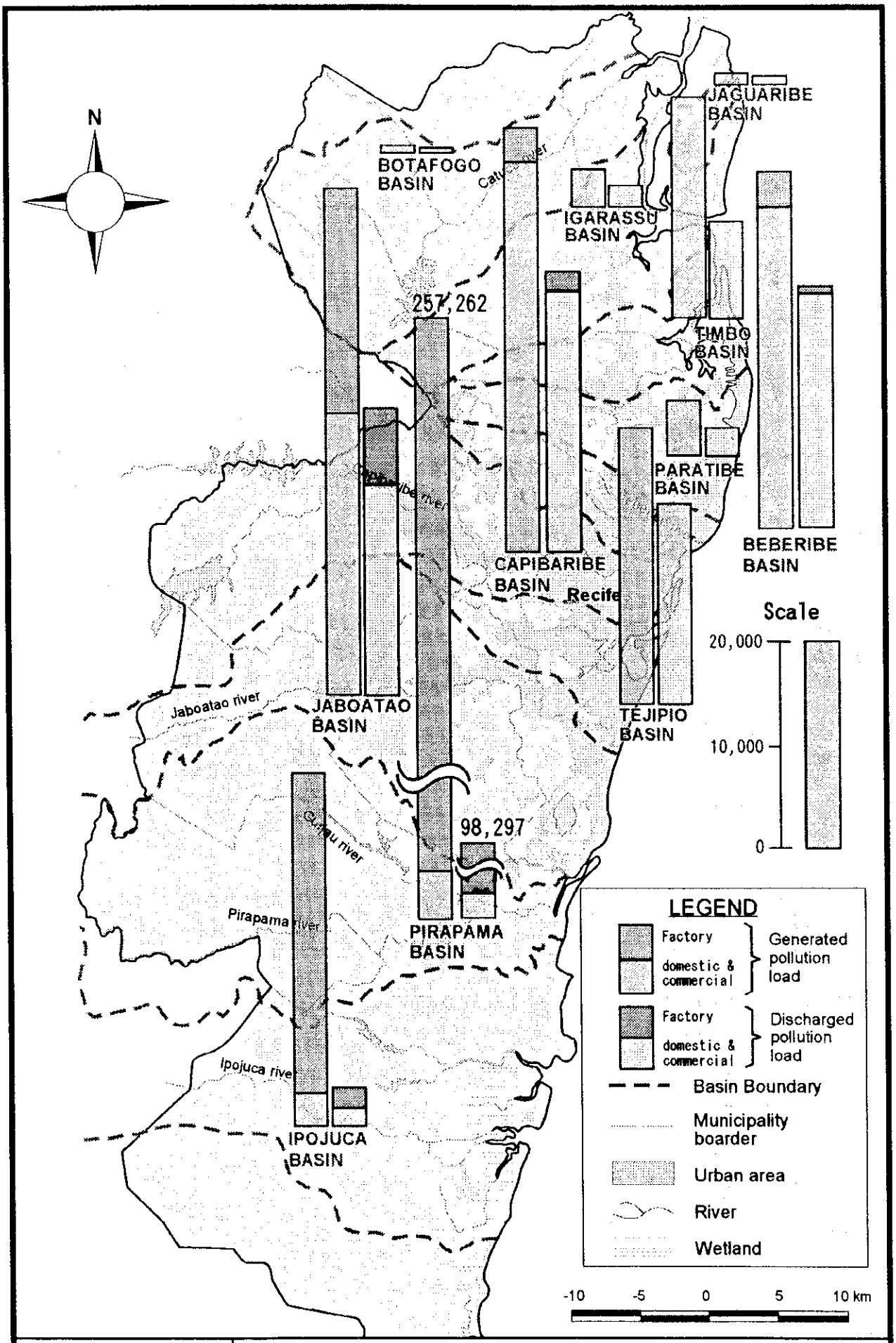


Fig. 2.7-1 Present Distribution of Pollution Load in the RMR

THE STUDY ON STORMWATER DRAINAGE AND WASTEWATER MANAGEMENT PLAN FOR RMR

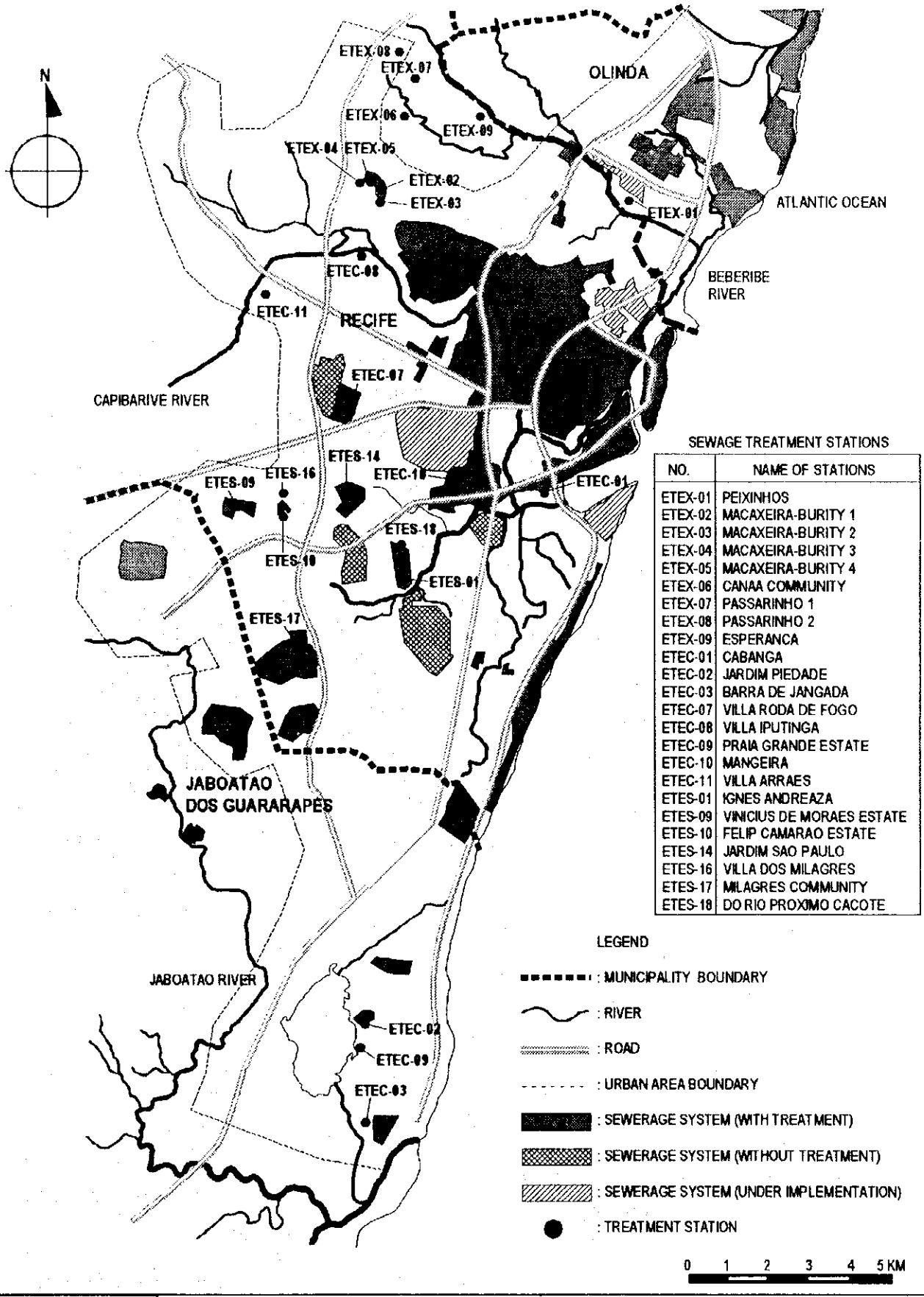


**Fig.2.7-2** **Location of Existing Sewerage Systems in the Central Area of RMR**

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR

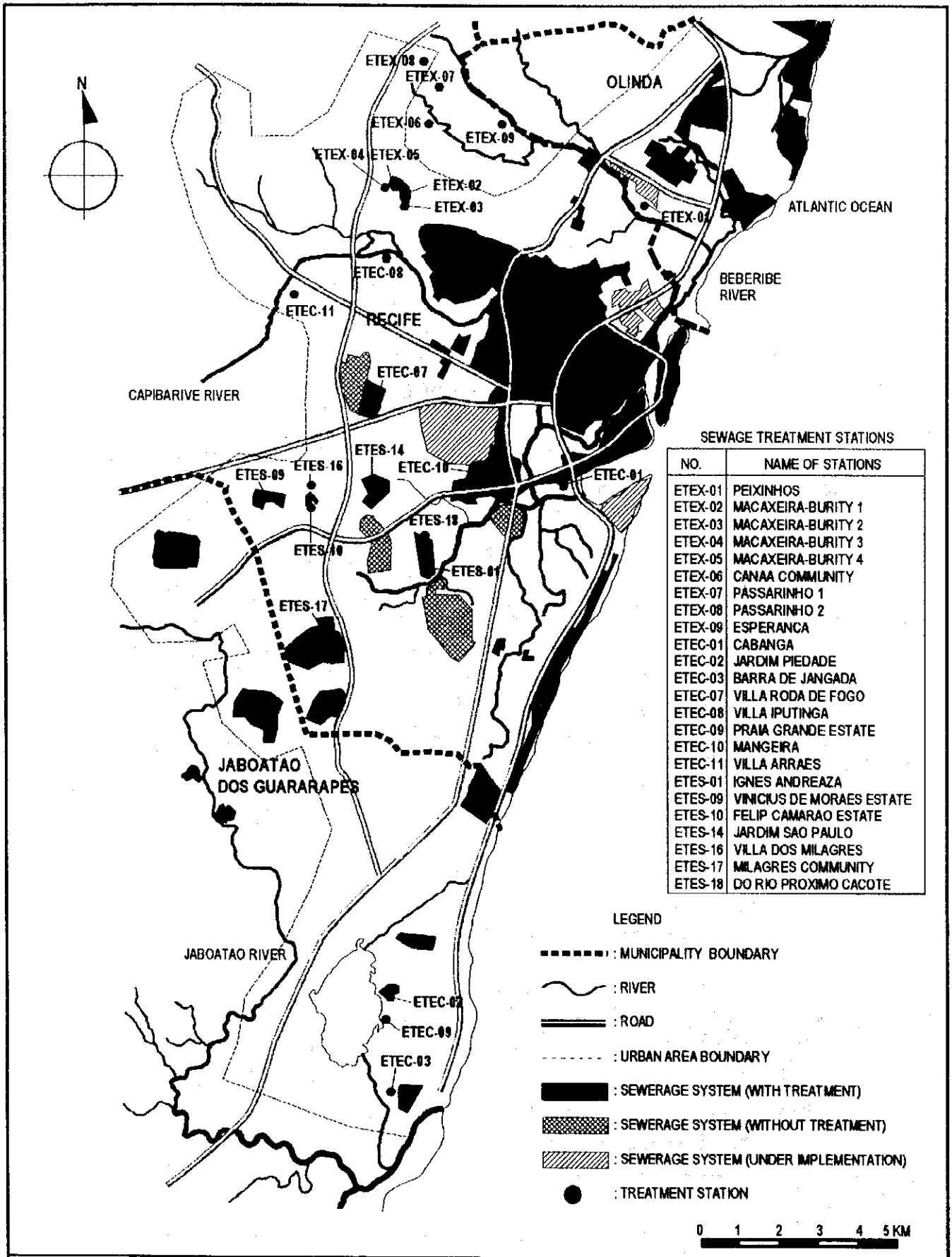


**Fig.2.7-3** **Location of Existing Sewerage Systems in the Central Area of RMR**

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR

## 2.8 Condominial Sewerage Systems

### 2.8.1 General

The Condominial Sewerage System is a type of sewerage system that has been implemented in the RMR as well as other places in Brazil since the beginning of the 80's. Similar systems are also implemented in other developing countries and have become the object of financing lines by the World Bank. The system might be an effective and economical sewerage system for the RMR. However, there are many systems, which are inactive or not successfully completed.

This study aims at disclosing some findings about the implementation of these systems in the RMR and to find out the reasons for the success or failure of the systems, with a special attention to the residents' participation in the planning, implementation and maintenance process.

In order to trace the concept of the Condominial Sewerage Systems, several interviews were carried out with officials in charge at the time when the first systems were implemented and a questionnaire survey was conducted at 10 Condominial Sewerage Systems selected in the RMR.

### 2.8.2 Concept and History

#### (1) Concept

The basic concept of the Condominial Sewerage System was developed by a group of sanitary engineers working in Northeast Brazil led by José Carlos Melo,[1] one of Recife based engineers, The Condominial Sewerage System concept, or the "Condominial Model", which is to utilize shallow collectors and branch sewers in its design, is based on a broad concept that encompasses the following ideas:

- Adaptation to Local Conditions:
  Specially regarding to poverty areas that have limited basic infrastructure but nevertheless should be supplied with a proper sewerage system.
- Community Participation:
  Also regarding to poverty areas, it allows an increase of residents' awareness about the project in order to enhance their abilities in negotiating with the agency in charge, make decisions, and honor agreements such as the maintenance of the system.
- Gradualism:

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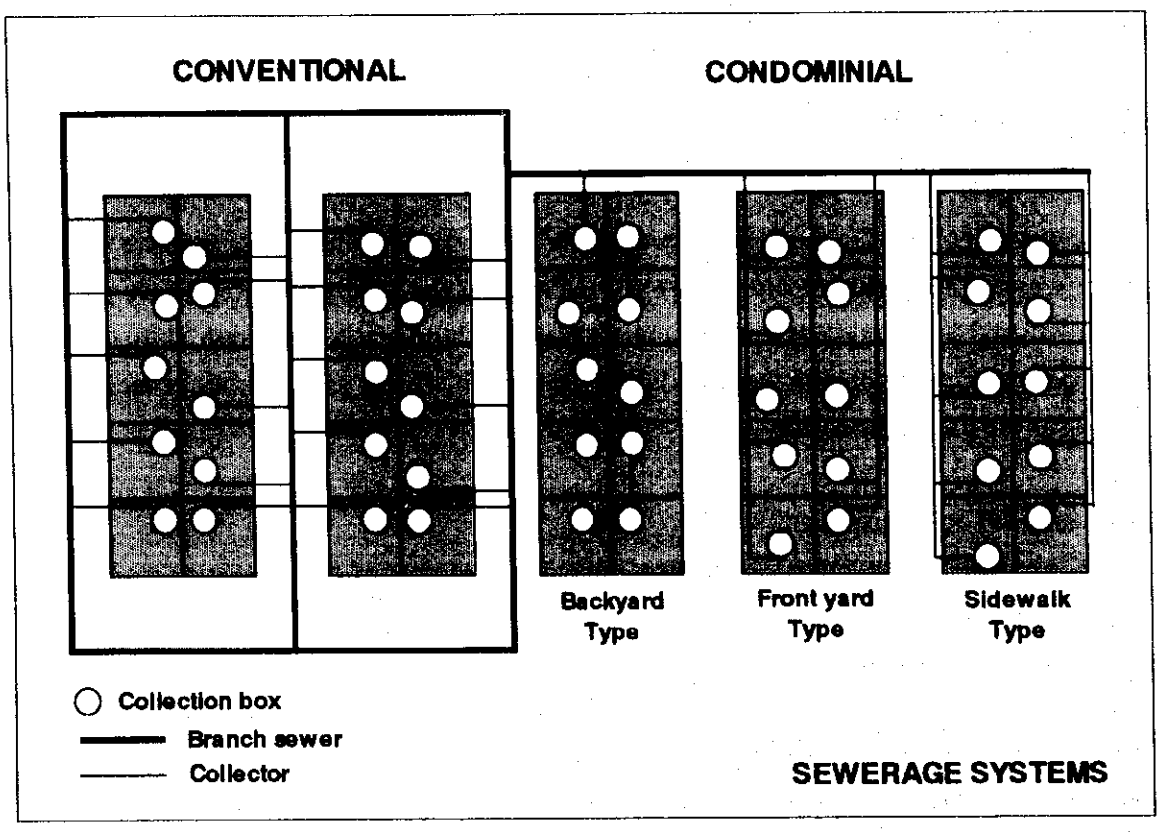
[1] WATSON, Gabrielle. **Good Sewers Cheap? Agency-Customer Interactions in Low-Cost Urban Sanitation in Brazil.** UNDP – Word Bank, Water & Sanitation Program, 1995.

The sewerage systems should cover as many people as possible with the available funds, being up-graded as more funds become available.

- Dissemination:
  Investments shall be broadly distributed.
- Differentiated Services:
  The basic service standard should be that which is appropriate to the majority. Those wishing a higher standard shall bear the correspondent cost.
- Service Integration:
  Urban services shall be integrated and the responsible agencies should work together to attain efficiency and improvement.
- Municipalization:
  The cities and municipalities are the natural institutional jurisdiction to mediate the interests of residents and service providers.

In terms of technical aspects, the Condominial Sewerage System is different from the Conventional one as shown in the following Figure.




The idea is to reduce the costs by installing a shallower collection network which in turn will allow the installation of shallower branch sewers and so on. Besides that, the household connection length also becomes shorter reducing the cost that is to be borne by the resident. As

for the Operation & Maintenance costs, the charges for these services are also reduced considering that the user shall carry out the maintenance of the collector (except for the "sidewalk type"). The sewerage charges by COMPESA are as follows: (1) 40% to 50% of the water charge for the "backyard" and "front yard" collectors types; and (2) 80% to 100% of the water charge for the "sidewalk" collector type. The charge becomes higher when the treatment is carried out in a conventional sewage treatment plant, while the charge is lower when the treatment is carried out in a simplified sewage treatment plant. For the case of a conventional sewerage system, with the collector sewer located under the street bed, the sewerage charge is equal to 100% of the water charge.

In the "Condominial Model", the treatment system is also supposed to be decentralized, being limited to small collection units in order to save the costs for sewage transportation, besides avoiding the construction and maintenance of complex treatment plants.

The maintenance of internal collectors (backyard and front yard types) demands the organization of the block residents into a condominium (like in an apartment building), with the election of a responsible for the block internal collection sewer. Each resident shall be aware of the location of his/her own collection box and the collector route within his/her lot of land, besides also being conscious about his/her own responsibility in the use and maintenance of the system as a whole.

In order to attain such an organization level, the residents shall intensively participate in all the stages of the system implementation: from the first discussions and decisions, through the detailed design, until the construction itself. They shall also be fully instructed about hygiene practices (utilization of toilet facilities, proper disposal of solid waste, etc.) so that they don't discharge into the system materials that can obstruct the sewers. Their participation in the routine maintenance is also very important.

This mobilization and organization effort is supposed to result in the upgrade of the overall organization and negotiation skills of the whole community, enhancing their role as citizens and propitiating a democratic management of the urban issues by the concerning Authorities.

### (2) History

In Brazil, the first experiences with Condominial Sewerage Systems took place in the beginning of the 80's. This was the response to the failure of the sanitation policy in force at the time. At that time, the Federal Government through the PLANASA (National Plan for Sanitation) had a centralized sanitation policy, with a vertical planning structure, concentration of funds, with no residents' participation in the decisions. In Pernambuco State, at the local

level, this policy was carried out by COMPESA[2].

In the 80's the Country suffered a serious economic crisis. As a consequence, resources for the sanitation systems became scarce. Besides that, COMPESA had prioritized the utilization of the PLANASA resources for water supply.

The first Condominial Sewerage Systems were implemented during the mandate (1986 – 1988) of the first directly elected Mayor of the City of Recife, Mr. Jarbas Vasconcelos, after 20 years of military ruling in the Country.

These first systems were small, covering sometimes only a street or a block as a response for the residents who at first wanted their street paved. This was a repressed demand from the previous Mayor mandate that had a special program for paving the streets. The new government decided that the streets to be paved should be first supplied with sewerage and consequently the residents were prepared for the installation of sewerage of the condominial type, going through the discussion and mobilization process previously described. The beneficiaries were basically middle and low-middle class residents in partially urbanized areas (not slums). Some fewer large-scale systems started to be planed and implemented during this period too.

During the following Mayor mandate (1989 – 1992), no new condominial systems were implemented in Recife City. In 1993, Mr. Vasconcelos was again elected as the Mayor of Recife and the implementation of condominial sewerage systems was resumed. From 1993 to 1997, several large scale Condominial Sewerage Systems were implemented by the funds procured from other sources such as the World Bank, Federal Government, etc.

Not all of these systems were completed, therefore they could not be officially handed over to COMPESA for Operation & Maintenance. At present, during the mandate of other Mayor, no new systems are implemented, but some complementary works are being carried out to complete the unfinished ones (e.g. household connections) in order to make them ready to be officially handed over to COMPESA.

Therefore, as for the activities of Recife City, in the last few years 13 Communities (among which *Mustardinha* and *Mangueira* stand out) were provided with Condominial type sewerage

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[2] VASCONCELOS, Ronald. **Descentralização Político-Administrativa na Cidade do Recife: O Caso do Esgotamento Sanitário na Gestão da Frente Popular (1986-1988)**. Masters' degree thesis for the Urban and Regional Development Course of the Federal University of Pernambuco (UFPE). December/1995.

systems, serving a population of around 42,500, with an investment of R$ 4,000,000 from the own budget[3].

COMPESA has also implemented some Condominial Sewerage Systems, within some special programs such as the PROSANEAR (Sanitation Program for Low-Income Population) Program of the Federal Government. The funds were both from the Federal Government as well as from the World Bank, through the CEF (Federal Reserve Bank). Another funding source was the PASS – OGU (Social Action Program in Sanitation – General Federal Budget).

The Recife City, assuming the role established by the Federal Constitution (1988), elaborated its Organic Law (April 04th, 1990) in which defines its Basic Sanitation Policy (Chapter IV, articles 123 and 124) and Environmental Policy (Chapter V, articles 125 to 130). At the same time, in its Development Master Plan for the City of Recife (Law 15.547/91, articles 67 to 111), defines the **Condominial Model** as the **Sanitation Services Standard** to be implemented in all the City territory[4].

### 2.8.3 Existing Condominial Sewerage Systems

For all the Condominial Sewerage Systems to be operated and maintained by COMPESA, they shall get the approval of a special Commission. Even those systems implemented by COMPESA itself shall get this approval.

The procedures for this official hand over are as follows:

- Assignment of a Commission to evaluate and to elaborate a report about the system. This Commission is composed of one president and 2 or 3 members.
- Visiting the system site for technical inspection.
- Elaboration of the 1st report containing the requirements to be fulfilled for the corrections of the construction items that are not complying with COMPESA technical specifications. This also includes a drawing with the technical records of the works. Remarks: If there is no requirement to be fulfilled (in case the systems were constructed within the specifications), this 1st report shall be the only one, i.e., it will become the system receiving report.
- The responsible for the system implementation writes an official letter to the Commission informing the fulfillment of the requirements listed in the 1st report.

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[3] Recife Prefecture, Secretariat of Planning, Urbanism and Environment. **RECIFE, Cadernos do Meio Ambiente, Saneamento do Recife.** v. 1, no. 2, pg. 46. Jul/Dec 1998.

[4] Idem.

- New visit to the site to check the corrections, according to the information in the official letter previously mentioned. Remarks: New reports may be elaborated until the complete fulfillment of the requirements pointed out by the Commission.
- The fulfillment of all the items generates the COMMISSION FINAL REPORT informing the official transference of the system to COMPESA.
- At last, internal communication for all the COMPESA concerned divisions:
  - Concerning ELO: for implementation of sewerage charge in the monthly bill (water charge bill);
  - ACS (Social Communication Advisory): for a social work in the area informing the residents about the start of operation by COMPESA as well as the additional amount to be charged within the above mentioned bill;
  - DO (Operation Directorship): informing the start of maintenance services in the area for the respective Sewerage Division;
  - Concerning Sewerage Division: receiving of the drawings containing the technical records of the works, and authorization for the start of operation of the branch sewer in the area.

At present the GME (Metropolitan Sewerage Management) of COMPESA is managing 22 Condominial Sewerage Systems, which are presented in the following table.

**Condominial Sewerage Systems being Operated & Maintained by GME**

| | Community Name | Location | | Executing Agency |
|---|---|---|---|---|
| | | District | Municipality | |
| 1 | Afogados (streets) | Afogados | RECIFE | URB - Recife |
| 2 | Alto Santa Isabel | Casa Amarela | RECIFE | former EMOPER - Recife |
| 3 | Beirinha / Rua do Rio | Areias | RECIFE | URB - Recife |
| 4 | Canãa / Bela Vista | Dois Unidos | RECIFE | COMPESA |
| 5 | João de Barros | Santo Amaro | RECIFE | URB - Recife |
| 6 | Mangueira | Afogados | RECIFE | URB - Recife |
| 7 | Marron Glacê | Jiquiá | RECIFE | URB - Recife |
| 8 | Planeta dos Macacos | Sancho | RECIFE | COMPESA |
| 9 | Poço da Panela | Casa Forte | RECIFE | URB - Recife |
| 10 | PROMORAR Coelhos | Boa Vista | RECIFE | |
| 11 | Roda de Fogo | Torrões | RECIFE | former COHAB |
| 12 | São José | Água Fria | RECIFE | URB - Recife |
| 13 | Tamarineira | Tamarineira | RECIFE | URB - Recife |
| 14 | Vila Arraes | Várzea | RECIFE | COMPESA |
| 15 | Vila dos Milagres | Ibura | RECIFE | COMPESA |
| 16 | Vila Esperança | Dois Unidos | RECIFE | COMPESA |
| 17 | Vila São João | Iputinga | RECIFE | COMPESA |
| 18 | Vila São Miguel | Jiquiá | RECIFE | URB - Recife |
| 19 | Vila Vintém | Parnamirim | RECIFE | URB - Recife |
| 20 | Cidade Alta | Varadouro | OLINDA | Olinda Prefecture |
| 21 | Passarinho | Passarinho | OLINDA | former COHAB |
| 22 | Vila Benigna / Arraes | A. Lundgren Paulista | PAULISTA | Paulista Prefecture |

Source: GME - COMPESA (Metropolitan Sewerage Management Dept.), Jul/2000.

Besides these Condominial Sewerage Systems, there are others that were implemented but were considered incomplete by the Commission.

### 2.8.4 Survey of 10 Condominial Sewerage Systems in Recife City

Ten (10) Condominial Sewerage Systems located mainly in Recife City were selected and surveyed, and their locations are shown in Fig.2.8.1.

The surveyed systems were selected by the executing agencies (URB-Recife and COMPESA) taking into account the available information about them and the fact that they should be at present in operation. These two premises, however, were not fully accomplished as can be realized by the description of each system provided in the Table 2.8.1.

In order to elaborate the concise history of each of the selected systems, the executing agencies responsible officials of the executing agencies as well as the community leaders involved in the process were interviewed.

**Sample for "Interview with Residents" Survey**

| Community | Executing Agency | Population Served | No. of Residences | Sample (1%) | Final Enlarged Sample |
|---|---|---|---|---|---|
| 1 Cannã / Bela Vista | COMPESA | 6,816 | 1,363 | 14 | 14 |
| 2 João de Barros | URB-Recife | 1,700 | 340 | 3 | 10 |
| 3 Jorge Pimenta | URB-Recife | 2,600 | 520 | 5 | 10 |
| 4 Mangueira | URB-Recife | 20,000 | 4,000 | 40 | 40 |
| 5 Mustardinha | URB-Recife | 14,000 | 2,800 | 28 | 28 |
| 6 Tamarineira | URB-Recife | 600 | 120 | 1 | 10 |
| 7 Vila Arraes | COMPESA | 1,780 | 356 | 4 | 10 |
| 8 Vila dos Milagres | COMPESA | 4,965 | 993 | 10 | 10 |
| 9 Poço da Panela | URB-Recife | 730 | 146 | 1 | 10 |
| 10 Rua do Rio / Beirinha | URB-Recife | 4,230 | 846 | 8 | 10 |
| TOTAL | | 57,421 | 11,484 | 115 | 152 |

Source: URB-Recife, DO-DOS (Sanitation Works Division). COMPESA, APT (Technical Planning Advisory Division). 2000

Note: The number of residences was calculated by dividing the served population by 5.

Technical information, O&M activities by COMPESA and resident's participation for the selected condominial sewerage systems are summarized and shown in Tables 2.8-2, 2.8-3 and 2.8-4.

The analysis of the results of the "Interviews with Residents" survey is presented in the Supporting Report E (Social Issues) while the Conclusions are presented in the following.

### 2.8.5 Considerations

The Condominial Sewerage Systems were basically implemented in communities where the residents get in average a family monthly income of 3 Minimum Wages or less. These communities are what we call in this report as "Poverty Areas".

This type of community is used to be lack of basic urban infrastructure. It is concluded that the main infrastructure needed is: 1) street paving, 2) stormwater drainage system, and 3) sewerage system. The combination of the lack of this infrastructure plus the littering of solid waste/garbage in improper places is the main cause of the floods and consequently the poor sanitary conditions.

The educational level in these communities is usually very low. Some residents don't even

know how to use a toilet and its fittings. Some are not conscious that the improper disposal of solid waste/garbage on vacant land and/or on the drainage system causes the worsening of flooding problems in their own places, and consequently leads to the worsening of their health conditions.

The idea of a collective maintenance of the collectors was a failure in all surveyed communities. This can be also blamed on the low educational level and somehow on the individualistic feature of the society to which these citizens belong.

On the side of the Authorities, problems were also observed. Most of the systems were implemented in a discontinuous way, without a proper implementation or financial planning. Training activities to prepare the residents for the collectors' maintenance were not enough to allow them performing this activity. The maintenance in which concerns to COMPESA is mostly faulty as well.

Thus the survey about the Condominial Sewerage Systems lead to conclude that:

- The implementation of the Condominial Sewerage System shall always be accompanied by the implementation of a drainage system together with the paving of the streets.
- A permanent environmental educational program shall be implemented in the communities where this infrastructure is to be implemented. This will contribute to the success of the system operation and maintenance, and more important to the upgrade of the community sanitary conditions. When we talk about "permanent" we mean that it shall not stop when the system implementation is finished but shall continue until the resident's awareness is regarded as sufficient.
- The household connection and in some cases even the toilet facilities shall be subsidized by the Authorities considering the low income of these communities residents. Obviously, each resident financial condition shall be analyzed case by case. This subsidy is necessary sometimes to allow the system full operation.
- As for the maintenance of the collectors, it shall be the object of the environmental program already mentioned. For a start, task groups can be formed with communities own residents to perform the maintenance of the collectors. These task groups shall be subsidized by the Authorities or NGOs in terms of equipment and remuneration for their members. Most important point among these task groups shall also be prepared to act as environmental agents teaching the residents how to use the toilet facilities, how to prevent the collectors clogging, how harmful can be the accumulation of garbage/solid waste for their health conditions, and other important issues.

- Regarding the Authorities, the implementation of Condominial Sewerage Systems shall be part of an overall plan to deal with the sewage and stormwater drainage problems. For that, the concerning agencies shall be strengthened and qualified. It includes COMPESA staff and equipment as well as the concerning municipal agencies.

As already taking place in other municipalities such as in Petrolina, in the western end of Pernambuco State, the Condominial Sewerage Systems are not only to be implemented in poverty areas but in the whole city, as much as possible. In such case, the subsidies for the implementation of household connection and the maintenance of collectors can not be extended to everyone. The subsidies shall be analyzed case by case. However, the environmental educational program is perfectly applicable to any citizen considering that in general there is a lack of awareness about environmental and sanitary issues among all the income classes citizens.

## Table 2.8.1 General Information about the Surveyed Condominial Sewerage Systems

| | COMMUNITY NAME | GENERAL INFORMATION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Served Area (ha) | Served Population | Executing Agency | Funding Source | Implementation Period* | Total Cost (R$) | Cost per Resident (R$) |
| 1 | CANÃA / BELA VISTA | 25.8 | 5,000 | COMPESA | PROSANEAR Program (Federal Government, World Bank) | Jun/95 ~ Dec/96 | 760,000.00 | 152.00 |
| 2 | JOÃO DE BARROS ZEIS | 1.8 | 1,650 | URB - Recife | PREZEIS Fund | Feb/94 ~ Jul/95 | 97,370.00 | 59.01 |
| 3 | JORGE PIMENTA (WITHIN CAMPO GRANDE ZEIS) | 9.0 | 3,000 | URB - Recife | PREZEIS Fund + Municipal Budget | Nov/97 ~Dec/99 | 532,380.00 | 177.46 |
| 4 | MANGUEIRA ZEIS | 67.5 | 15,500 | URB - Recife / COMPESA | Municipal Budget + Federal Government (PASS - CEF) | Feb/93 ~Dec/98 | 2,645,000.00 | 170.65 |
| 5 | MUSTARDINHA ZEIS | 35.0 | 14,600 | URB - Recife / COMPESA | Municipal Budget + Federal Government (PASS - CEF) | Apr/95 ~ Dec/98 | 1,938,623.00 | 132.78 |
| 6 | TAMARINEIRA ZEIS | 1.6 | 725 | URB - Recife | Municipal Budget | Sept/93 ~ May/94 | 47,370.00 | 65.34 |
| 7 | VILA ARRAES | 6.0 | 1,780 | COMPESA | Federal Government (PASS - OGU) | Jul/97 ~ Jan/98 | 200,000.00 | 112.36 |
| 8 | VILA DOS MILAGRES | 20.0 | 5,000 | COMPESA | Federal Government (PASS - OGU) | Sept/97 ~ Nov/98 | 815,000.00 | 163.00 |
| 9 | POÇO DA PANELA ZEIS | 2.5 | 800 | URB - Recife | Municipal Budget | May/95 ~ Dec/95 | 64,092.00 | 80.12 |
| 10 | RUA DO RIO ZEIS | 6.9 | 2,000 | URB - Recife | Federal Goverment (Habitar Brasil Program) + Municipal Budget | Jul/96 ~ Dec/98 | 1,014,295.00 | 507.15 |
| 11 | BEIRINHA ZEIS | 8.3 | 2,315 | | | | 920,000.00 | 397.41 |

Source: URB-Recife (DO-DOS and DIUR). COMPESA (APT). Aug / 2000.

Note: (*) The "Implementation Period" covers the first participatory activities until the completion of the civil works, including interruptions occurred during the process

## Table 2.8.2 Technical Information about the Surveyed Condominial Sewerage Systems

| COMMUNITY NAME | SEWERAGE SYSTEM | | | | | | | TREATMENT SYSTEM | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Branch Sewer (m) | Condominial Collector Sewers (m) | Type of Collector* (%) | % of Household Connections in relation to the served Residences | Pumping Station EE 1 (cv) | Pumping Station EE 2 (cv) | Pressure Sewer (m) | Type | Volume (m3) | Retention Time (h) |
| 1 CANÃA / BELA VISTA | 2,483 | 10,016 | BY (90%) | unknown | 1.0 | 7.5 | 895 | RAFA + Drying Yard for sludge | 164 | 6:00 |
| 2 JOÃO DE BARROS ZEIS | 524 | 1,830 | S (50%) BY (50%) | 100% | 1.0 | - | 355 | Connected to a COMPESA trunck sewer for treatment in the CABANGA treatment plant | | |
| 3 JORGE PIMENTA (WITHIN CAMPO GRANDE ZEIS) | 750 | 4,200 | S (100%) | unknown | 15.0 | - | 240 | Connected to a COMPESA trunck sewer for treatment in the PEIXINHOS treatment plant | | |
| 4 MANGUEIRA ZEIS | 6,832 | 26,740 | S (70%) BY(30%) | 70% | 10.0 | - | 12 | RAFA + Polishing Pond | 810 | 6:00 |
| 5 MUSTARDINHA ZEIS | 1,650 | 18,180 | S (70%) BY(30%) | 49% | 16.0 | - | 200 | Connected to a COMPESA trunck sewer for treatment in the CABANGA treatment plant | | |
| 6 TAMARINEIRA ZEIS | (*) | (*) | BY (100%) | 100% | - | - | - | Connected to a COMPESA trunck sewer for treatment in the PEIXINHOS treatment plant | | |
| 7 VILA ARRAES | 610 | 2,841 | BY (100%) | 30% | 2.0 | 2.0 | 104 | RAFA | 60 | 5:00 |
| 8 VILA DOS MILAGRES | 1,747 | 11,754 | BY (80%) | 100% | 3.0 | 5.5 | 585 | RAFA + Drying Yard for sludge | 210 | 8:00 |
| 9 POÇO DA PANELA ZEIS | 323 | 1,259 | S (70%) BY(30%) | 100% | - | - | - | Connected to a COMPESA trunck sewer for treatment in the PEIXINHOS treatment plant | | |
| 10 RUA DO RIO ZEIS / 11 BEIRINHA ZEIS | 2,654 | 4,230 | BY (90%) | 71% (Beirinha) 38% (Rua do Rio) | 3.0 | 3.0 | 877 | RAFA + Drying Yard for sludge | 202 | 6:00 |

Source: URB-Recife (DO-DOS and DIUR). COMPESA (APT and GME). Aug / 2000.

Note: (*) Non available information.

## Table 2.8.3 COMPESA Operation & Maintenance Activities in the Surveyed Systems

| COMMUNITY NAME | Date of Formal Transference of the System to COMPESA | Division in Charge of Operation & Maintenance | Main Problems | Remarks |
|---|---|---|---|---|
| 1. CANAÃ / BELA VISTA | November / 1999 | Peixinhos Division (DEX) | The RAFA facilities were looted and equipment was stolen thus the system is not in operation. Besides, EMLURB during the dredging of the Morno river damaged the pressure sewer that crossed the river and connected the Bela Vista Community to the system. | The system is over an year without a contracted firm to carry out its operation and maintenance. The COMPESA responsible division personnel is not enough to carry out these services. The looting was carried out by some irresponsible residents what shows their low educational level. |
| 2. JOÃO DE BARROS ZEIS | December / 1995 | Peixinhos Division (DEX) | Without problems. | The Cooperative carries out also the services which were supposed to be carried out by COMPESA: maintenance of branch sewers. |
| 3. JORGE PIMENTA | The system was not formally handed over to COMPESA that is waiting URB-Recife to finish the construction of household connections for all the residences. | - | - | - |
| 4. MANGUEIRA ZEIS | The system is being operated informally by COMPESA. No official transference was carried out. | Cabanga Division (DEC) | Many problems are caused by the precarious storm water drainage conditions. Besides that, there are several new residents in the area who do not accept the condominial system and want to have the collection box moved out of their land subdivision. | There is a lack of COMPESA personnel to carry out the maintenance of the system. |
| 5. MUSTARDINHA ZEIS | The system was not formally handed over to COMPESA that is waiting URB-Recife to finish the construction of household connections for all the residences. | - | - | - |
| 6. TAMARINEIRA ZEIS | The system is being operated informally by COMPESA. No official transference was carried out. | Peixinhos Division (DEX) | Without major problems. | Sometimes COMPESA has to perform some maintenance in the condominial collectors due to the resistance of some residents in doing it themselves. |
| 7. VILA ARRAES ZEIS | The system is being operated informally by COMPESA. No official transference was carried out. | Cabanga Division (DEC) | The pumping stations are temporarily out of operation due to lack of maintenance. | Until May/2000, there was a Contractor operating and maintaining the system. If another firm is not contracted soon, this system is also under the risk of looting and damaging by some irresponsible residents. |
| 8. VILA DOS MILAGRES | April / 1999 | South Sewerage Division (DES) | Due to land sliding problems, when it rains strongly, some condominial collectors as well as collection boxes are washed away down the hill, even threatening the safety of the residents living downstream. | Occasionally, fight between neighbors lead to the condominial collectors damage and obstruction. |
| 9. POÇO DA PANELA ZEIS | The system is being operated informally by COMPESA. No official transference was carried out. | Peixinhos Division (DEX) | Without major problems. | Sometimes COMPESA has to perform some maintenance in the condominial collectors due to the resistance of some residents in doing it themselves. |
| 10. RUA DO RIO ZEIS / 11. BEIRINHA ZEIS | The system is being operated informally by COMPESA. No official transference was carried out. | South Sewerage Division (DES) | The RAFA facilities are starting to be subject to looting. The same is happening to the pumping stations | There is a lack of COMPESA personnel to carry out the maintenance of the system, specially a 24 hour guard staff for the facilities. |

## Table 2.8.4 Residents' Participation during the Systems Implementation and Operation & Maintenance Stages (1/3)

| COMMUNITY NAME | IMPLEMENTATION STAGE | | | OPERATION & MAINTENANCE | | |
|---|---|---|---|---|---|---|
| | **Agency in charge of the Residents' Participatory Activities** | **Participatory Activities** | **Residents' Counterpart** | **Condominial Collectors Maintenance** | **Community Leaders evaluation on Residents' Maintenance Activities** | **Community Leaders evaluation on COMPESA Operation & Maintenance Activities** |
| 1. CANAÃ / BELA VISTA | COMPESA (coordination) – Contracted Consultant Firm for Community's Mobilization | Meetings at several places (community center, church, health post, etc.), distribution of leaflets and manuals, video presentation, exhibition of a model at the Contractor site office. Meetings by block to explain the collector sewers' maintenance procedures. | None | Residents individually | Not good. Low educational level of the residents. Lack of hygiene notions. The residents were not prepared for such an organization demanding system. | Faulty. COMPESA responsible office is too far and rarely someone appears to perform maintenance. The treatment facilities are abandoned and not working. |
| 2. JOÃO DE BARROS ZEIS | DIUR URB-Recife | Proposals were discussed by COMUL and Residents' Council. The other activities were: visits to residences, visits to the work front, meetings by block and by collector, general meetings and educational campaigns. There was no official training in how to perform the condominial collectors maintenance. | Purchase of sanitary fittings + household connections | Task group of the Community's Cooperative.<br><br>Residents individually | Not good. The residents still don't understand the need for cleanness. They are too dependent on the Cooperative work. A permanent educational program is required. | COMPESA performs the pumping station maintenance regularly. However, the rest of the system is maintained solely by the Cooperative task group and the residents. |
| 3. JORGE PIMENTA (WITHIN CAMPO GRANDE ZEIS) | DIUR URB-Recife | The residents took part in training activities and participated in courses for the formation of "Information Multiplying Agents", promoted by the Municipal Secretariat of Health. Meetings were carried out at streets, Associations' centers, at the Contractor site office also with the participation of the engineers in charge of the construction works. | None | No one at present. | While the Integrated Actions Plan (PAI) carried out by the Secretariat of Health was in force, their participation was good. However, with the interruption of the Program, the sanitary conditions of the Community worsened. | This Community's system was still not officially handed over to COMPESA. This company is waiting for the conclusion of household connections being constructed by URB-Recife. |
| 4. MANGUEIRA ZEIS | DIUR URB-Recife and COMPESA (contracted out supporting staff) | Implementation of a Pilot Project in a small area for the purpose of demonstration. Meetings with the Residents' Council and Residents' Association. Meetings at the streets, distribution of leaflets, meetings at the residences. | Purchase of condominial collector pipes (with subsidies for the most destitute families). Recycling Program was carried out to collect funds for this pupose. | Residents individually.<br><br>Some residents hire some local labor force to do the work and then share the cost. | Still some residents are not interested or do not know how the system operates thus they did not connect their residences to the system. Another reason is the lack of financial resources to construct the household connections. | The system is not well guarded. One little boy almost drowned in the "polishing pond". The system is too disorganized, not everybody receives the sewerage bill. COMPESA does not carry out the maintenance services for which it is responsible. |

## Table 2.8.4 Residents' Participation during the Systems Implementation and Operation & Maintenance Stages (2/3)

| COMMUNITY NAME | IMPLEMENTATION STAGE | | | OPERATION & MAINTENANCE | | |
|---|---|---|---|---|---|---|
| | **Agency in charge of the Residents' Participatory Activities** | **Participatory Activities** | **Residents' Counterpart** | **Condominial Collectors Maintenance** | **Community Leaders evaluation on Residents' Maintenance Activities** | **Community Leaders evaluation on COMPESA Operation & Maintenance Activities** |
| 5. MUSTARDINHA ZEIS | DIUR URB-Recife and COMPESA (contracted out some supporting staff). | General meetings and local meetings were carried out to explain the concept of the condominial sewerage system and the partnership with the residents included in this concept. When the agreement between COMPESA and URB-Recife was formalized, the residents were also informed in general meetings. | 1st Stage – purchase of collector pipes. Recycling Program was carried out for this purpose<br><br>2nd Stage - None | No one at present. | Although the residents regard the system as a good accomplishment for the Community, there is a lack of confidence because of delays in the system conclusion. Besides, there is a lack of hygiene notions. A permanent environmental educational program is required. | This Community's system was still not officially handed over to COMPESA. This company is waiting for the conclusion of household connections being constructed by URB-Recife. The leaders complain that the Contractor hired by URB-Recife is not carrying out the works properly using poor construction materials. |
| 6. TAMARINEIRA ZEIS | DIUR URB-Recife | Survey to evaluate socio-economic and sanitary conditions of the residents was carried out. The survey also served to inform the residents about the system and get their consent to participate in it. The planning and implementation actions were decided together with the Residents' representatives | Purchase of 50% of the material except the pipes that were supplied by URB-Recife (sand, iron, cement, gravel). Supply of sanitary fittings for 10 destitute families. | Residents' Association sometimes contract local labor force to carry out the maintenance services.<br><br>Residents individually. | The residents are well aware about the system operation and counts on the Residents' Association support. | COMPESA performs the branch sewers unclogging whenever there is a problem. |
| 7. VILA ARRAES ZEIS | COMPESA (coordination) Contracted out Consultant firm | Meetings with community leaders to inform about the system implementation and operation. Environmental Education workshops. Selection of Environmental Education Agents among the residents to teach the other residents about the systems' maintenance and hygiene notions (hired by the Consultant). | None | Residents individually | Most of the residents didn't make their own household connections. They seem not interested in participating in any improvement activities. The educational level is very low. They discharge into the system several improper material. | Not Good. The pumping stations are not operating, thus the treatment plant is temporarily out of operation. |

## Table 2.8.4 Residents' Participation during the Systems Implementation and Operation & Maintenance Stages (3/3)

| COMMUNITY NAME | IMPLEMENTATION STAGE | | | OPERATION & MAINTENANCE | | |
|---|---|---|---|---|---|---|
| | **Agency in charge of the Residents' Participatory Activities** | **Participatory Activities** | **Residents' Counterpart** | **Condominial Collectors Maintenance** | **Community Leaders evaluation on Residents' Maintenance Activities** | **Community Leaders evaluation on COMPESA Operation & Maintenance Activities** |
| 8. VILA DOS MILAGRES | COMPESA (coordination) Contracted out Consultant firm | Meetings with Community Leaders to explain the system implementation and operation and maintenance. Environmental workshops. Selection of Environmental Education Agents among the residents (paid by the Consultant). | None | Residents individually.<br><br>Sometimes COMPESA | The residents respect the Association guidance for the system maintenance. However, there are some residents who try to drain storm water through the sewerage system. | There was no specific complaints about COMPESA operation and maintenance activities. |
| 9. POÇO DA PANELA ZEIS | DIUR URB-Recife | General meeting for presentation of the system. Meetings by block and with the community leaders. Presentation of educational videos and a model. Lectures about "Water Borne Diseases" and "Condominial Sewerage Systems' Maintenance". | Purchase of condominial collector pipes | Residents individually.<br><br>Sometimes COMPESA | The residents organize themselves to solve the problem or call COMPESA to have it solved. | The maintenance is carried out satisfactorily by COMPESA. |
| 10. RUA DO RIO ZEIS<br>11. BEIRINHA ZEIS | DIUR URB-Recife | General meetings and meetings by block for each of the Communities that compose the system. Distribution of leaflets, exhibition of educational video.<br><br>In BEIRINHA, the works did not occur smoothly thus more meetings were carried out to ask for the residents cooperation. | None | Residents individually | RUA DO RIO: The residents, in general, got involved with the project. They try to maintain the system despite their low income condition.<br><br>BEIRINHA: The residents are not prepared for the system. There is a lack of environmental awareness and interest. A permanent environmental educational program is needed. | COMPESA performance is considered deficient. |

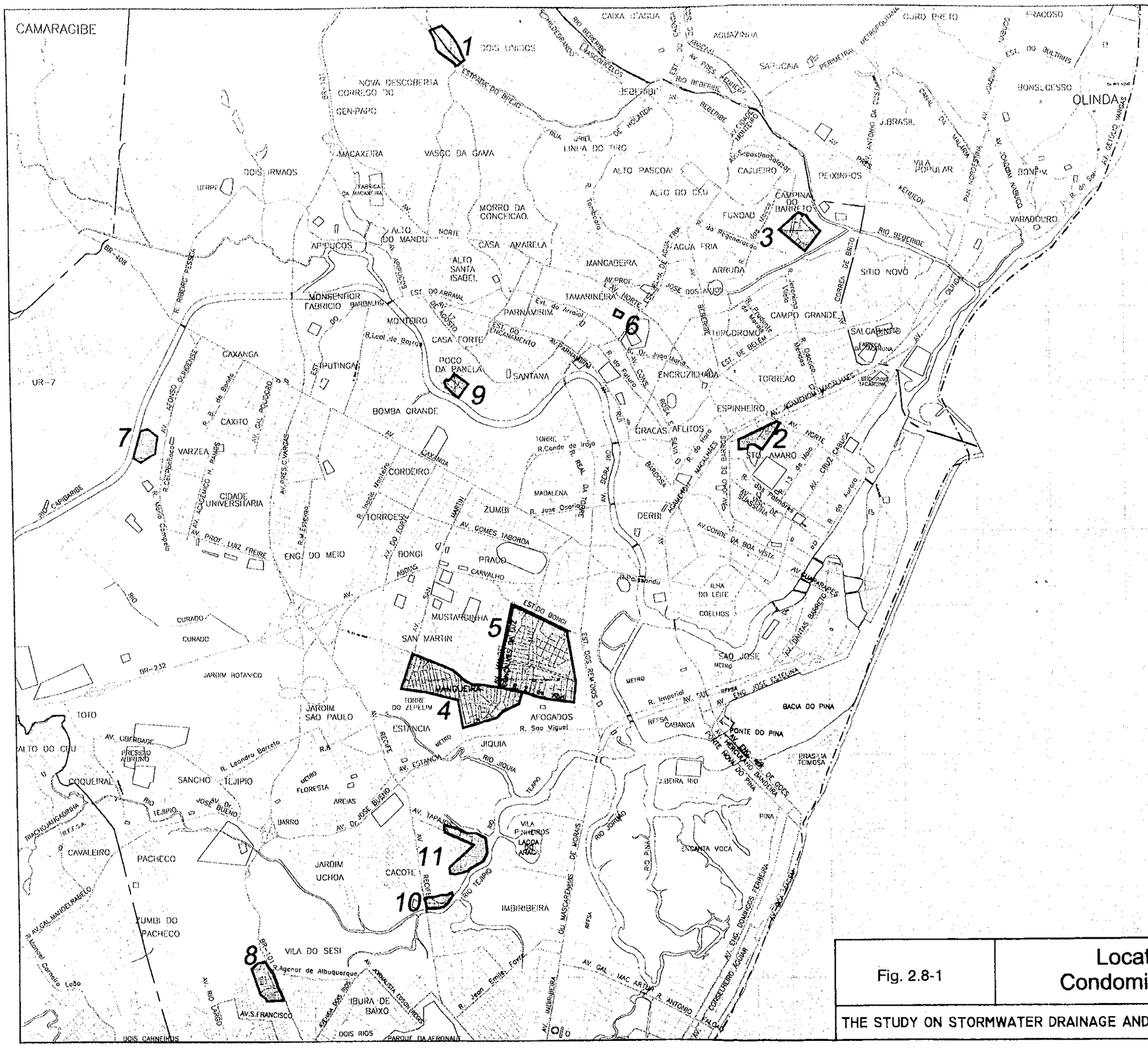


Fig. 2.8-1 Location of the Survey's Condominial Sewerage Systems

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR

## 2.9 Stormwater Drainage

### 2.9.1 Drainage Channels

The major existing drainage facilities within the urban area in the RMR consist of 66 rivers/channels flowing into the main rivers as shown in Table 2.9-1(1/2), (2/2) and Figs. 2.9-1 (1/4) - (4/4). Most of these were originally natural streams and were improved or are being improved.

### 2.9.2 Drainage Structures

Major drainage structures are the following concrete-lined artificial channels along the roads:

1) Canal Derby-Tacaruna (No. 28, Recife)
   Two tide gates on both outlet sides of the Canal Derby-Tacaruna were provided in 1999.

2) Canal de Setubal (Nos. 46&61, Recife-Jaboatao)
   There is no drainage pumping station in the RMR. Drainage occurs by gravity flow. Land-use regulation and reclamation are applied to control drainage of the wetland areas.

3) Other Drainage Channels
   Revetments of concrete are common for flood prone sections of the drainage channels in the urban area.

### 2.9.3 Maintenance of Drainage Facilities

The municipalities are responsible for the maintenance of the drainage facilities. The major maintenance work is as follows:

1) Dredging of the river/channels,
2) Cleaning of the drainage channels (canals) such as removal of mud, trees, solid waste, etc.,
3) Improvement and cleaning of the small drainage channels (micro drainage) such as road surface drainage, small drains, etc.

There is sufficient maintenance of the major channels along the roads; however, maintenance of the rivers and the small drains is not sufficient due to shortage of funds.

### 2.9.4 Ongoing Projects

The ongoing projects related to stormwater drainage were mainly proposed and are being conducted by municipalities. They are as follows:

### (1) Recife

1) Since the beginning of the 1980s, seven channels have been improved. At the moment, three channels are being improved; however, progress is not satisfactory due to shortage of funds.
2) For minor flooding along the roads and drains, a survey on the existing conditions of the drainage facilities is proposed.

### (2) Jaboatao

1) Improvements of the Canal Olho d'Agua and Canal de Setubal,
2) Olha d'Agua Lagoon Metropolitan Park Development Plan.

### (3) Olinda

1) Improvements of the Rio Molto system,
2) Redevelopment of the coastal low land along the Canal da Malaria
3) Pro Metropole Project for the Beberibe River basin (financed by an IBRD loan)

## Table 2.9-1 List of Drainage Channels (1/2)

| NUMBER | SUB-BASIN | CHANNEL/SECTION |
|---|---|---|
| **Beberibe River Basin** | | |
| 1 | Vasco da Gama/Peixinhos | Curso Principal - Main Watercourse |
| 2 | | Corrego Frederico Osanam |
| 3 | | Corrego Malaco |
| 4 | | Canal Nova Descoberta |
| 5 | | Corrego da Areia |
| 6 | | Corrego do Arcanjo |
| 7 | | Corrego do Eucalipto |
| 8 | | Corrego Imbauba |
| 9 | | Canal Bomba do Hemeterio |
| 10 | | Corrego do Euclides |
| 11 | | Corrego Domingos Savio |
| 12 | | Corrego Jose Grande |
| 13 | | Corrego Coto |
| 14 | | Corrego do Tiro |
| 15 | | Corrego Sao Gabriel |
| 16 | | Canal Sao Sebastiao |
| 17 | | Canal Pedro de M. Pedrosa |
| 18 | | Canal da Regeneracao |
| 19 | | Canal da Tamarineira |
| 20 | | Canal Ponto de Parada |
| 21 | Canal da Malaria | |
| **Capibaribe River Basin** | | |
| 22 | Canal do Prado | |
| 23 | | Canal do Zumbi |
| 24 | | Canal do Valenca |
| 25 | Canal St. Edwiges | |
| 26 | Canal da Mustardinha { from ABC} | |
| 27 | | Canal do Ipa |
| 28 | Canal Derby-Tacaruna | |
| 29 | | Canal Lins Petit |
| 30 | | Canal do Torrerao |
| 31 | | Canal da Cohab |
| 32 | Canal Santana-Parnamirim | |
| 33 | | Canal do Serpo |
| 34 | Braco Morto do Capibaribe | |
| 35 | | Canal do Coque |
| 36 | | Canal do Sport |
| 37 | Canal do Golf Club | |
| 38 | Canal Sao Mateus | |
| 39 | Canal do Cavouco | Curso Principal |
| 40 | | Canal do Caiara |
| 41 | | Canal Santa Rosa |

## Table 2.9-1 List of Drainage Channels (2/2)

| NUMBER | SUB-BASIN | CHANNEL/SECTION |
|---|---|---|
| **Tejipio River Basin** | | |
| 42 | Corrego do Abacaxi | |
| 43 | Rio Moxoto | |
| 44 | Canal da Malaria-2 | |
| 45 | Rio Jordao | Curso Principal |
| 46 | | Canal de Setubal |
| 47 | Rio Jiquia | |
| 48 | | Canal do Curado |
| 49 | | Canal 30 de Outubro |
| 50 | | Canal da Estancia |
| 51 | | Canal de Guarulhos |
| 52 | | Canal de Areias |
| 53 | | Canal Jardim Sao Paulo |
| 54 | | Canal da Vaca {Barreto Street} |
| 55 | | Canal da Marinha |
| 56 | | Canal da Mangueira |
| 57 | | Canal Arq. Maria Lucia {Jose Vicente Street} |
| **Jaboatao River Basin** | | |
| | | |
| 58 | | Canal Cajueiro Seco and tributary |
| | | Canal 5 Irmaos |
| 59 | | Canal Jardim Copacabana |
| 60 | | Canal da Linha Ferrea e Canal and 4 de Outubro |
| 61 | | Canal de Setubal {South Stream} |
| 62 | | Canal Olho D Agua |
| 63 | | Canal de Carolina |
| 64 | | Canal Pedro Simon |
| 65 | | Canal do Carmo |
| 66 | | Canal Aritana |
| 67 | | Canal Rio Morto |
| 68 | | Canal Bultrins |
| 69 | | Canal do Matadouro |