

**CHAPTER 4**  
**FEASIBILITY STUDY**

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### **4.1 Introduction**

In the Master Plan the 55 sewerage systems were proposed for the RMR to be improved and developed to restore the water quality and environmental conditions in the urban area. The secondary treatment of the sewage in the 55 sewerage systems was planned in the Master Plan and disinfection and sludge treatment systems were studied in the F/S stage.

As for the existing sewerage facilities at the Janga and Cabanga sewerage systems, a rehabilitation plan for the existing sewerage facilities, i.e., sewers, pumping stations and sewage treatment plants, was proposed based on the rehabilitation plan in the PQA, and the existing major facilities except the sewer pipes, were examined in the F/S stage through the field investigation.

The 55 sewerage systems have been proposed to be improved and developed by 2020 as follows:

- Phase 1 (From 2001 to 2010): 25 sewerage systems,
- Phase 2 (From 2011 to 2020): 30 sewerage systems

The priority projects were selected from the sewerage systems scheduled in Phase 1, located in the major river basins and having existing sewerage facilities, considering an early restoration of the urban environment as follows:

- In the RMR about 90 % of the BOD pollution load generated in the urban area was estimated to be discharged into the five major rivers, i.e., the Capibaribe, Beberibe, Jaboatao, Tejipio and Timbo rivers, of which lower reaches are located in the central part of the RMR. It is an urgent measure for the RMR to reduce the pollution loads from urban areas in the major river basin by improvement and development of the sewerage facilities.
- Also it is an urgent measures for the RMR to rehabilitate the existing sewerage facilities as well as new development, because there are many sewerage units, which are not working or do not fulfil their functions, are discharging the collected sewage directly or indirectly into the rivers or water bodies without proper treatment. This is accelerating the deterioration of the urban environment.

The following seven (7) sewerage systems were selected as the priority projects for F/S:

### **Priority Projects**

System	River basin	Municipality	Service Area (ha)
1. Conceicao	Timbo	Paulista	1,400
2. Janga	Timbo	Paulista	3,721
3. Cabanga	Capibaribe	Recife	2,802
4. Boa Viagem	Tejipio	Recife	1,214
5. Cordeiro	Capibaribe	Recife	974
6. Prazeres	Jaboatao	Jaboatao dos Guararapes	1,597
7. Curcurana	Jaboatao	Jaboatao dos Guararapes	781
Total			12,489

Note: The priority projects do not include systems in the Beberibe River, because the river basin has already been selected for the Pro-Metropole Project (Project of Infrastructure in Low-income Areas of the RMR) financed by the World Bank, which includes the construction or improvement of drainage and sewerage systems, including the major sewerage sub-system in the basin.

In order to get supplementary data and information for the F/S on the priority projects, the field surveys carried out for the seven sewerage systems are as follows:

- Soil investigation and topographic surveys for preliminary design of the sewerage treatment facilities,
- Examination of the existing sewerage treatment facilities and pumping stations to identify required rehabilitation at the Janga and Cabanga sewerage systems,
- Questionnaire survey on existing condominial sewerage systems to examine public participation in planning, implementation and O&M stages.
- Environmental Impact Assessment (EIA) of the impacts by the implementation of the proposed seven sewage treatments.

Based on the supplementary data the F/S have been conducted in the following chapters.

## **4.2 Sewerage Improvement Plan**

### **4.2.1 Basic Conditions and Design Criteria**

#### **(1) General**

This is a basic plan for the preliminary design of the seven sewerage systems selected as priority projects for F/S in the Master Plan. In the Study the major tasks conducted are as follows:

- To review the proposed sewerage systems and service areas,
- To prepare a basic plan for the 7 sewerage systems.

The location of the 7 sewerage systems is shown in Fig.4.2-1

#### **(2) Basic Conditions**

The basic conditions for the basic plan are as follows:

- The capacity of the facilities to serve the population in 2020,
- The available lands for the proposed facilities,
- The environmental conditions to minimize adverse impacts by the projects,
- Early implementation of the proposed projects as urgent measures for the RMR,
- Effective use of existing facilities,
- Phased implementation of the proposed projects,
- Efficient O&M, including human resource development and procurement of equipment for efficient O&M.

#### **(3) Planning Criteria**

The basic planning criteria are basically as the same as that of the Master Plan.

#### **(4) Design Criteria**

##### **1) Trunk sewers**

Since the sewer network is planned as a separate system, the sewer collects only sewage and conveys it to the sewage treatment station. The planned sewer system is composed of gravity flow sewers, pressure sewers and pump stations.

Major sewers were planned based on the following considerations.

- The trunk sewers to be planned along public roads, considering avoiding interfering

with traffic during the construction as much as possible.

- The area of each UE to be determined in such a way that the collector sewers are constructed at as shallow a depth as possible. If an area has a large natural gradient, a larger maximum area is taken as a single UE. If an area has a small natural gradient, the UE is defined as small as possible.
- The areas with low-lying and poor drainage system, to be planned as a temporary sewerage system until the proper measures for drainage to be taken.

For determination of the capacity of sewer facilities, the hourly maximum flow was applied as the design sewage quantity. The actual sewage flow for each trunk sewer was calculated by multiplying the collection area (ha) of each sewer network by the unit sewage quantity of the area (m<sup>3</sup>/ha).

- The formula for the calculation of flow in a pipeline  
Manning's equation was applied.

$$V = 1/n \times R^{2/3} I^{1/2}$$

V: velocity of flow, m/sec

n: coefficient of roughness

R: hydraulic radius

I: hydraulic gradient

- Material and roughness coefficient (n) of pipes

Concrete pipe  $n = 0.013$

Polyvinyl chloride pipe (PVC)  $n = 0.010$

- Flow velocity and flow allowance\* for gravity flow pipes

Minimum flow velocity (full)  $v = 0.6\text{m/sec}$

Maximum flow (full)  $v = 3.0\text{m/sec}$

Flow allowance\* 75% of internal diameter

\* determined to allow for a momentary surge of flow and sedimentation in the pipe.

- Gradient of pipes

The minimum gradient of pipes was determined to assure the minimum flow velocity for each diameter of pipe. For the pipes with a minimum flow velocity of 0.0015 l/sec or less, the gradient was set to be 4.5 ‰.

- Minimum soil cover
  - Road 0.9 m
  - Sidewalk 0.65 m

## **2) Pumping station**

Pumping stations are used to pump up sewage that would flow through a pipe buried too deep to be efficiently constructed and maintained. At the pump station, sewage is elevated and transferred to another pipeline at a shallower depth. Pump stations are also used when a pipeline crosses a river or when the sewage treatment facility is located at a higher altitude than its service area.

The planned pumping capacity was designed on the basis of the hourly maximum sewage flow. The design criteria for sewerage collection facilities including pump stations are discussed in Section 4.3.

## 4.2.2 Basic Plan

### (1) General

The outline of the seven sewerage systems in 2020 is shown in the following table.

Planning Item		Conceicao	Janga	Cabanga	Boa Viagem	Cordeiro	Prazeres	Curcurana	Total
Area	(ha)	853	3,954	2,671	1,203	1,054	1,570	1,160	12,465
Population	(person)	62,440	322,450	306,690	157,010	109,230	233,400	150,160	1,341,380
Daily Average Flow	(m <sup>3</sup> /day)	13,135	64,464	57,381	27,087	19,308	32,677	24,795	238,847
Daily Maximum Flow	(m <sup>3</sup> /day)	14,900	73,585	66,374	31,337	22,245	38,218	28,762	275,421
Hourly Maximum Flow	(m <sup>3</sup> /day)	20,508	102,382	93,791	44,408	31,091	53,936	40,638	386,754
Pollution Load (BOD)	(kg/day)	3,372	17,423	17,443	8,525	5,898	12,604	8,108	73,373
Pollution Load (SS)	(kg/day)	3,747	19,358	19,381	9,472	6,553	14,004	9,009	81,524
Inlet BOD	(mg/l)	257	270	304	315	305	386	327	
Inlet SS	(mg/l)	285	300	338	350	339	429	363	

The Proposed Wastewater Discharge and Wastewater Quality in 2020 and 2010 for the 7 sewerage systems are shown in Tables 4.2-1 and 4.2-2. The basic plan for the seven sewerage systems are planned and summarized in the following table and shown in Figs.4.2-1 to 4.2-8.

**Sewerage Facility Plan for the Priority Projects**

Description				Conceicao	Janga	Cabanga	Boa Viagem	Cordeiro	Prazeres	Curcurana	Total	
Sewerage Facility	Pipe (km)	Trank Sewers	Gravity Flow	6.5	11.9	2.5	15.9	8.7	13.9	10.5	69.9	
			Pressure Flow	1.7	16.8	6.8	4.5	2.1	7.5	7.5	46.9	
			Rehabilitation	0	3.6	3.2	0	0	1.8	0	8.6	
			Total	8.2	32.3	12.5	20.4	10.8	23.2	18	125.4	
	Side walk and Branch Pipes			110.9	426.4	188.2	168.4	132.3	215.9	157	1399.1	
	Pump Stations (Spot)	New Construction			4	5	6	5	6	5	12	43
		Rehabilitation (Existing)			1	13	20	0	2	2	0	38
		Total			5	18	26	5	8	7	12	81
	S.T.F(Spot)				1	1	1	1	1	1	1	7



## (2) Conceicao System

The sewerage system service area and basic sewerage facility plan are shown in Fig 4.2-2.

### 1) Planning Context

This system includes the UEs 01, 02 and 03 of Paulista defined in the Plan of Sewerage and Stormwater Drainage Management of the RMR and in the PQA – Program of Water Quality of the RMR. This delineation has not been altered.

The sewage produced in the housing estate, of which the wastewater is to be treated at the Timbó sewage treatment station, will be diverted to the new sewage treatment station of the Conceicao system, for geographic reasons.

### 2) Wastewater Volume and Pollution Load

• Served population in 2020	62,440 persons
• Sewerage area in 2020:	853 ha (100%)
1. New construction area	853 ha (100%)
2. Area covered by existing system	0ha (0.0%)
• Sewage volume in 2020:	
1. Daily average	13,135 m <sup>3</sup> /day
- Population	9,450 m <sup>3</sup> /day
- Major Consumers	0 m <sup>3</sup> /day
- Design Infiltration	3,685 m <sup>3</sup> /day
2. Daily Max	14,900 m <sup>3</sup> /day
3. Hourly Max	20,508 m <sup>3</sup> /day
• Pollution Load in 2020	
1.BOD	3,372 kg/day
2.SS	3,747 kg/day

### 3) Main Facility Layout

#### ● Trunk sewer

The basic premise of the layout of the main collector is to avoid the roads with heavy traffic, but this is not possible in this system and both the PE 1 and the PE 22 will have collectors along them.

#### ● Pump station

Five pumping stations, including one existing pump station, which serves the Conceição/Dona

Duda housing estate, are planned. There are three to the left of the PE 22 from north to south, two of which are near the Timbó estuary, one in the road parallel to the PE 22 and one in a road perpendicular to it, before the two PEs meet.

The third is at the side of the PE 22 and belongs to the treatment plant and one is at the left-hand side of the PE 1 (UE 03) in the northerly direction, near the beach at Nossa Senhora do Ó. The last one is in Afonso Pena Street, near the mouth of the River Timbó (UE 01).

### ● Sewage treatment facility and receiving body

Topographically the treatment area of Conceicao is low and flat in the north and the southern part is a low hill area. The planned site for the sewage treatment facility is in the middle of the treatment area and advantageous for the effective collection of sewage from both sides.

The site has adequate land for large facilities that are easy to be constructed and require a minimal level of maintenance.

The treated sewage is planned to be discharged into the Timbo River.

### (3) Janga System

The sewerage treatment area and basic facility plan are shown in Fig 4.2-3.

#### 1) Planning Context

This system is composed of UEs 22 and 23 in Olinda and UEs 04, 05, 06, 07 and 09 in Paulista, defined by the Plan of Sewerage and Stormwater Drainage Management of the RMR and by the PQA – Program of Water Quality of the RMR. According to these documents, UE 06 corresponds to the Mutirão system. However, as a consequence of the COMPESA decision not to reactivate the treatment plant of this system, this UE was integrated into the Janga system. An area located in the municipalities of Olinda and Paulista, more specifically to the right side of highway PE 15, which was not considered by the PQA, was included in this study. Especially the municipality of Olinda, as available for expansion considers this area.

#### 2) Wastewater Volume and Pollution Load

- Served population in 2020 322,450 person
- Sewerage area in 2020: 3,954 ha (100%)
  1. New construction area 2,665 ha (67.4%)
  2. Area covered by existing system 1,289 ha (32.6%)
- Sewage volume in 2020:

1. Daily average	64,464 m <sup>3</sup> /day
2. Daily Maximum	73,585 m <sup>3</sup> /day
3. Hourly Maximum	102,382 m <sup>3</sup> /day
• Pollution Load in 2020	
1. BOD	17,423 kg/day
2. SS	19,358 kg/day

### 3) Main Facility Layout

#### ● Trunk sewer

In this system, the route of the new collectors was included in UEs 22 in Olinda and 04 and 05 in Paulista, as well as the new area incorporated in the present study. Two collectors were proposed along the Fragoso river. They can be considered as trunk sewers, one on each side of the river, to convey the contribution of Cidade Tabajara, in Olinda, and the contribution of the new area to the existing Rio Doce trunk sewer, which conveys the sewage to EEJ3 in Pedras Altas.

The main crossings of this system are three to cross the PE 15, and two to cross the Fragoso River.

There are existing facilities, of which the trunk sewers were evaluated for their capacity.

#### ● Pumping station

18 pumping stations, including 13 existing pumping stations, which serve parts of Olinda and the municipality of Paulista – two housing estates and the neighborhoods of Mutirão (Engenho Maranguape), Maranguape I and II, are planned.

The existing pumping station of Fragoso (EEJ 01), will receive all the contributions from the UEs in Olinda, Maranguape I (belonging to Paulista), and from the expansion areas of both municipalities. In the present system, the Maranguape I contribution is conveyed from the pump station EEJ 06 to the pumping station EEJ 05 in Maranguape II.

#### ● Sewage treatment facility and receiving body

Some additional facilities are required to be planned next to the existing treatment plant. The site has an area of 6 ha, owned by COMPESA. The treated sewage is planned to be discharged into the main stream of the Timbo River as the same as the existing sewage treatment facility.

### (4) Cabanga System

The sewerage treatment area and basic facility plan are shown in Fig 4.2-4.

### 1) Planning Context

This system is composed of UEs 44, 45, 46, 85, 87, 88, 89, 94, 95, 96 and 97 in Recife, defined by the Plan of Sewerage and Stormwater Drainage Management of the RMR and by the PQA – Program of Water Quality of the RMR, and by the Sewerage Districts D1, D2, D2A, D3, D4, D5, D6, D6A, D7, D9 and D15, defined by COMPESA. UEs 85 and 87 belonged to the Boa Viagem system. However due to topographic conditions and to the existence of a collection network in UE 87, which conveys the contribution to the collector C-1 of district D15, it was decided to remove them from this system. This facilitated the geographic delimitation between the Boa Viagem and Cabanga systems. Consequently, the downstream section of Setúbal canal, up to Cândido Ferreira Avenue (limit with the Prazeres system), will belong to the Cabanga system. Another alteration was the modification of the UE 96 limit, after discussions with COMPESA. Only the area comprising the locality known as Ponte do Maduro will belong to this UE, while the rest will become part of district D14, which in turn is part of the Peixinhos system.

### 2) Wastewater Volume and Pollution Load



### 3) Main Facility Layout

#### ● Trunk sewer

In this system, new collectors are planned in UEs 44, 45 and 95 in Mustardinha, Madalena (Retiro), and Coque. The areas served by these UEs do not have heavy traffic, except for Abdias de Carvalho avenue, the limit between UEs 44 and 45, in which no collector was designed. In UE 95, two crossings are necessary at the railway in order to convey the sewage from this UE to district D1. The UEs 46, 85, 87, 88, 89, 94, 96 and 97 have a totally or partially

existing system. UE 87 is partially served by the collection network implemented within its area. For UEs 88 and 89 there is already a COMPESA collection network project. As regards the main collectors in the sewerage districts, the pre-evaluation of their capacity was carried out and this will be further detailed in a future phase of the project.

● **Pumping station**

26 pumping stations including, 20 existing pumping stations (including one on going pumping station), which serve the existing districts, are planned. Their distribution is as follows: two in the Prado neighborhood (UE 44), and the biggest one which will serve all the UE, to be located near Estrada dos Remédios; One in the Madalena neighborhood (Retiro – UE 45); three in the locality of Coque (UE 95); and one between Coque and the São José neighborhood.

● **Sewage treatment facility and receiving body**

Some additional facilities are planned to be constructed adjacent to the existing treatment plant. The plot for expansion is owned by COMPESA and currently used as a soccer field. The treated sewage is planned to be discharged into the Pina River in the Capibaribe River system as the same as the existing plant.

(5) **Boa Viagem System**

The sewerage system service area and basic facility plan are shown in Fig 4.2-5.

1) **Planning Context**

This system is composed of UEs 15 and 17 in Jaboatão, and 68, 78, 79, 80, 81, 82, 83, 84 and 86 in Recife, defined by the Plan of Sewerage and Stormwater Drainage Management of the RMR and by the PQA – Program of Water Quality of the RMR. Within these studies, UEs 85 and 87 belong to the Boa Viagem system. However, due to topographic characteristics and due to the fact that there is a trunk sewer in UE 87, which conveys the contribution into collector C-1 of district D15, the transference of these UEs to the Cabanga system was decided, which also facilitated the geographic delimitation of the Boa Viagem and Cabanga systems. Part of UEs 15 and 17, originally belonging to the Boa Viagem system, was incorporated into the Prazeres system.

2) **Wastewater Volume and Pollution Load**

- Served population in 2020                      157,010 person
- Sewerage area in 2020:
  - 1. New construction area                      1,203 ha (100%)

2. Area covered by existing system	0 ha (0%)
• Sewage volume in 2020:	
1. Daily average	27,087 m <sup>3</sup> /day
2. Daily Maximum	31,337 m <sup>3</sup> /day
3. Hourly Maximum	44,408 m <sup>3</sup> /day
• Pollution Load in 2020	
1. BOD	8,525 kg/day
2. SS	9,472 kg/day

### 3) Main Facility Layout

#### ● Trunk sewer

For routing the main collectors, busy highways were avoided, such as Barão de Souza Leão Avenue, Ribeiro de Brito and Ernesto de Paula Santos streets, in the neighborhood of Boa Viagem. However, in the streets and avenues that border the Setúbal canal and the Jordão river, for example Visconde de Jequitinhonha street and Almirante Neves street, collectors were necessary in order to receive the contributions that topographically should be sent to the margins of these water bodies. The diameters of these collectors vary from 150mm to 600mm. This system will have three crossings over the Jordão river, one by way of a pressure pipe and the other two through collectors, three crossings at the railway, and one in Mascarenhas de Moraes avenue, close to Estrada da Batalha, with a diameter of 500mm, to convey the sewage collected in UEs 15 (Jaboatão) and 68 (Recife) to UE 81. All the contribution collected upstream of the railway will be sent directly to the pump station before treatment.

#### ● Pumping station

5 pumping stations are planned, distributed as follows: one near Guararapes Airport, in the neighborhood of Jordão (UE 68); one in the neighborhood of Setúbal, between the Setúbal canal and Visconde de Jequitinhonha street (UE 84); two in the neighborhood of Boa Viagem (UE 82 and UE 79, this last one before the treatment plant); and one in the neighborhood of Imbiribeira (UE 78), which will be located close to the interception of the Jordão River with the Tejipló River.

The existing pumping station EEC-20, located in UE81, is considered not to be utilized, as well as EEC-19, located in UE 84.

#### ● Sewage treatment facility and receiving body

The service area of Boa Viagem spreads over the catchment area of the Jordao River. The planned site for the treatment station is located downstream, close to the river mouth. This makes the collection of sewage easy and efficient. The site has adequate land for large facilities

that are easy to be constructed and require a minimal level of maintenance. The treated water is planned to be discharged into the Jordao River in the Tejipio River system.

## **(6) Cordeiro System**

The sewerage system service area and basic facility plan are shown in Fig 4.2-6.

### **1) Planning Context**

This system is made up of the UEs 39, 40, 41, 42, 43 and 54 in Recife, defined by the Plan of Sewerage and Stormwater Drainage Management of the RMR and by the PQA – Program of Water Quality of the RMR. UE 54 belongs to the system Roda do Fogo, but although it has a collection system, its sewage is not treated at present.

It was decided to remove it from the system which would have to be expanded if it were retained.

Its sewage will be conveyed to UE 42. To facilitate the geographic delineation of the system, part of UE 53, also belonging to the Roda de Fogo system, will be served by Cordeiro. The boundary with the Cabanga system, particularly in the neighborhood of Torre, was more clearly defined.

Although the sewage from Vila Santa Luzia is sent to the Peixinhos system, crossing the Capibaribe River, this sewage too, for geographical reasons, will be treated in the new ETE in the Cordeiro system.

### **2) Wastewater Volume and Pollution Load**

- Served population in 2020 109,230 person
- Sewerage area in 2020: 1,054 ha (100%)
  - 1. New construction area 946 ha (89.7%)
  - 2. Area covered by existing system 108 ha (10.3%)
- Sewage volume in 2020:
  - 1. Daily average 19,308 m<sup>3</sup>/day
  - 2. Daily Maximum 22,245 m<sup>3</sup>/day
  - 3. Hourly Maximum 31,091 m<sup>3</sup>/day
- Pollution Load in 2020
  - 1. BOD 5,898 kg/day
  - 2. SS 6,553 kg/day

### 3) **Main Facility Layout**

#### ● **Trunk sewer**

As a basic premise for the layout of the principal collectors, the major traffic routes were avoided, especially Caxangá avenue.

The project includes collectors along the banks of the Cavouco canal, Mário Alvarez Pereira Avenue, Santa Rosa canal, Caiara canal, Zumbi canal and the Capibaribe River, the future Beira Rio Avenue, to receive the contributions of sewage from areas, which naturally drain towards these banks.

#### ● **Pumping station**

8 pumping stations, including two existing pump stations, which serve the neighborhood of Engenho do Meio and Vila Santa Luzia, are planned. One in the neighborhood of Monsenhor Fabrício (UE 40), one in Bomba Grande, on the banks of the Caiara canal (UE 40), two in Cordeiro, one being part of the treatment plant (UE 40) and the other on the banks of the Cavouco canal (UE 42), two in Torre, one of which will be near Vila Santa Luzia, and one in Madalena, on the banks of the Zumbi canal.

#### ● **Sewage treatment facility and receiving body**

The planned construction site for the treatment station is located between the Capibaribe River and a planned road. The site is owned by the State of Pernambuco. The planning area is sufficient even taking into account the park planned next to it. The treated sewage will be discharged into the Capibaribe River.

### (7) **Prazeres System**

The sewerage system service area and basic facility plan are shown in Fig 4.2-7.

#### 1) **Planning Context**

This system is composed of Use 16, 18, 19 and 21 in Jaboatão, defined by the Plan of Sewerage and Stormwater Drainage Management of the RMR and by the PQA – Program of Water Quality of the RMR. UE 20, which belonged to the Curcurana system, was partly incorporated into UE 21 in order to facilitate the geographic delimitation between the Curcurana and Prazeres systems. Part of UEs 15 and 17, belonging to the Boa Viagem system, was also incorporated into the Prazeres system.



## 2) Wastewater Volume and Pollution Load

- Served population in 2020 233,400 persons
- Sewerage area in 2020: 1,570 ha (100%)
  - 1. New construction area 1,542 ha (98.2%)
  - 2. Area covered by existing system 28 ha (1.8%)
- Sewage volume in 2020:
  - 1. Daily average 32,677 m<sup>3</sup>/day
  - 2. Daily Maximum 38,218 m<sup>3</sup>/day
  - 3. Hourly Maximum 53,936 m<sup>3</sup>/day
- Pollution Load in 2020
  - 1. BOD 12,604 kg/day
  - 2. SS 14,004 kg/day

## 3) Main Facility Layout

### ● Trunk sewer

In the layout of principal collectors, major traffic routes were avoided, such as, for example, Bernardo Vieira de Melo Avenue and Copacabana Avenue. However, in this last one, in the stretch between the limit with the Boa Viagem system and Shopping Guararapes (Barreto de Menezes avenue), two collectors were included, one on each side of the avenue since this avenue runs alongside the Setúbal canal, and in order to receive the contributions from UEs 18 and 19. The diameters of these collectors vary from 150mm to 400mm. This system will have one crossing at the Setúbal canal (through a pressure pipe), four crossings under the railway, and one crossing under the highway BR 101/South, with a diameter of 1,500mm, to reach the proposed treatment station.

### ● Pumping station

7 pumping stations, including 2 existing pumping stations EEC-16 and EEC-21, in the Housing Estates Dom Hélder Câmara and Jardim Piedade, to be used to elevate part of the UE 21 sewage, are planned.

They are distributed as follows: two in the neighborhood of Piedade (UE 18 and 21); two in the neighborhood of Cajueiro Seco, close to the Setúbal canal (UE 19); and one in the neighborhood of Prazeres (UE 16).

### ● Sewage treatment facility and receiving body

The service area of the Prazeres sewerage system covers the coastal area to the north of the Olho d'Água lagoon. The PQA, however, proposed the site for the treatment station near the river mouth of the Jaboatao River, a few kilometers to the south of the lagoon. This is because the PQA avoided discharging treated sewage into the Olho d'Água lagoon.. The site has

adequate land for the construction of large facilities that are easy to be built and require a minimal level of maintenance. The treated sewage is planned to be discharged into the Jaboatao River.

## **(8) Curcurana System**

The sewerage system service area and basic facility plan are shown in Fig 4.2-8.

### **1) Planning Context**

This system is made up of the UEs 20, 22, 23 and 24 of Jaboatão, defined in the master plan. UE 24 belong to the Comportas system but as it drains into the Olho d'Água lagoon, it is included here.

To facilitate the geographic delineation of the system and reduce the contribution of UE 20 to the system, due to the increase from UE 24, UE 20 was divided between the Curcurana System and the Prazeres System.

The decision not to increase the size of the ETE at Curcurana was because there are areas of environmental preservation here.

### **2) Wastewater Volume and Pollution Load**



### **3) Main Facility Layout**

#### **● Trunk sewer**

In the layout of principal collectors, the major traffic routes were avoided, such as, for example, Bernardo Vieira de Melo Avenue and Ulisses Motarroyas Avenue, popularly known as "the three lanes".

Hence the Curcurana road will have a collector along its entire length, with diameters varying from 600mm to 1200mm, to transport the contributions from all the UEs to the treatment plant.

- **Pumping station**

12 pumping stations are proposed in this sewerage system.

4 are in the neighborhoods of Candeias and Barra de Jangada (UE 22), 3 in Curcurana (UE 23), 2 in Pontezinha, 1 in Pau Seca and 2 in the Nossa Senhora das Graças subdivision. All pump stations will be of the wet-pit type, proposed to avoid lowering the collector network by approximately 6m.

- **Sewage treatment facility and receiving body**

The service area of the Curcurana system covers the coastal area to the south of Olho d'Água lagoon which also corresponds to the area on the left bank of the Jaboatao river. The service area includes the neighborhood of the lagoon, which the city of Jaboatao plans to develop as a lakeside resort. The site for the construction of the sewage treatment plant was designated as an environmental protection area (Z4-10) and construction work is strictly restricted. The city of Jaboatao, however, gave a favorable consideration to the application and agreed to the use of the site for the construction of a treatment plant because the project is aimed at the improvement of the aquatic environment in the vicinity.

In the PQA the treated sewage was planned to go to the drainage canal of Olho d'Água lagoon. In this study, however, it is planned to be discharged into the Jaboatao River to avoid the reverse flow of sewage into the canal caused by high tides.

**Table 4.2-1 Proposed Wastewater Discharge and Wastewater Quality in 2020 for the 7 Systems**

Planning Item		Conceicao	Janga	Cabanga	Boa Viagem	Cordeiro	Prazeres	Curcurana	Total	
Sewerage Area (ha)	New Construction Area	853	2,665	1,176	1,203	946	1,542	1,122	9,507	
	Area Covered by Existing Area	0	1,289	1,495	0	108	28	38	2,958	
	Total	853	3,954	2,671	1,203	1,054	1,570	1,160	12,465	
Population (person)	Wastewater Volume Large	51,620	248,980	233,490	108,260	75,220	87,330	90,710	895,610	
	Wastewater Volume Middle	0	35,260	330	0	0	0	11,440	47,030	
	Wastewater Volume Small	10,820	38,210	0	17,760	0	7,870	0	74,660	
	ZEIS and Informal Areas	0	0	72,870	30,990	34,010	138,200	48,010	324,080	
	Total	62,440	322,450	306,690	157,010	109,230	233,400	150,160	1,341,380	
Wastewater Discharge (m3/day)	Daily average	Population	9,450	48,448	43,230	21,754	14,755	25,895	19,784	183,316
		Major Consumers	0	28	2,612	136	0	0	0	2,776
		Design Infiltration	3,685	15,988	11,539	5,197	4,553	6,782	5,011	52,755
		Total	13,135	64,464	57,381	27,087	19,308	32,677	24,795	238,847
	Daily maximum	Population	11,215	57,563	51,700	25,977	17,692	31,436	23,751	219,334
		Major Consumers	0	34	3,135	163	0	0	0	3,332
		Design Infiltration	3,685	15,988	11,539	5,197	4,553	6,782	5,011	52,755
		Total	14,900	73,585	66,374	31,337	22,245	38,218	28,762	275,421
	Hourly maximum	Population	16,823	86,344	77,551	38,966	26,538	47,154	35,627	329,003
		Major Consumers	0	50	4,701	245	0	0	0	4,996
		Design Infiltration	3,685	15,988	11,539	5,197	4,553	6,782	5,011	52,755
		Total	20,508	102,382	93,791	44,408	31,091	53,936	40,638	386,754
Pollution Load (kg/day)	BOD	3,372	17,423	17,443	8,525	5,898	12,604	8,108	73,373	
	SS	3,747	19,358	19,381	9,472	6,553	14,004	9,009	81,524	
Inlet Water Quality (mg/l)	BOD	257	270	304	315	305	386	327		
	SS	285	300	338	350	339	429	363		

**Table 4.2.-2 Proposed Wastewater Discharge and Wastewater Quality in 2010 for the 7 Systems**

Planning Item		Conceicao	Janga	Cabanga	Boa Viagem	Cordeiro	Prazeres	Curcurana	Total	
Sewerage Area (ha)	New Construction Area	853	2,665	1,176	1,203	946	1,542	1,122	9,507	
	Area Covered by Existing Area	0	1,289	1,495	0	108	28	38	2,958	
	Total	853	3,954	2,671	1,203	1,054	1,570	1,160	12,465	
Population (person)	Wastewater Volume Large	44,582	230,262	225,983	103,053	72,953	78,537	80,197	835,567	
	Wastewater Volume Middle	0	31,236	323	0	0	0	10,251	41,810	
	Wastewater Volume Small	9,348	35,178	0	16,312	0	7,081	0	67,919	
	ZEIS and Informal Areas	0	0	69,168	29,249	32,255	124,089	43,107	297,868	
	Total	53,930	296,676	295,473	148,614	105,209	209,708	133,555	1,243,165	
Wastewater Discharge (m3/day)	Daily average	Population	8,161	44,616	41,731	20,623	14,253	23,272	17,561	170,217
		Major Consumers	0	28	2,612	136	0	0	0	2,776
		Design Infiltration	3,685	15,988	11,539	5,197	4,553	6,782	5,011	52,755
		Total	11,846	60,632	55,882	25,956	18,806	30,054	22,572	225,748
	Daily maximum	Population	9,686	53,008	49,902	24,626	17,087	28,252	21,086	203,647
		Major Consumers	0	34	3,135	163	0	0	0	3,332
		Design Infiltration	3,685	15,988	11,539	5,197	4,553	6,782	5,011	52,755
		Total	13,371	69,030	64,576	29,986	21,640	35,034	26,097	259,734
	Hourly maximum	Population	14,529	79,513	74,853	36,938	25,630	42,377	31,629	305,469
		Major Consumers	0	50	4,701	245	0	0	0	4,996
		Design Infiltration	3,685	15,988	11,539	5,197	4,553	6,782	5,011	52,755
		Total	18,214	95,551	91,093	42,380	30,183	49,159	36,640	363,220
Pollution Load (kg/day)	BOD	2,912	16,030	16,837	8,071	5,681	11,324	7,212	68,067	
	SS	3,236	17,811	18,708	8,968	6,313	12,582	8,013	75,631	
Inlet Water Quality (mg/l)	BOD	246	264	301	311	302	377	320		
	SS	273	294	335	346	336	419	355		



9130000



9120000

**Conceicao System**

**Janga System**

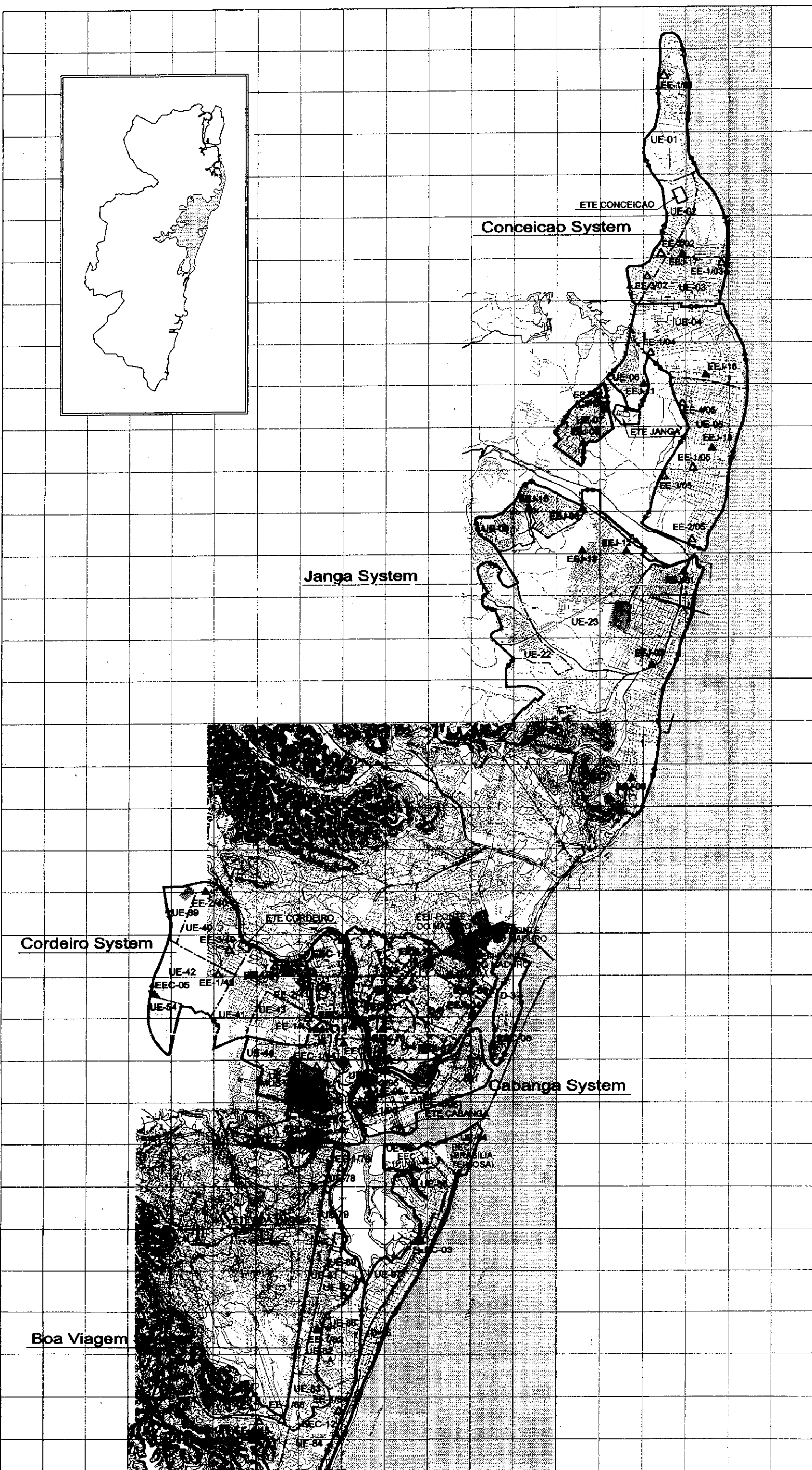
9110000

**Cordeiro System**

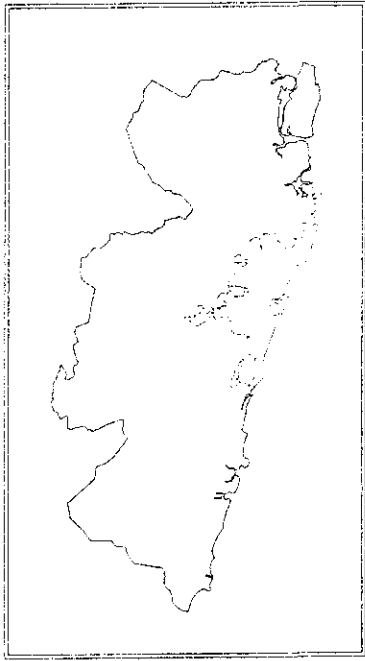
**Caibanga System**

9100000

**Boa Viagem**



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Conceicao System

Janga System

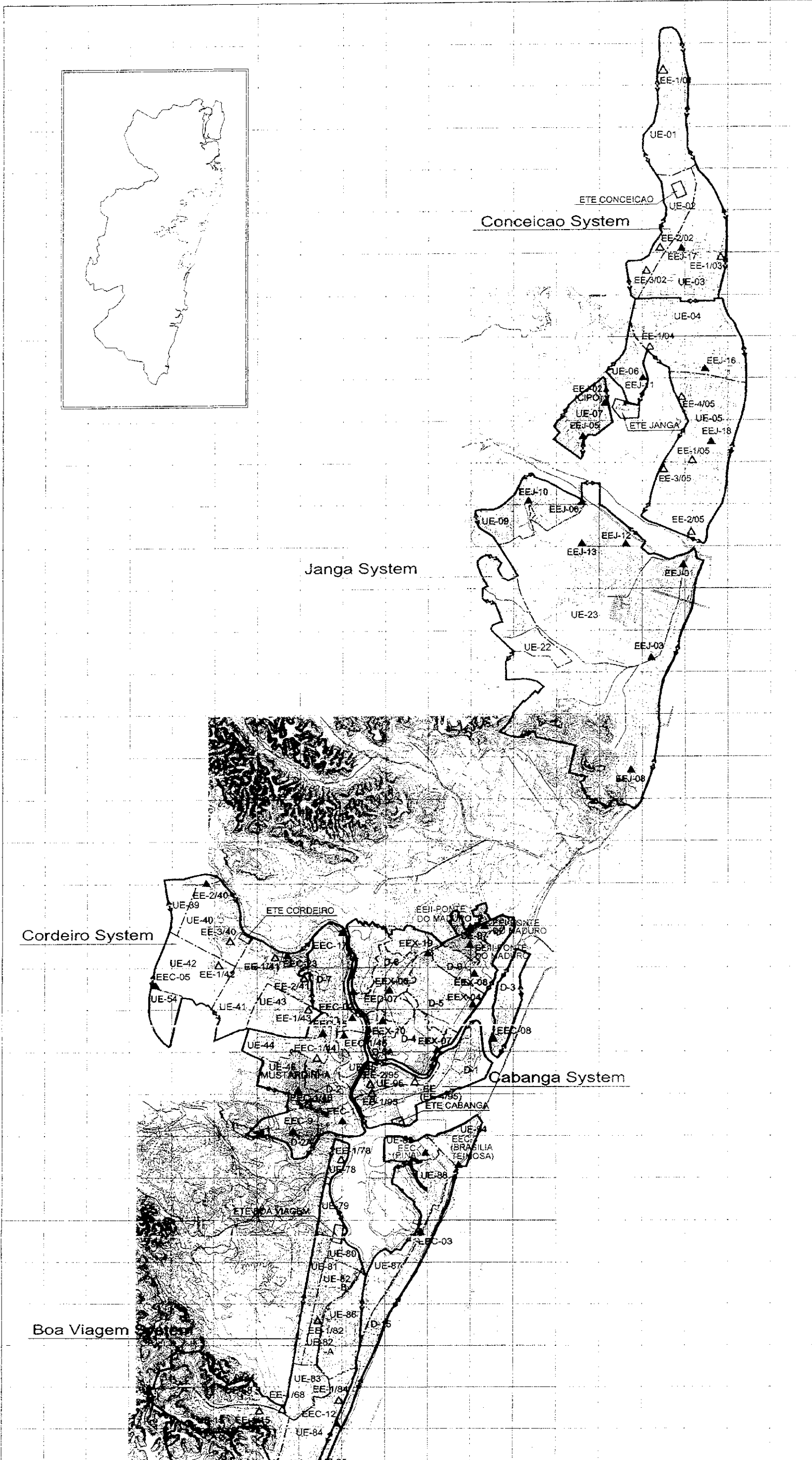
Cordeiro System

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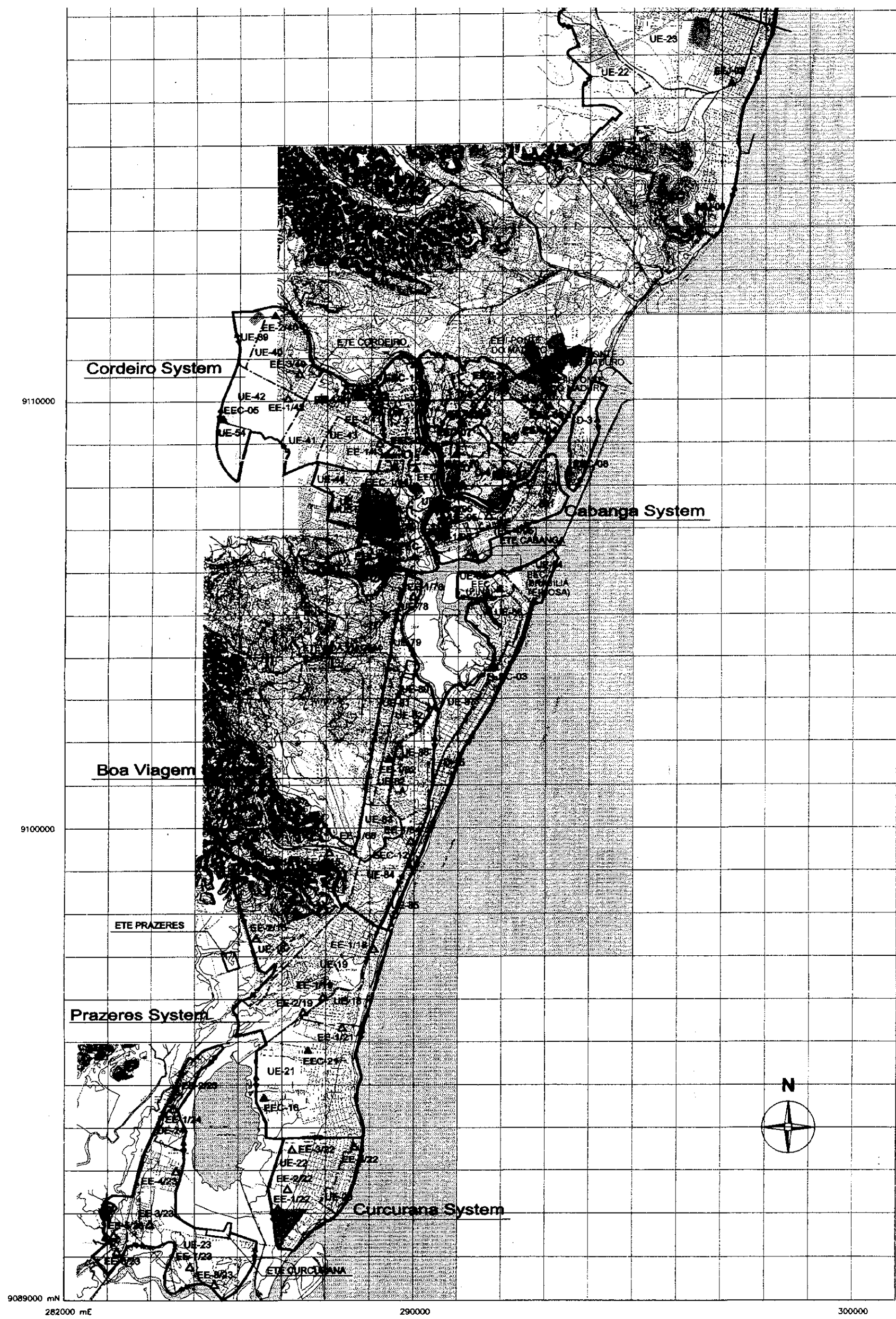
Cabanga System

Boa Viagem System

9100000







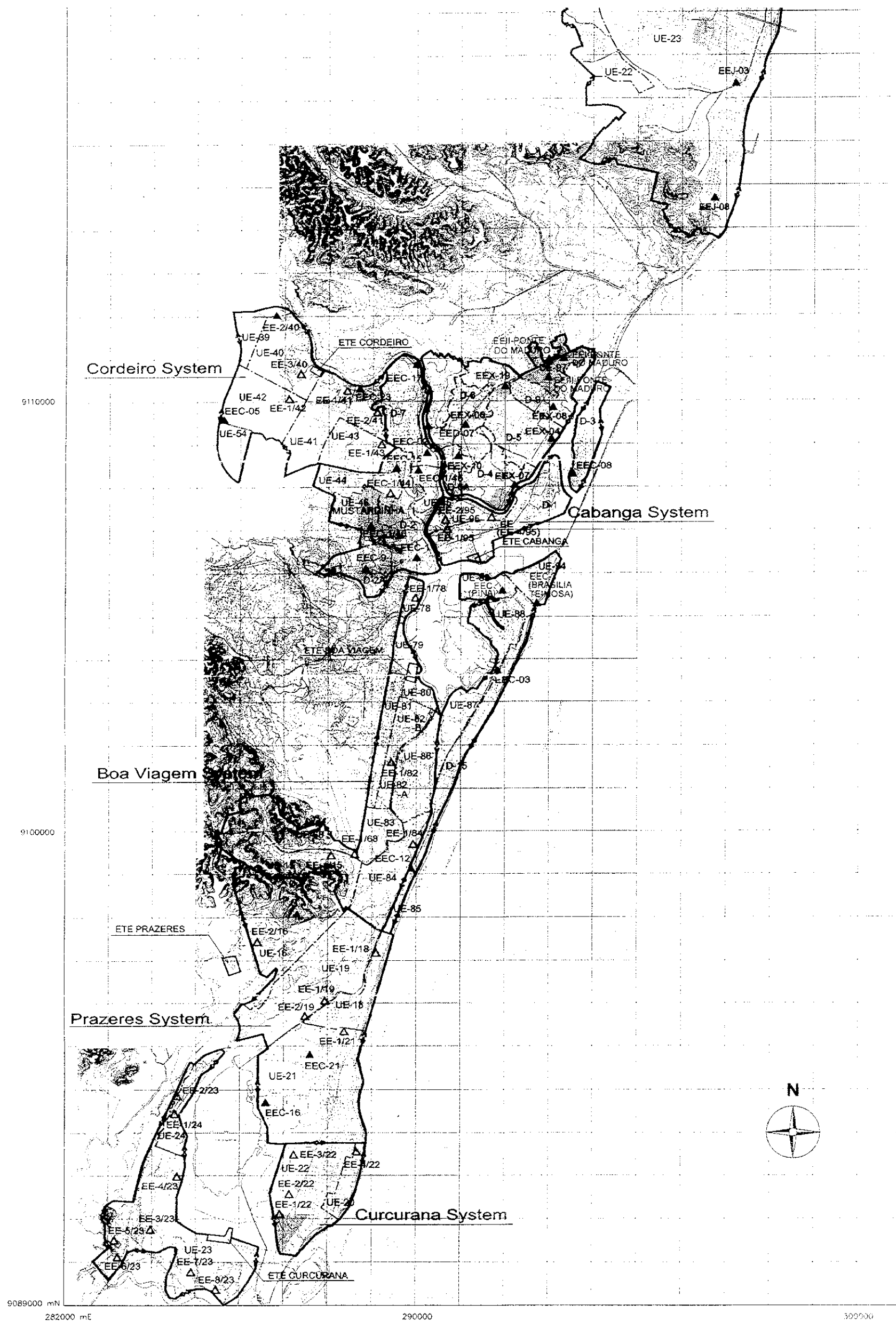
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- SISTEM BOUNDARY
- UE BOUNDARY
- SEWERAGE UNIT
- PUMP STATION
- TREATMENT FACILITY
- PLANNED PUMP STATION
- EXISTING PUMP STATION
- EXISTING AREA (CONVENTIONAL)
- EXISTING AREA (CONDOMINIAL)

SCALE 1:90.000  
 0 1000 2000 m

**Layout Plan of 7 Systems**

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR



**LEGEND**

- SYSTEM BOUNDARY
- UE BOUNDARY
- UE SEWERAGE UNIT
- EE PUMP STATION
- ETE TREATMENT FACILITY
- PLANNED PUMP STATION
- EXISTING PUMP STATION
- EXISTING AREA (CONVENTIONAL)
- EXISTING AREA (CONDOMINIAL)

**Layout Plan of 7 Systems**

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR

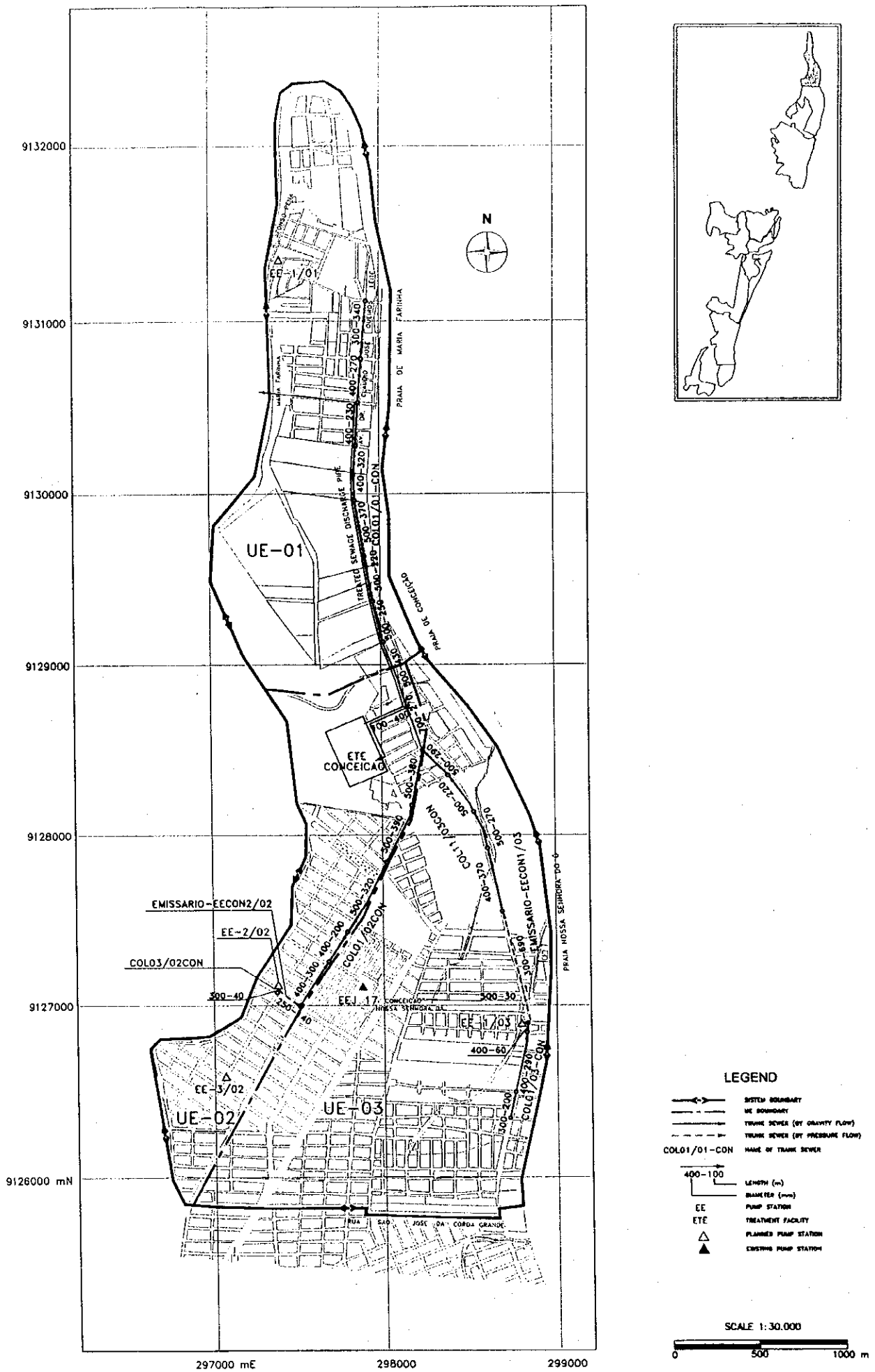


Fig.4.2-2

Layout Plan of Conceicao System



9128000



9127000

9126000

9125000

TIMBO RIVER

SEWAGE DISCHARGE PIPES

UE-04

C-4/04

EE-1/04

C-3/04

UE-08

EEJ-11

C-1/04

9124000

ETE JANGA

EE-4/04

9123000

EEJ-05

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EE-3/05

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EE-2/05

9119000

A-3/22

A-1/22

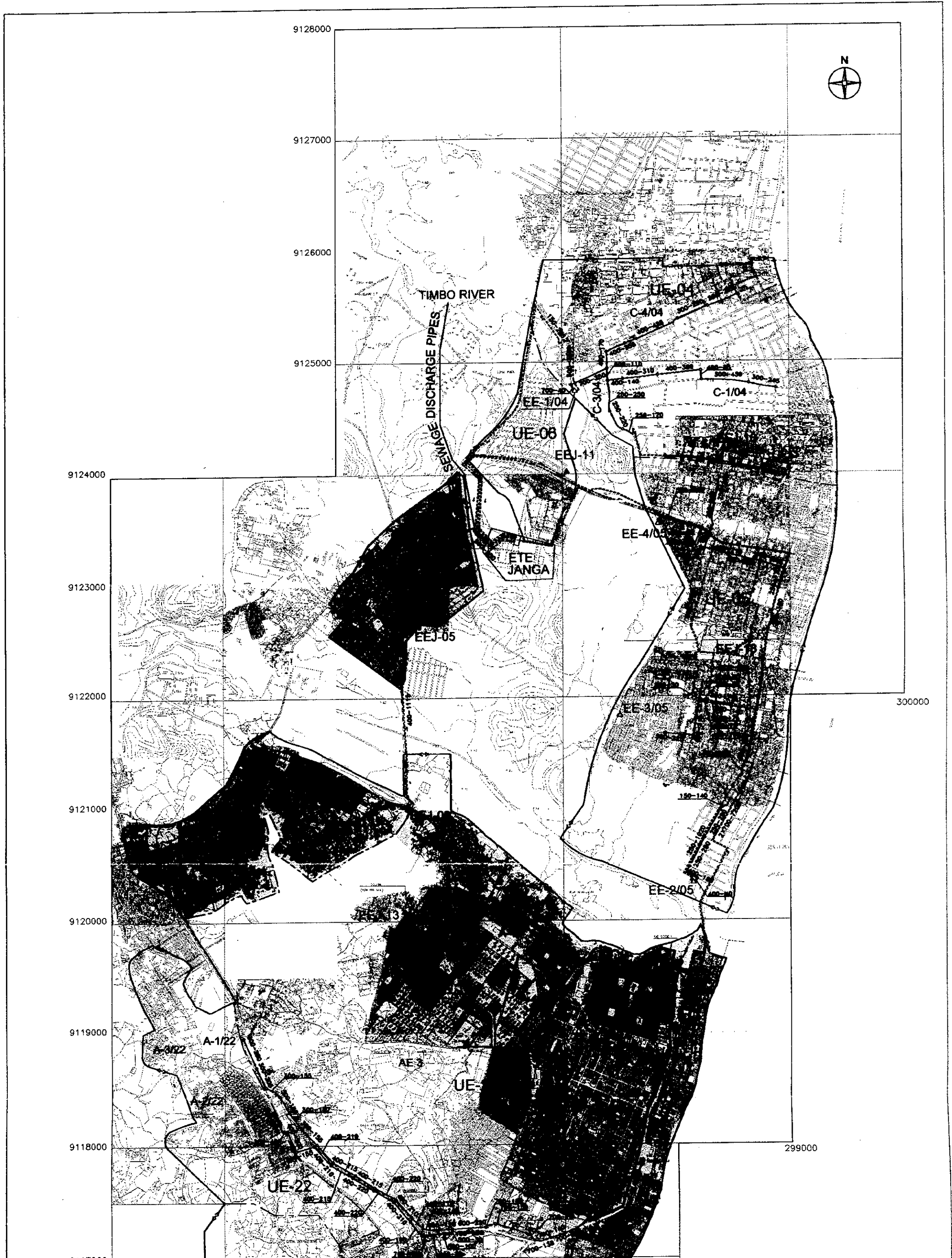
AE-3

UE

9118000

UE-22

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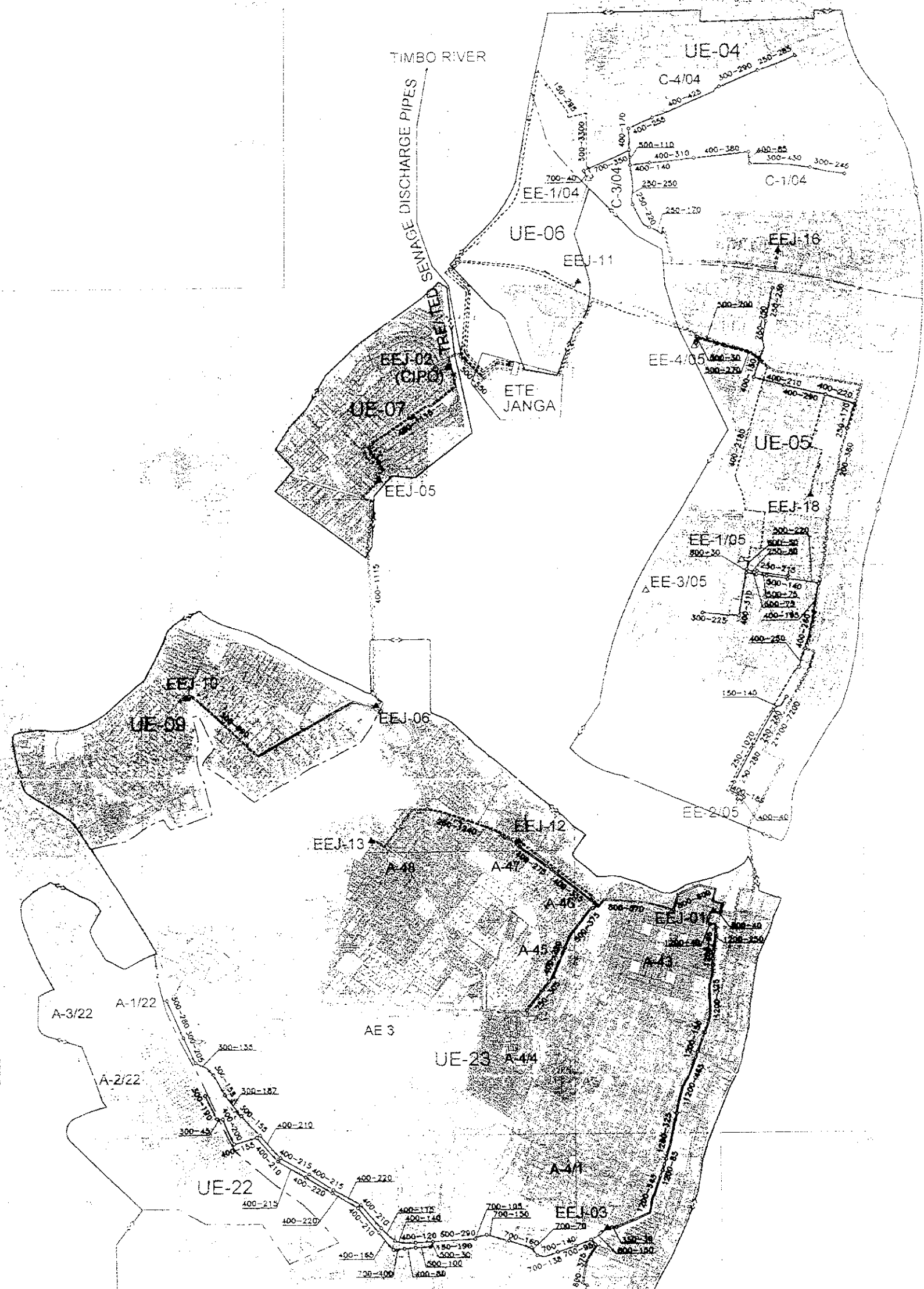
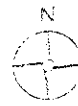




Fig.4.2-3

Layout Plan of Janga System

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR



Fig.4.2-3

Layout Plan of Janga System