SUPPORTING REPORT G

COST ESTIMATION

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1. Construction Plan

1.1 General

The Report deals with the construction plan and corresponding schedule for the Recife metropolitan sewerage system which comprises seven subsystem identified in the feasibility study. The project consists of pipe networks, pumping stations, and wastewater treatment plants for the sewerage system. Construction works for the project include earthworks, concrete work, pipe work, mechanical/electrical work, architectural work, and miscellaneous works.
The construction work will be carried out using conventional construction methods and equipment, where possible, due to limited construction periods and the need to achieve high quality.

Most of the construction materials are available in Brazil. Specialized equipment and materials should be procured in overseas markets.

1.2 Geological Characteristics at the Sites of the Treatment Plants

Soil surveys by core borings have been carried out at the proposed sites of wastewater treatment plants. The results are summarized as follows.

(1) Conceicao

Topsoil layer was identified to be in good condition. Spread type of foundation is recommended.

(2) Janga

Top subsoil layers were identified to be in good condition. However, N values of less than 3 were measured 3.0 to 4.0 meters in depth below ground level. In order to improve the subsoil condition, the sand fill method (replacement of subsoil) will be effective in the places where N value is insufficient for the proposed structures. A rocky subsoil layer was identified 12.0m below ground level in some parts.

(3) Cabanga

A hard subsoil layer was identified, 26 meters in depth, below ground level. Therefore, piled foundations are required for the proposed heavy structures. As the highest part of the foundation is planned at 1 m below ground level, a pile length of over 25m is required.

(4) **Boa Biagem**

A soft subsoil layer was identified 3 m in depth below ground level. Therefore, soil stabilization method or the sand fill method (Replacement to subsoil) is required in order to improve the subsoil condition.

(5) **Cordeiro**

A hard subsoil layer was identified 31 meters in depth below ground level. Therefore, piled foundations are required for the proposed structures. The pile length required is estimated at 30m or more.

(6) **Prazeres**

An N Value of less than 1 was measured at 20 meters below ground level. Therefore piled foundations are required in this place, where subsoil is unconsolidated. Spread types of foundations are appropriate at the place where subsoil is consolidated

(7) **Curcurana**

A soft subsoil layer was identified up to 6.0 meters below ground level. Piled foundations are required for the proposed structures.

1.3 Major Construction Works

(1) Sewer Pipe-laying

Sewer pipe-laying works are to be carried out for the seven systems; Conceicao, Janga, Cabanga, Cordeiro, Boa Viagem, Prazeres and Curcurana in the RMR (Recife Metropolitan Region). The new sewer pipes consist of trunk and branch sewers. There are two flow types of trunk sewers, by gravity and under pressured. The sewerage collected by the branch and trunk sewers, is received by pumping stations, and conveyed to the wastewater treatment plants to be constructed at the proposed sites. Rehabilitation works for the existing sewer pipes will also be carried out.

1) **Preparatory work**

Preparatory work for the installation of sewer pipes should be carried out in advance, to assess the site conditions in order to select the best construction method, temporary works required and safety management during the construction period.

To assess the current conditions of the project sites, studies should be carried out for the following items.

- Geographical features
- Drainage conditions
- Road traffic conditions
- Roads, buildings, retaining walls, utility poles, fire hydrants, overhead and underground structures, electric power and telephone lines
- Survey of underground water, and drainage pipes
- Topographical/Land survey
- Soil survey
- Exploratory excavation, where required, to confirm the location of underground structures

2) Construction materials

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

The following materials are used for sewer pipes.

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

3) Construction methods

The most appropriate methods will be selected taking into account site and soil conditions, economic efficiency and additional construction methods required. Noise, vibration, subsidence and traffic conditions should be considered. The main study items for the selection of construction methods are as follows.

- Alternative alignments for pipe routes, depth, shape, types of structures
- Temporary work required
- Additional construction methods if required
- Environmental conservation during the construction period
- Vibration and noise reduction in relation to site working hours
- Safety and traffic management
- Construction site organization

- Labor, material and construction equipment

Open Cut Trench Method:

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

a) Rapid progress can be expected with minimum inconvenience.

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

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

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

In order to reduce the ground water level and keep the excavated area dry, the well point method is used, consisting of pipes (or well point) which penetrate the soil. Water coming from the well point is normally drained by a vacuum pump. A pump head of 6 to 8 meters is commonly used. A concept drawing of the open cut trench method is shown in Table G.1-1.

Cutting Edge Pipe - Jacking Method

The pipe jacking method is one of the pipe-laying methods of pushing-in pipes using the driving force of a jack. In general, this method is limited to use in straight sewer routes. It will be used across the national highways and railroad. A concept drawing of the cutting edge pipe jacking method is shown in Table G.1-2.

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

Branch Sewer (Gravity flow type):

- Open trench cut method with/without sheeting

  Excavation depth: 1.2m-2.5m

  PVC 150-400mm diameter

Trunk sewer (Gravity flow type):

Case 1

- Open trench (Single cross section) cut method with sheeting and well point.

  Excavation depth: 2.0-3.0m

PVC 150-400mm diameter

Case 2

- Open trench (Compound cross section) cut method with sheeting and well point
  Excavation depth: 4.0-6.0m
  RC 500-1500mm diameter

Trunk sewer (Pressured flow type):

Case 1

- Open cut trench method with sheeting
  Excavation depth: 2.0 m
  PVC 150- 300mm diameter

Case 2

- Open cut trench method with sheeting and well point
  Excavation depth: 2.0m
  CIP 400-700mm diameter

The installation of sewer pipes should be carried out using the following process:

- Excavation
- Placement of sheet pile
- Installation of well point machine
- Installation of pipe lines
- Sand fill of pipes
- Backfill of excavated soil
- Pavement

4) Major Equipment Required

Major construction equipment for the installation of the sewer pipes is described as follows.

- Excavation work

Backhoe	Excavation work
Dump truck	Removal of surplus soil

- Pipe laying work

Wrecker	Pipe lifting

- Backfill

Rammer	Sand bottoming roll
Roller	Sand base rolling

- Removal of pavement

Cutter	Pavement cutting
Pneumatic Compressor	Removal of concrete pavement
Pneumatic Drill	ditto

- Dewatering

Submersible pump	Dewatering
Well point machine	Dewatering
Pavement machine	Pavement restoration
Truck	Transportation

(2) Construction of Pumping Stations

1) Preparatory Work

In order to ascertain site conditions such as existing access road, drainage, underground water pipes and utilities, etc, site surveys should be carried out before the construction of the pumping stations.

2) Construction methods

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

The construction should be carried out using the following process.

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

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

3) Major Equipment Required

Major construction equipment for the construction of pumping stations is described as follows.

- Earthworks

Backhoe	Excavation work
Bulldozer	Removal of surplus soil
Dump truck	Transport of surplus soil
Tractor shovel	Earth leveling
- Well point	
Well point machine	Groundwater level lowering
- Foundation pile driving	
Pile driver	Piling work
Diesel hammer	Piling work
- Foundation work	
Backhoe	Excavation work
Bulldozer	Leveling of earth
Dump truck	Transport of soil and sand
Tractor shovel	Leveling of earth
Concrete pump car	Concrete placement
Submersible pump	Dewatering work
- Concrete work	
Crawler crane	Transport of materials
Truck	Transport of materials
Concrete pump car	Concrete placement
Transit mixer	Transport of concrete
Vibrator	Concrete placement
Air compressor	Cleaning of form
Electric welding machine	Welding of reinforcing bar
- Temporary work	
Crawler crane	Transport of material
Vibro hammer	placement of sheet pile
Backhoe	Excavation work
Bulldozer	Grading of earth
Dump Truck	Transport of soil and sand

(3) Construction of Sewage Treatment Facilities

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

1) Preparatory Work

In order to ascertain the site conditions such as existing access road, drainage, underground water pipes and utilities, etc, site surveys should be carried out before the construction.

2) Construction Methods

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

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

Main Civil Work Items for Sewage Treatment Facilities

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

Note: Construction/rehabilitation of the access roads is required in the following wastewater treatment plants.

Janga:

- Improvement of existing road
- Widening and paving are needed

Boa Viagem

- Existing road can be used after paving

Prazeres

- New construction of access road is required

Curcurana

- Improvement of existing road

-Widening of existing road

Foundation type applied in each treatment facilities is as followed

- Conceisao: Spread type foundation
- Janga: Replacement of sand
- Cabanga: Pile foundation (pile length: 25m)
- Boa Biagem: Spread type foundation
- Cordeiro: Pile foundation (pile length: 30m)
- Prazeres: Spread foundation
- Curcurana: Pile foundation (Pile length: 9m)

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

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

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

3) Major Equipment Required

The major construction equipment for the construction of the sewage treatment facilities is described as follows.

- Earthworks

Backhoe	Excavation work
Bulldozer	Removal of surplus soil
Dump truck	Transport of surplus soil
Tractor shovel	Earth leveling
Well point machine	Groundwater level lowering

- Foundation pile driving

Pile driver	Piling work
Diesel hammer	Piling work
Crawler crane	Transport of pile

- Foundation work

Backhoe	Excavation work
Bulldozer	Leveling of earth
Dump truck	Transport of soil and sand
Tractor shovel	Leveling of earth
Concrete pump car	Concrete placement
Submersible pump	Dewatering work

- Concrete work

Crawler crane	Transport of materials
Truck	Transport of materials
Concrete pump car	Concrete placement
Transit mixer	Transport of concrete
Vibrator	Concrete placement
Air compressor	Cleaning of form
Electric welding machine	Welding of reinforcing bar

- Temporary work

Crawler crane	Transport of material
Vibro hammer	Steel sheet piling
Backhoe	Excavation work
Bulldozer	Grading of earth
Dump Truck	Transport of soil and sand

2. CONSTRUCTION SCHEDULE

2.1 Annual Workable Days

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

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

2.2 Workable Time

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

2.3 Required Construction Period and Sequence of Works

Required construction periods were estimated based on the construction volume and the working days and work time assumptions for each type of construction works/structures.

The sewerage facilities of the Conceisao, Cordeiro and Curcurana are planned to be constructed during the three years period from 2004 to 2006, while that of Janga, cabanga, Boa Biagem and Prazeres will be constructed during four years period from 2004 to 2007. Required construction schedule for each sewerage system is presented in the following Table.

Construction Schedule of the project

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

3. COST ESTIMATE

3.1 Basis of Cost Estimate

The project cost is estimated under the following conditions.

(1) All the costs are expressed under the economic conditions that prevailed in July 2000.

(2) Exchange rate of currencies is US$1.00=R$1.80

(3) Project cost is not classified into foreign and local currency portions.

(4) Engineering services and government administration costs are assumed to be 10% of total construction cost each.

(5) Basic construction unit price data are derived from:

1) Service price list - COMPESA, June 2000

2) Construction services costs - PINI, June 2000

(6) Price inflation is not taken into account.

3.2 Component of Project Cost

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

The project cost consists of:

1) Construction cost,
   - Collection sewers
   - Pumping stations
   - Sewage treatment facilities

2) Land acquisition cost,

3) Procurement of O & M equipment

4) Engineering service cost,

5) Government administration cost, and

6) Physical contingencies

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

3.3 Basic Unit Cost

Basic unit cost of labor, material and equipment rental are shown in the following Table.

Unit Cost of Labors

Item	R$/hour	R$/month	Remarks
Engineer	15.30	3,375.00	220hours/month
Foreman	4.55	1,000.00	
Common Labor	2.34	514.80	
Mechanic	3.13	688.60	
Electrician	3.13	688.60	
Driver	5.27	1,158.75	
Carpenter	3.13	688.60	

Unit Cost of Materials

Item		Unit	Cost (R$)
Sand		m3	23.00
Soil		m3	10.00
Crushed stone		m3	14.00
Gravel		m3	33.00
Asphalt		m3	120.00
Ready mix concrete	FK90	m3	109.00
Ready mix concrete	FK200	m3	115.00
PVC pipe	D150 mm	m	10.00
PVC pipe	D200 mm	m	15.53
PVC pipe	D300 mm	m	27.53
PVC pipe	D350 mm	m	41.31
PVC pipe	D400 mm	m	55.21
Reinforced concrete pipe	D400 mm	m	30.00
Reinforced concrete pipe	D500 mm	m	35.00
Reinforced concrete pipe	D600 mm	m	40.00
Reinforced concrete pipe	D800 mm	m	60.00
Reinforced concrete pipe	D 900mm	m	73.00
Reinforced concrete pipe	D1000mm	m	80.00
Reinforced concrete pipe	D1200mm	m	118.00
CIP pipe	D400 mm	m	131.00
CIP pipe	D500 mm	m	181.00
CIP pipe	D600 mm	m	236.00

Rental Cost of Equipment

Items		Unit	Unit cost	Remarks
Dump truck	10t	R$/hr	30.00	
Flat body truck		R$/hr	12.00	
Truck		R$/hr	31.00	
Truck crane	20t	R$/hr	63.00	
Vibro Hammer		R$/hr	5.00	
Mechanical shovel		R$/hr	41.00	
Bulldozer	11t	R$/hr	39.00	
Backhoe	0.6m3	R$/hr	25.00	
Concrete mixer	0.7m3	R$/hr	4.00	
Generator 20KVA		R$/day	26.00	
Compressor 35HP		R$/hr	15.00	
Drainage pump 4"		R$/hr	1.00	
Well Point		R$/day	130.00	

3.4 Unit Construction Cost

(1) Sewer Pipes

The branch and trunk sewer pipes with diameter 150- 400 mm are polyvinyl chloride (PVC) pipe for gravity flow. For pressure flow, diameter 100-300 mm of PVC will be used. And trunk sewers with diameter 500-1200 mm are of reinforced concrete (RC) pipe for gravity flow. The cast iron pipes (CIP) with diameter 350-700 mm are used for pressure flow.

Unit construction cost (construction cost per meter) of the sewer pipes varies according to a diameter of pipe and earth covering depth of pipe laying. These were estimated based on the following work items.

- Pin setting
- Safety management
- Demolition of the paving
- Excavation
- Sheet pile
- Well point
- Pipe installation
- Backfill
- Restoration of Paving
- Pipe material
- Disposal of surplus soil
- Test
- Completion drawing

- Miscellaneous

The unit construction cost by pipe diameter and by earth covering depth is tabulated as follows.

Unit Construction Cost of Sewers

Trunk Swers (Unit:R$/m)

Pipe materials	Earth covering (m)				Remarks
	Less than 2m	2m-4m	4m-6m	More than 6m	
PVC D100	138	285	510	592	
PVC D150	145	291	517	598	
PVC D200	159	301	530	610	
PVC D250	169	322	554	637	
PVC D300	191	345	579	663	
PVC D350	225	381	628	715	
PVC D400	249	407	657	749	
CIP D350	267	425	654	738	
CIP D400	317	476	711	816	
CIP D450	340	501	737	844	
CIP D500	376	549	763	848	
CIP D600	455	615	860	952	
CIP D700	563	725	976	1,069	
RC D500	194	355	538	694	
RC D600	208	372	557	718	
RC D700	237	402	590	756	
RC D800	248	415	607	777	
RC D900	272	442	636	811	
RC D1000	293	474	661	847	
RC D1200	358	535	735	925	
RC D1500	473	658	865	1,069	

Branches and Collectors

Pipe materials	Earth covering (m)				Remarks
	1.2m	1.5m	2.5m		
PVC D150	45	54	138		
PVC D200	50	59	151		
PVC D250	63	76	159		

(2) Pumping Stations

Unit construction cost (construction cost per station) of pumping station changes according to the type of the civil structure, pump capacity, construction method, excavation depth and so on. It includes civil work, mechanical & electrical equipment, building and temporary work. Main work items of civil work are excavation, backfill, disposal of surplus soil casting in place of reinforced concrete and temporary work; sheeting, installation of well point and dewaterting.

(3) Sewage Treatment Facilities

The construction cost for each sewage treatment facilities was estimated by each construction items /structures. The main work items of civil work are of excavation, backfill, embankment, disposal of surplus soil, casting in place of reinforced concrete, driving pre-cast concrete pile and temporary work; sheeting, installation of well point and dewatering. The structure of each sewage treatment facilities includes some of the following items.

1) Civil work

- Sewerage distribution well
- Grit chamber
- Influence well
- RAFA reactor
- Aerated lagoon
- Polishing pond
- Bio-filter
- Re-circulation tank
- Sedimentation tank
- Disinfection tank
- Sludge thicker
- Sludge drying bed
- Treated sewage discharge pipe
- Out fall

2) Building

3) Ground Leveling, etc.

4) Mechanical equipment and Electrical instrument

3.5 Construction cost

(1) Sewers

1) Branches and collectors

The construction cost of branch sewers and collectors of each system is estimated at R$ 89 million. The construction cost of branches and collectors is shown in the following Table. Details, see Table G.3-1.

Construction Cost of Branches and Collectors

(Unit:R$1000)

	Collector	Branch	Total
Conceidao	3,572	3,493	7,065
Janga	13,736	13,432	27,168
Cabanga	6,100	5,927	12,027
Boa Viage	5,460	5,305	10,765
Cordeiro	4,247	4,167	8,414
Prezeres	6,998	6,800	13,798
Curcurana	5,092	4,948	10,040
Total	**45,205**	**44,072**	**89,277**

2) Construction cost of pressure sewers

The construction costs of expansion and rehabilitation works for the pressure sewers are estimated at R$ 16.0 million and R$ 1.4 million, respectively. The construction cost of pressure sewers for each system is presented as follows: Details, see Table G.3-2.

Construction Cost of Pressure Sewers

(Unit: R$1000)

	Trunk Sewer	Rehabilitation Sewer	Total
Conceicao	282		282
Janga	7,582	677	8,259
Cabanga	1,915	237	2,152
Boa Viagem	1,580		1,580
Cordeiro	513		513
Prazeres	3,124	470	3,594
Curcurana	1,024		1,024
Total	16,020	1,384	17,404

3) Trunk Sewers

The construction costs of expansion and rehabilitation works for the trunk sewers are estimated at R$ 32.0 million and R$ 2.4 million, respectively. The breakdowns are as follows: Details see Table G.3-3.

Construction Cost of Trunk Sewers

(Unit: R$1000)

	Trunk	Pipe Jacking	Subtotal	Rehabilitatio	Total
Conceicao	2,458.0	135.0	2,593.0	0.0	**2,593.0**
Janga	5,969.0	270.0	6,239.0	0.0	**6,239.0**
Cabanga	1,507.0	180.0	1,687.0	2,377.0	**4,064.0**
Boa Viagem	5,836.0	855.0	6,691.0	0.0	**6,691.0**
Cordeiro	3,676.0	405.0	4,081.0	0.0	**4,081.0**
Prazeres	6,400.0	315.0	6,715.0	0.0	**6,715.0**
Curcurana	3,646.0	405.0	4,051.0	0.0	**4,051.0**
Total	**29,492.0**	**2,565.0**	**32,057.0**	**2,377.0**	**34,434.0**

(2) Pumping Stations

The 43 units of pumping stations for the expansion works will be constructed in the project areas; these are of 4 sets for Conceiciao, 5 sets for Janga, 6 sets for Cababga, 5 sets for Boa Biagem, 6 sets for Cordeiro, 5 sets for Prazeres and 12 sets for Curcrana. The construction cost of pumping stations for the expansion and rehabilitation works is estimated at R$ 9.6 million and 7.0 million, respectively. The breakdown of each construction cost is shown as follows: Details, see Tables G.3-4 and G.3-5.

Construction Cost of Pumping Stations

(Unit: R$1,000)

Systems	Expansion				Rehabilitation			Total
	Civil Work	M & E	Controll System	Subtotal	Civil Works	M & E	Subtotal	
Conceicao	208.0	246.6	48.0	503	37.1	37.1	74.2	577
Janga	526.8	765.2	810.0	2,102	704.7	704.7	1409.4	3,511
Cabanga	272.4	330.0	720.0	1,322	2,533.4	2,533.4	5066.8	6,389
Boa Viage	689.8	1020.1	79.0	1,789	0.0	0.0	0	1,789
Cordeiro	363.7	481.8	64.0	910	104.9	104.9	209.8	1,120
Prazeres	526.8	954.7	73.0	1,555	133.5	133.5	267	1,822
Curcurana	583.3	754.2	70.0	1,408	0.0	0.0	0	1,408
Total	3171.0	4553.0	1864.0	9,589	3,513.6	3,513.6	7027.2	16,616

(3) Sewage Treatment Facilities

The plants for the expansion works for seven sewerage systems, and two existing treatment plants (Janga and Cabanga) for the rehabilitation works were planned to be implemented. The construction cost of the treatment facilities for the expansion and rehabilitation works are estimated at R$ 68.7 million. Details, see Tables G.3-6 to G.3-14.

Construction Cost of Treatment Facilities

(R$1000)

System	Expansion						Rehabili.	Total
	Civil Work	Buildings	Ground leveling	Green Belts	M & E facilitiess	Subtotal		
Conceisao	3,234	1,139	660	25	560	5,618		5,618
Janga	6,922	1,659	2,746	10	1,210	12,547	959	13,506
Cabanga	7,768	2,040	552	5	3,290	13,655	1,478	15,133
Boa Viagem	3,617	1,452	820	15	1,190	7,094		7,094
Cordeiro	3,623	1,392	599	14	1,300	6,928		6,928
Prazeres	6,820	1,515	846	20	1,370	10,571		10,571
Curcurana	4,790	1,316	2,670	13	1,050	9,839		9,839
Total	36,774	10,513	8,893	102	9,970	66,252	2,437	68,689

(4) Total Construction Cost

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

Expansion (Unit :R$1000)

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

Rehabilitation (Unit :R$1000)

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

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

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

3.6 Land Acquisition and Compensation Cost

The required land acquisition of the project consists of the areas of the sewage treatment facilities, pumping stations and access roads. The compensation for house relocations in the area of treatment plant in Boa Viagem is due required for the implementation of the project. The land acquisition and compensation cost of the project is estimated at R$ 45.5 as following Table. Details, see Tables G.3-15 and G.3-16.

Land Acquisition and Compensation Cost

Systems	Treatment Facilities	Pumping St..	Subtotal	Road	House Relocation	Total
Conceicao	3,280	16	3,296			3,296
Janga		48	48			48
Cabanga		480	480			480
Boa Viagem	23,142	434	23,576		675	24,251
Cordeiro	1,400	27	1,427			1,427
Prazeres	14,520	143	14,663	336		14,999
Curcurana	950	11	961	63		1,024
Total	43,292	1159	44,451	399	675	45,525

3.7 Procurement cost of O & M Equipment

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

Procurement Cost of O & M Equipment

(Unit: R$1000)

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

3.8 Project Cost

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

Project Cost

(Unit: R$1000)

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

3.9 Implementation Schedule

The project will be completed within 6 years from 2002 to 2007. The detailed design will be completed with in 12 months in the year of 2002. The construction work will be commenced in 2004 and be completed in 2007 with in a net construction period of 60 month. Breakdown Disbursement Schedule of the Project is show in Table G.3-17.

3.10 O & M Cost

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

3.11 Disbursement Schedule of O & M Cost

The annual O & M cost of Conceisa, Cordeiro and Curcrana will be disbursed from the year 2007, while other four systems will be disbursed from the year 2008 after construction of expansion sewerage systems. The annual O & M cost in the year 2007 was estimated at 3.9 million. The annual O & M cost of all the systems from the year 2008 was estimated at 13.6 million. The disbursement schedule and a amount of each system is as follows.

Disbursement Schedule of O & M Cost

(Unit: R$1000)

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

Construction Cost 226,420

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

Table G.1-1 Comparative Table of Cut and Cover Tunneling Method

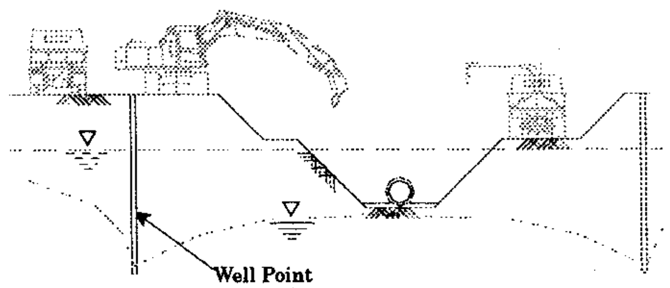
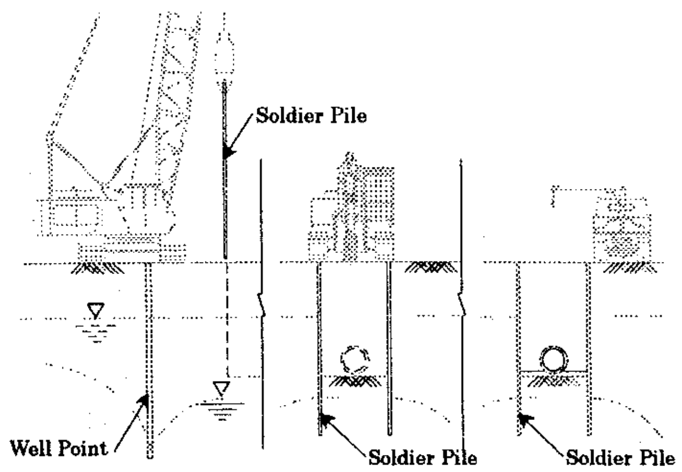
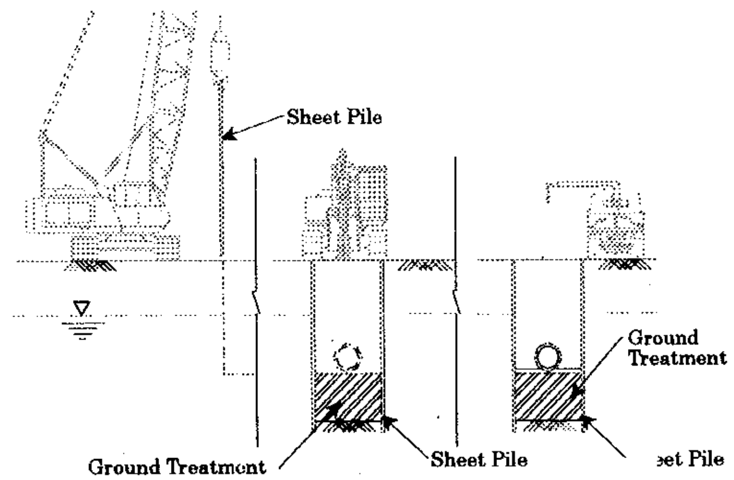
	Open Cut Method	Earth Retaining Method	
		Soldier Piles and Lining Method	Sheet Piles Method
General figure			
Execution process	1. Decide on the slope according to the condition of the ground. 2. Excavate it to the fixed depth to a fixed depth. 3. Install a pipe in the ground. 4. Backfill.	1. Install soldier piles at intervals appropriate for ground condition. 2. Install a lining between soldier piles at the same as excavating. 3. Install a pipe in the ground. 4. Backfill.	1. Install sheet piles in the ground. 2. Install a pipe in the ground. 3. Backfill.
Characteristics	· This method isn't suitable for soft ground. · Special material is not be necessary for excavating. · Measures are necessary to prevent groundwater from a leaking from slope excavated. · The width of the excavation is large due to soil.	· This method can be applied in soft ground. · A lining unable to retain the water. · The interval between soldier piles must be small when the ground is very soft. · A pile driving machine is necessary.	· This method can be applied in soft ground as well. · Measures to deal with ground water are unnecessary. because sheet piling can retain water.. · A pile driving machine is necessary.
Site	The site area with this method is the largest of all methods because the width of the excavation of is large.	The site area with this method is smaller than with open cut method because the excavation width is small.	The site space is smaller than with the open cut method because the excavation width is small.
Adaptability to the soil concerned	The excavation slope is gentle because this ground is clayey-silty sand. The N value of the soil is about 10. An auxiliary construction is necessary because the ground water level is high.	As the ground becomes softer the pile interval is reduced. An auxiliary construction is necessary when the ground water level is high.	An auxiliary measure is necessary when the ground water level is high.
Auxiliary construction	Required when special measures are needed to deal with drainage.		The trench will be drained where necessity.
Influence on the environment	Settlement with this method is larger than which other methods.	Settlement with this method is larger than with sheet piling on, because the wall stiffness is lower.	Subsidence by this method is smaller than with the soldier pile method. Also the wall stiffness of this method is higher.
Cost			
Evaluation	(A large auxiliary construction and large site area are necessary.)	(A large Auxiliary construction is necessary.)	

Table G.1-2 Comparative Table for Pipe Jacking Tunneling Method

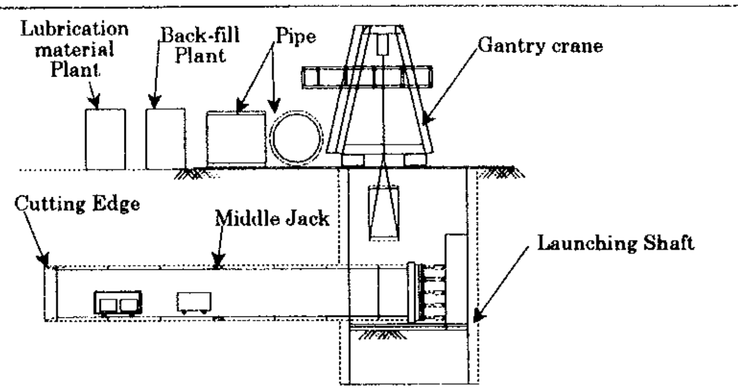
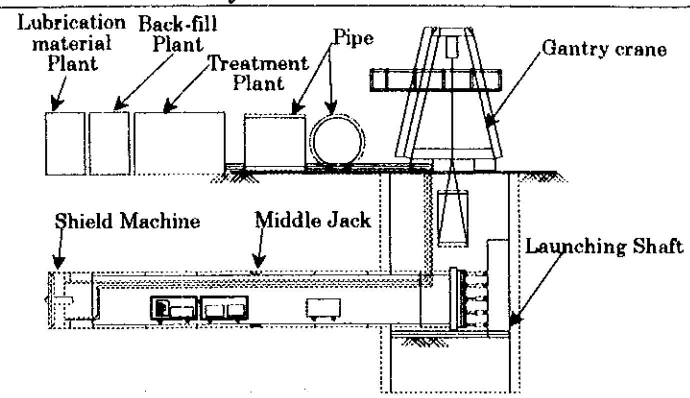
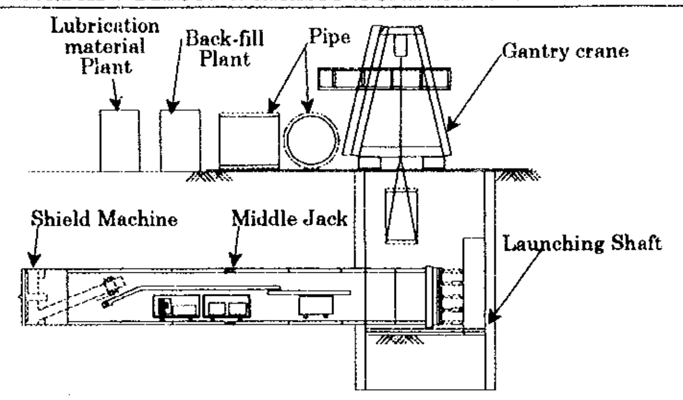
	Cutting Edge Type Pipe Jacking Method	Semi shield method	
		Slurry Semi Shield Method	Earth Presser Balance Semi Shield Method
Conceptual Figure of Method			
Outline of Method and Operation System	This method uses the cutting edge set on the front end of a reinforced concrete pipe which is thrust into the ground by the base jack located in the launching shaft. There is no support equipment for the face of ground in front of the cutting edge. Excavation is carried out by hand. Excavated soil is transported and mucked out by the trolley and the crane.	This method uses a shield machine, which does not have shield jacks, set on the front end of a reinforced concrete pipe and thrust into the ground by the base jack located in the launching shaft. The shield machine has a bulkhead between the face of ground and the machine inside. The cutter chamber between the cutter face and the bulkhead, is entirely filled with slurry. The excavated soil is mixed into slurry by the agitator and transported to the slurry treatment plant. The cutter head generally has a face plate with slits. The slurry consists of water and additive that can filter out and settle on the face to form an impervious layer. This layer then transfers the pressure of the support fluid to the ground.	This method uses a shield machine, which does not have shield jacks, set on the front end of a reinforced concrete pipe and thrust into the ground by the base jack located in the launching shaft. The shield machine has a bulkhead between the face of ground and the machine inside. The rotating cutter wheel at the front of shield machine scrapes off the ground that is pressed into the cutter chamber. At the same time, the equivalent amount of spoil is removed from the cutter chamber by the screw conveyor. The excavated soil is transported and mucked out by the trolley and the gantry crane. The cutter head is of the open type with cutter wheel spokes or semi-closed with a face plate. Excavated soil in the cutter chamber is agitated by the cutter wheel to give it for plastic fluidity and entirely filled in the cutter chamber to provide an earth pressure balance to the excavated face.
Adaptability to Ground Condition	Highly stable soil force ground soil (self-supporting) is required this method. However, the ground where the tunnels are driven mostly consists of loose clayey-silty sand layers. The N value of these layers is about 10. The ground water level appears 2.0m below the ground surface. The collapse of face ground is expected. When the ground condition is unstable and/or a large water inflow appears, the supplementary shield excavation is required.	The ground condition is shown in column to the left. It is certain that the impervious layer can be fully formed on the face. Therefore, this method is applicable to this ground. However, the face stability is very sensitive to the change of support pressure maintained by controlling the pumping rate of slurry into and out of the cutter chamber to the face stability. A significant fluctuation of face pressure is possible. when starting the slurry pumps and/or the slurry pipes are clogged. At the portion where the earth cover is small, the collapse of face ground caused by the fluctuation of face pressure would have the direct effect of ground settlement directly.	The ground condition is shown the first column. The support medium for face ground is the excavated material itself that required high viscosity. When there is fine content (silt and clay) , it is necessary to inject additives to generate the plastic fluidity of excavated soil and make it impervious. Face pressure is controlled by balancing the rate of advance of the shield machine and the rate of discharge of the excavated soil from the screw conveyor. Fluctuation of the face pressure is possible to when there is delay in the control of the screw conveyor. The effect of face instability is not as serious as it is for the slurry shield. Even large stress differences between earth/water pressures and the support pressure in the cutter chamber can result in only limited face deformation, because the stress in the excavated soil mass rise immediately.
Supplementary Methods	The soil improvement of the face ground is required. The tunnel section and along the tunnel or a compressed air tunnelling method must be used. A blow-out of compressed air is to be expected at the small earth cover portion.	Supplementary methods are not required.	Same as column to the left.
Environmental Impact	Because the open excavation is carried out at the front of the shield machine, the stress at the face ground is released completely. Therefore, a large settlement of the ground surface is expected.	The slurry pressure which forms an impervious layer supports the face ground. Settlement due to release of the stress at the face ground is small.	The face ground is supported by the excavated soil in the cutter chamber. Settlement due to release of the stress at the face ground is small.
Plants and Yards	The gantry crane for mucking out and moving the concrete pipes and other materials is located around the shaft area. A pipe storage yard and excavation soil pits are required in the stock yard. The area of stock yard for this method is the smallest.	An area for a slurry treatment plant is be required in addition to an area for the open type shield method. The stock yard for this method is the largest.	When an additive injection is necessary, an area for additive plants is required in addition to the area for the open type shield method. The stock yard area for this method is smaller than slurry shield method.
Cost			
Assessment	(Supplementary methods are required.)	(A large treatment plant is necessary.)	

Table G.3-1 Breakdown of Construction Cost for Branch and Collector

	Pipe material	Conceicao				Janga			
		1.2	1.5	2.5	Total	1.2	1.5	2.5	Total
Collector	150 PVC	449		1,377	1,826	1,727		5,296	7,023
	200 PVC		118	703	821		453	2,704	3,157
	250 PVC		79	846	925		302	3,254	3,556
	Sub total	449	196	2,927	3,572	1,727	755	11,254	13,736
Branch	150 PVC	3,493			3,493	13,432			13,432
Total		3,942	196	2,927	7,065	15,159	755	11,254	27,168

	Pipe material	Cabanga				Boa Viagem			
		1.2	1.5	2.5	Total	1.2	1.5	2.5	Total
Collector	150 PVC	762		2,337	3,099	682		2,092	2,774
	200 PVC		200	1,193	1,393		179	1,068	1,247
	250 PVC		172	1,436	1,608		154	1,285	1,439
	Sub total	762	371	4,966	6,100	682	332	4,445	5,460
Branch	150 PVC	5,927			5,927	5,305			5,305
Total	**Total**	6,689	371	4,966	12,027	5,987	332	4,445	10,765

	Pipe material	Cordeiro				Prezeres			
		1.2	1.5	2.5	Total	1.2	1.5	2.5	Total
Collector	150 PVC	536		1,643	2,179	874		2,681	3,556
	200 PVC		119	839	958		229	1,369	1,598
	250 PVC		100	1,010	1,110		197	1,648	1,844
	Sub total	536	219	3,492	4,247	874	426	5,698	6,998
Branch	150 PVC	4,167			4,167	6,800			6,800
Total	**Total**	4,703		3,492	8,414	7,675	426	5,698	13,799

	Pipe material	Curcrana			
		1.2	1.5	2.5	Total
Collector	150 PVC	636		1,951	2,587
	200 PVC		167	996	1,163
	250 PVC		143	1,199	1,342
	Sub total	636	310	4,146	5,092
Branch	150 PVC	4,948			4,948
Total	**Total**	5,584	310	4,146	10,040

Table G.3-2 Breakdown of Construction Cost for Pressure Sewer Pipes (1/2)

Pipe material		Conceicao					Janga				
		2.0 >	2.1~4.0	4.1~6.0	6.1 <	Total	2.0 >	2.1~4.0	4.1~6.0	6.1 <	Total
100	PVC	36				36					
150	PVC						44				44
200	PVC	114				114					
250	PVC						172				172
300	PVC	132				132					
350	CIP										
400	CIP										
450	CIP										
500	CIP						2,060				2,060
600	CIP						1,274				1,274
700	CIP						4,032				
Sub total		282				282	7,582				7,582

		Cabanga					Boa Viagem				
		2.0 >	2.1~4.0	4.1~6.0	6.1 <	Total	2.0 >	2.1~4.0	4.1~6.0	6.1 <	Total
100	PVC	35				35					
150	PVC	153				153	113				113
200	PVC	74				74	16				16
250	PVC	74				74					
300	PVC										
350	CIP	320				320	291				291
400	CIP										
450	CIP										
500	CIP	1,260				1,260					
600	CIP						1,160				1,160
700	CIP										
Sub total		1,915				1,915	1,580				1,580

		Cordeiro					Prezeres				
		2.0 >	2.1~4.0	4.1~6.0	6.1 <	Total	2.0 >	2.1~4.0	4.1~6.0	6.1 <	Total
100	PVC										
150	PVC										
200	PVC										
250	PVC										
300	PVC	260				260	143				143
350	CIP										
400	CIP						159				159
450	CIP	253				253					
500	CIP						1,322				1,322
600	CIP										
700	CIP						1,501				1,501
Sub total		513				513	3,124				3,124

Table G.3-2 Breakdown of Construction Cost for Pressure Sewer Pipes (2/2)

		Curcrana				
		2.0 >	2.1～4.0	4.1～6.0	6.1 <	Total
100	PVC					
150	PVC	66				66
200	PVC	241				241
250	PVC	299				299
300	PVC	418				418
350	CIP					
400	CIP					
450	CIP					
500	CIP					
600	CIP					
700	CIP					
Sub total		1,024				1,024

G.3-3 Breakdown of Construction Cost for Tunk Sewers (1/2)

		Conceisao					Janga				
		2.0 >	2.1~4.0	4.1~6.0	6.1 <	Total	2.0 >	2.1~4.0	4.1~6.0	6.1 <	Total
300	PVC		117.3	23.16	132.6	273.06	83.085	307.74	390.825		781.65
400	PVC	217	334		262	813	218	1,311	1,518	494	3,540
500	RC	287	138	624	21	1,070		37	557	76	670
600	RC							30	162		191
700	RC	79		223		302			384	401	785
800	RC										
900	RC										
1000	RC										
1100	RC										
1200	RC										
1500	RC										
Sub total		583	589	870	416	2,458	301	1,685	3,011	971	5,969

		Cabanga					Boa Viagem				
		2.0 >	2.1~4.0	4.1~6.0	6.1 <	Total	2.0 >	2.1~4.0	4.1~6.0	6.1 <	Total
300	PVC			952.455		952.455	255.94	703.8	929.295		1889.04
400	PVC			509	45	554	375	411	230		1,016
500	RC						106	284	288		678
600	RC						137	195	407		739
700	RC						201	28			229
800	RC						335	365	367		1,067
900	RC										
1000	RC								218		218
1100	RC										
1200	RC										
1500	RC										
Sub total				1,462	45	1,507	1,409	1,987	2,439		5,836

		Cordeiro					Prezeres				
		2.0 >	2.1~4.0	4.1~6.0	6.1 <	Total	2.0 >	2.1~4.0	4.1~6.0	6.1 <	Total
300	PVC	141	29.325	393.72	79.56	643.945	316.105	389.85	636.9		1342.86
400	PVC	553	183	1,271	180	2,187	264	645	884		1,793
500	RC	58	99	151	42	350	103		516		619
600	RC	125			180	304	95		437		532
700	RC		112			112			128		128
800	RC			61		61			413		413
900	RC										
1000	RC		19			19		372	33		405
1100	RC										
1200	RC							86	562		648
1500	RC								519		519
Sub total		877	442	1,876	480	3,676	778	1,493	4,129		6,400

G.3-3 Breakdown of Construction Cost for Tunk Sewers (2/2)

		Curcrana				
		2.0 >	2.1～4.0	4.1～6.0	6.1 <	Total
300	PVC	117	281.175	347.4		746.04
400	PVC	95	350		202	647
500	RC	223	122			346
600	RC		208	125		334
700	RC	144	355	354		852
800	RC	269	83	91		443
900	RC					
1000	RC	271				271
1100	RC					
1200	RC	7				7
1500	RC					
Sub total		1,126	1,400	917	202	3,646

Table G.3-4 Construction Cost of Pumping Stations

Sewerage System	Pump Type	Manhole Type P/S	Simplified Type(I) P/S	Simplified Type(II) P/S	Standard Type(I) P/S	Standard Type(II) P/S	Total
	Unit Cost	45.4	71.8	83.9	232.6	268.2	
Conceicao	Quantities(Unit	3	1	0	0	0	4
	Cost	136.2	71.8	0.0	0.0	0.0	208.0
Janga	Quantities(Unit	2	0	2	0	1	5
	Cost	90.8	0.0	167.8	0.0	268.2	526.8
Cabanga	Quantities(Unit	6	0	0	0	0	6
	Cost	272.4	0.0	0.0	0.0	0.0	272.4
Boa Viagem	Quantities(Unit	1	2	0	1	1	5
	Cost	45.4	143.6	0.0	232.6	268.2	689.8
Cordeiro	Quantities(Unit	3	2	1	0	0	6
	Cost	136.2	143.6	83.9	0.0	0.0	363.7
Prazeres	Quantities(Unit	2	0	2	0	1	5.0
	Cost	90.8	0.0	167.8	0.0	268.2	526.8
Curcurana	Quantities(Unit	11	0	1	0	0	12.0
	Cost	499.4	0.0	83.9	0.0	0.0	583.3
Total	Quantities(Unit	28.0	5	6	1	3	43.0
	Cost	1271.2	359.0	503.4	232.6	804.6	3170.8

P/S : Pumping Station

Table G.3-5 Breakdown of Construction Cost of Pumping Stations (1/2)

Type 1: Manhole type

Items	Units	Quantities	Unit cost	Cost	Remarks
(1) Civil work					
1) Excavation	m3	100	4.36	0.4	
2) Backfill	m3	74	8.86	0.7	
3) Disposal of surplus soil	m3	27	10.2	0.3	
4) Reinforced Concrete	m3	9.8	553.88	5.4	
5) Leveling concrete	m3	1.4	116.56	0.2	
(2) Temporary work					
1) H pile 10"x4" 5/8	m	130	60	7.8	
2) Lumber 2"x10"	m2	110	48	5.3	
3) Installation of pump	set	2	1000	2.0	
4) Well point period	month	6	3900	23.4	3 x 2 sets
Total				45.4	

Type 2: Simplyfied type(1)

Items	Unit	Quantities	Unit cost	Cost	Remarks
(1) Civil work					
1) Excavation	m3	315	4.36	1.4	
2) Backfill	m3	202	8.86	1.8	
3) Disposal of surplus soil	m3	113	10.20	1.2	
4) Reinforced Concrete	m3	47	553.88	26.0	
5) Leveling concrete	m3	3.7	116.56	0.4	
(2) Temporary work					
1) H pile 10"x4" 5/8	m	264	60.00	15.8	
2) Lumber 2"x10"	m2	218	48.00	10.5	
3) Installation of pump	set	3	1,000.00	3.0	
4) Well point period	month	3	3,900.00	11.7	
Total				71.8	

Type 3: Simplyfied type(2)

Items	Units	Quantities	Unit cost	Cost	Remarks
(1) Civil work					
1) Excavation	m3	390	4.36	1.7	
2) Backfill	m3	230	8.86	2.0	
3) Disposal of surplus soil	m3	160	10.20	1.6	
4) Reinforced Concrete	m3	60	553.88	33.2	
5) Leveling concrete	m3	4.5	116.56	0.5	
(2) Temporary work				0.0	
1) H pile 10"x4" 5/8	m	288	60.00	17.3	
2) Lumber 2"x10"	m2	245	48.00	11.8	
3) Installation of pump	set	4	1,000.00	4.0	
4) Well point period	month	3	3,900.00	11.7	
Total				83.9	

Table G.3-5 Breakdown of Construction Cost of Pumping Stations (2/2)

Type 4: Standard type(1)

Item	Unit	Quantities	Unit cost(R$)	Cost(1000R$)	Remarks
(1) Civil work					
1) Excavation	m3	790	4.36	3.4	
2) Backfill	m3	280	8.86	2.5	
3) Disposal of surplus soil	m3	520	10.20	5.3	
4) Reinforced Concrete	m3	210	553.88	116.3	
5) Leveling concrete	m3	12.8	116.56	1.5	
(2) Temporary work					
1) H pile 10"x4" 5/8	m	522	60.00	31.3	
2) Lumber 2"x10"	m2	450	48.00	21.6	
3) Installation of pump	set	3	1,000.00	3.0	
4) Well point period	month	4	3,900.00	15.6	
(3) Building					
1) Pump Room	m2	40	800	32.0	RC
Total				232.6	

Type 5: Standard type(2)

Item	Unit	Quantities	Unit cost	Cost	Remarks
(1) Civil work					
1) Excavation	m3	869	4.36	3.8	
2) Backfill	m3	308	8.86	2.7	
3) Disposal of surplus soil	m3	561	10.20	5.7	
4) Reinforced Concrete	m3	231	553.88	127.9	
5) Leveling concrete	m3	14	116.56	1.6	
(2) Temporary work					
1) H pile 10"x4" 5/8	m	580	60.00	34.8	
2) Lumber 2"x10"	m2	500	48.00	24.0	
3) Installation of pump	set	4	1,000.00	4.0	
4) Well point period	month	4	3,900.00	15.6	
(3) Building					
1) Pump Room	m2	60	800	48.0	RC
Total				268.2	

Table G.3-6 Breakdown of Rehabilitation Cost of Treatment Facilities (Janga)

(Unit:R$1000)

No.	Item	Rehabilitation Plan	Quantity	Unit Cost	Total
1	Inflow Well/ Regulator	B	1	1,500	1.50
2	Automatic Bar Screen Unit with Exhaust Fa	B	1	4,000	4.00
3	Inflow Pumping Station	-	-	-	-
	1) Pumps & Motors	A	5	0	0.00
	2) Valves & Gates	A	20	0	0.00
	3) Operation Panels	A	1	0	0.00
	4) Pipes	A	5	0	0.00
4	Grit Chamber	-	-	-	-
	1) Gates	B	2	5,000	10.00
	2) Guide Vanes	B	1	4,000	4.00
	3) Grit Collector	-	1	16,000	16.00
	4) Grit Helical Pump	B	1	13,000	13.00
	5) Other Equipment/Structures	B			
5	Distributor	Not used for this project		-	-
6	Sedimentation Unit No.1 to No.4	Not used for this project. A cost to remove them			
	1) Sludge Collector	to be considered.		-	-
	2) Turning Unit and accessaries	-	-	-	-
	3) Electrical	-	-	-	-
	4) Other Equipment/Structures	-	-	-	-
7	Digester No.1 & No.2	-	-	-	-
	1) Recirculation Pump (Suction & Deliver	B	2	23,100	46.20
	2) Motor	B	2	4,600	9.20
	3) Piping (20meter)	C	20	300	6.00
8	Valve 400mmdia	C	2	3,000	6.00
	Valve 450mmdia	C	2	3,500	7.00
	Check Valve 400 mmdia	C	2	3,800	7.60
9	Crude Mud Well	Not used for this project. A cost to remove them			
	1) Pumps & Motors	to be considered.		-	-
	2) Unloading Connection	-	-	-	-
	3) Supporting Guide Pipes	-	-	-	-
	4) W.Level Regulators	-	-	-	-
10	Chain Block	C	1	300	0.30
11	Steel Tripod for Chain Block	C	1	800	0.80
12	Operation Control Panel	B	1	17,000	17.00
13	Substation	B	1	12,000	12.00
14	Adjustment and Cleaning	B	1	17,000	17.00
15	Concrete Structureswells for the below	-	-	-	-
	1) Inflow Well	B1	1	2,000	2.00
	2) Automatic Bar Screen Well	B1	1	3,000	3.00
	3) Well & House of Inflow Pumping Stati	A	1	0	0.00
	4) Channel: Pumping Station to Grit Chan	A	1	0	0.00
	5) Grit Chamber Well	B1	1	3,200	3.20
	6) Sedimentation Wells No.1 & No.2	B1	2	5,000	10.00
	7) Purifier Wells No.1 No.2	B1	2	5,000	10.00
	8) Tanks & House of Digester No.1 & No.	B1	2	3,500	7.00
	9) Crude Mud Well	B1	1	2,500	2.50
	10) Gas Holder	B1	1	1,800	1.80
	11) Waste Gas Burner	B1	1	3,000	3.00
	12) Sludge Drying Bed (Removal)	B1	1	1,000	1.00
	13) Outflow Well	B1	1	2,000	2.00
	subtotal(1)				223.10
16	Labor Cost	B	-	-	33.47
	subtotal(2)	-	-	-	479.67
	Civil works				479.67
	Total				959.33

Note: A= Good in use
B= To be repaired, B1(Light), B2(Medium), B3(Heavy)
C= To be replaced

Table G.3-7 Breakdown of Rehabilitation Cost of Treatment Facilities (Cabanga)

R$1000

No.	Item	Rehabilitation Plan	Quantity	Unit Cost	Total
1	Inflow Unit	-	-	-	
	1) Inflow bend pipes 800mmdia	C	2	4,000	8.00
	2) Bar Screen	B	1	5,000	5.00
2	Inflow Meter	C	1	25,000	25.00
3	Grit Chamber	-	-	-	
	1) Grit Collector	B	1	14,000	14.00
	2) Grit Helical Pump	B	1	10,000	10.00
4	Aeration Unit	-	-	-	
	1) Aerator & Electrical	B	6	35,000	210.00
5	Sedimentation Unit	-	-	-	
	1) Sludge Collector	B	2	10,000	20.00
	2) Turning Unit	B	2	7,000	14.00
	3) Electrical	B	1	4,000	4.00
	4) Other Equipment/Structures	B	2	8,000	16.00
6	Sludge Return Helical Pump Unit	B	1	32,000	32.00
7	Valves and Gates	C	10	13,000	130.00
8	Operation Control Panel	B	1	25,000	25.00
9	Substation	B	1	45,000	45.00
10	Adjustment and Cleaning	B	1	15,000	15.00
11	Painting	B	1	4,000	4.00
12	Concrete Structure wells for the below	-	-	-	
	1) Inflow Well	B1	1	1,500	1.50
	2) Inflow Meter Well	B1	1	1,500	1.50
	3) Grit Chamber Well	B1	1	2,000	2.00
	4) Aeration Well	B1	2	5,000	10.00
	5) Sedimentation Well	B1	1	5,000	5.00
	6) Purifier Wells	B1	1	5,000	5.00
	7) Outflow Well	B1	1	1,500	1.50
	8) Control Center House	B	1	39,000	39.00
	Subtotal				642.50
13	Labor Cost		1		96.38
	Total				738.88
	Civil works				739
	Grand total				1,478

Note:

A= Good in use

B= To be repaired, B1(Light), B2(Medium), B3(Heavy)

C= To be replaced

G-3-8 Breakdown of Construction Cost for Conceicao STF (1/2)

(1) Conceicao (1/2)

1. Civil structures	Items	Unit	Quantities	Unit cost	Cost(R$1000)	Remarks
1.1 Grit chamber Influent well	1) Excavation	m3	1,200	2.18	2.6	
	2) Backfill	m3	320	8.86	2.8	
	3) Disposal of surplus soil	m3	880	10.2	9.0	
	4) Plain concrete	m3	30	116.56	3.5	
	5) Reinforced concrete(B200)	m3	271	553.88	150.1	
	6) H steel pile(10"x4"5/8")	m	451	80.00	36.1	Includes piling
	Breast boad(2"x10")	m2	340	48.00	16.3	
	7) Well piont installation	unit	2	1000.00	2.0	
	Well point machine lental	month	6	3900	23.4	3 m.x 2units
1.2 RAFA reactor	1) Reinforced concrete(B200)	m3	1,800	553.88	997.0	
1.3 Aerated lagoon	1) Excavation	m3	14,000	2.18	30.5	
	2) Embankment	m3	3,600	12.94	46.6	
	3) Disposal of surplus soil	m3	10,400	8.86	92.1	
	4) Mortar	m3	245	156.00	38.2	
1.4 Polishing pond	1) Excavation	m3	21,000	2.18	45.8	
	2) Embankment	m3	5,000	12.94	64.7	
	3) Disposal of surplus soil	m3	16,000	10.2	163.2	
	4) Mortar	m3	340	156.00	53.0	
1.5 Disinfection tank	1) Excavation	m3	200	2.18	0.4	
	2) Backfill	m3	150	8.86	1.3	
	3) Disposal of surplus soil	m3	50	10.2	0.5	
	4) Reinforced concrete(B200)	m3	30	553.88	16.6	
1.6 Sludge thickener	1) Excavation	m3	70	2.18	0.2	
	2) Backfill	m3	50	8.86	0.4	
	3) Disposal of surplus soil	m3	20	10.2	0.2	
	4) Reinforced concrete(B200)	m3	31	553.88	17.2	
1.7 Sludge drying bed	1) Excavation	m3	950	2.18	2.1	
	2) Disposal of surplus soil	m3	950	10.2	9.7	
	3) Reinforced concrete(B200)	m3	360	553.88	199.4	
1.8 Treated sewage discharge pipe	1) RC pipe D800	m	2,900	415	1203.5	
1.9 Treated sewage outfull	1) Reinforced concrete(B200)	m3	5	553.88	2.7	
	2) RC pileD250	m	16	50.00	0.8	
	3) Sandbag	m3	91	15.00	1.4	
	4) Waterproof sheet	m2	68	10.00	0.7	
Subtotal					3,234.0	

2. Buldings	Items	Unit	Quantities	Unit cost	Cost(R$1000)	Remarks
2.1 Influent pump roo	RC	m2	100	800	80.0	
2.2 Disinfection room	RC	m2	80	800	64.0	
2.3 Electrical room	Brick	m2	70	500	35.0	
2.4 Administration ro	RC	m2	800	1,200	960.0	
Subtotal					1,139.0	

G-3-8 Breakdown of Construction Cost for Conceicao STF (2/2)

(1) Conceicao (2/2)

3. Ground Leveling, d	Items	unit	Quantities	Unit cost	Cost(R$1000)	Remarks
3.1 Ground Leveling	1) Excavation	m3	20,140	2.18	43.9	
	2) Disposal of surplus soil	m3	20,140	10.20	205.4	
3.2 Inside road		m2	7,740	39.45	305.3	
3.3 Inside drain ditch	U type drain ditch					
	200x200 cast in place	m	2,480	30	74.4	
3.4 Fence and gate	Fence	m	1,170	27	31.6	
Subtotal					660.0	

4. Green Belt	Items	Unit	Quantities			Remarks
4.1 Green Belt		ha	2.5	10,000	25.0	
Subtotal					25.0	

5.Mechanical &Electrical	Items	Unit	Quantities			Remarks
	40% of civil related work cost				560.0	

Total					5,618.0	

Table G.3-9 Breakdown of Construction for Janga STF (1/2)

(2) Janga (1/2)

1. Civil structures	Items	Unit	Quantities	Unit cost	Cost	Remarks
1.1 Grit chamber Influent well	1) Excavation	m3	1,820	2	4.0	
	2) Backfill	m3	410	9	3.6	
	3) Disposal of surplus soil	m3	1,410	10	14.4	
	4) Plain concrete	m3	40	117	4.7	
	5) Reinforced concrete(B20	m3	390	554	216.0	
	6) H steel pile(10"x4"5/8")	m	562	80	45.0	Includes piling
	Breast boad(2"x10")	m2	410	48	19.7	
1.2 RAFA reactor	1) Reinforced concrete(B20	m3	4,000	554	2215.5	
1.3 Aerated lagoon	1) Excavation	m3	29,000	2	63.2	
	2) Embankment	m3	6,300	13	81.5	
	3) Disposal of surplus soil	m3	22,700	10	231.5	
	4) Mortar	m3	425	156	66.3	
1.4 Polishing pond	1) Excavation	m3	45,000	2	98.1	
	2) Embankment	m3	8,100	13	104.8	
	3) Disposal of surplus soil	m3	36,900	10	376.4	
	4) Mortar	m3	550	156	85.8	
1.5 Disinfection tank	1) Excavation	m3	310	2	0.7	
	2) Backfill	m3	190	9	1.7	
	3) Disposal of surplus soil	m3	120	10	1.2	
	4) Reinforced concrete(B20	m3	50	554	27.7	
1.6 Sludge thickener	1) Excavation	m3	350	2	0.8	
	2) Backfill	m3	160	9	1.4	
	3) Disposal of surplus soil	m3	190	9	1.7	
	4) Reinforced concrete(B20	m3	150	554	83.1	
1.7 Sludge drying bed	1) Excavation	m3	8,800	2	19.2	
	2) Disposal of surplus soil	m3	8,800	10	89.8	
	3) Reinforced concrete(B20	m3	3,300	554	1,828	
1.8 Treated sewage discharge pipe	1) RC pipe D1200	m	2,300	535	1,231	
					0.0	
1.9 Treated sewage outfull	1) Reinforced concrete(B20	m3	6	554	3.3	
	2) RC pileD250	m	16	50	0.8	
	3) Sandbag	m3	94	15	1.4	
	4) Waterproof sheet	m2	70	10	0.7	
Subtotal					6,922.0	

2. Buldings	Items	Unit	Quantities			Remarks
2.1 Influent pump room	RC	m2	180	800	144.0	
2.2 Disinfection room	RC	m2	150	800	120.0	
2.3 Electrical room	Brick	m2	150	500	75.0	
2.4 Administration room	RC	m2	1100	1,200	1320.0	
Subtotal					1,659	

Table G.3-9 Breakdown of Construction for Janga STF (2/2)

(2) Janga (2/2)

3. Ground Leveling, etc	Items	unit	Quantities			Remarks
3.1 Temporary access roa	W=6m,	m2	6,000	39.45	236.7	
3.2						
3.3 Ground Leveling	1) Excavation	m3	36,000	2.18	78.5	
	2) Embankment	m3	135,000	12.94	1,746.9	
3.4 Masonry retaining wa	1) Revetment	m2	2,150	60.00	129.0	
	2) Turf(Seed despersal)	m2	525	5.00	2.6	
3.5 Inside road		m2	10,320	39.45	407.1	
3.6 Inside drain ditch	U type drain ditch				0.0	
	200x200 cast in place	m	3,440	30.00	103.2	
3.7 Fence and gate	Fence	m	1,550	27.00	41.9	
Subtotal					2,745.9	

4. Green Belt	Items	Unit	Quantities			Remarks
4.1 Green Belt		ha	1.0	10,000	10.0	
Subtotal					10.0	

5.Mechanical &Electrical	Items	Unit	Quantities		Remarks
	40% of relted civil work cost			1,210.0	
Subtotal				1,210.0	

Total	12,547

Table G.3-10 Breakdown of Construction Cost for Cabanga STF (1/2)

(3) Cabanga (1/2)

1. Civil structures	Items	Unit	Quantities	Unit cost	Cost	Remarks
1.1 Transfer pump	1) Excavation	m3	400	2.18	0.9	
	2) Backfill	m3	260	8.86	2.3	
	3) Disposal of surplus soil	m3	140	10.20	1.4	
	4) Plain concrete	m3	6	116.56	0.7	
	5) Reinforced concrete(B20(	m3	55	553.88	30.5	
	6) PC pile D350	m	330	60.00	19.8	Includes pilin
1.2 RAFA reactor	1) Embankment	m3	8,000	12.94	103.5	
	2) Reinforced concrete(B20(	m3	6,500	553.88	3600.2	
	3) PC pileD350	m	5,220	60.00	313.2	
1.3 Bio-filter	1) Reinforced concrete(B20(	m3	3,200	553.88	1772.4	
	2) PC pileD350	m	8,532	60.00	511.9	
1.4 Recirculation tank	1) Excavation	m3	200	2.18	0.4	
	2) Backfill	m3	40	8.86	0.4	
	3) Plain concrete	m3	70	116.56	8.2	
	4) Reinforced concrete(B20(	m3	210	553.88	116.3	
	5) PC pileD350	m	594	60	35.6	
1.5 Sedimentation tank (Rectangular type)	1) Excavation	m3	11,000	2.18	24.0	
	2) Backfill	m3	7,700	8.86	68.2	
	3) Disposal of surplus soil	m3	3,300	10.20	33.7	
	4) Reinforced concrete(B20(	m3	1,250	553.88	692.4	
	5) PC pileD350	m	4,320	60	259.2	
1.6 Disinfection tank	1) Excavation	m3	400	2.18	0.9	
	2) Backfill	m3	230	8.86	2.0	
	3) Disposal of surplus soil	m3	170	10.20	1.7	
	4) Reinforced concrete(B20(	m3	70	553.88	38.8	
	5) PC pileD350	m	200	60	12.0	
1.7 Sludge thickener	1) Excavation	m3	280	2.18	0.6	
	2) Backfill	m3	140	8.86	1.2	
	3) Disposal of surplus soil	m3	140	10.20	1.4	
	4) Reinforced concrete(B20(	m3	121	553.88	67.0	
	5) PC pileD350	m	448	60	26.9	
1.8 Treated sewage discharge pipe	1) RC pipe D1000	m	50	293	14.7	
1.9 Treated sewage outfall	1) Reinforced concrete(B20(	m3	6	553.88	3.1	
	2) RC pileD250	m	16	50.00	0.8	
	3) sandbag	m3	93	15.00	1.4	
	4) Waterproof sheet	m2	69	10.00	0.7	
Subtotal					7,768	

2. Buldings	Items	Unit	Quantities	Unit cost	Cost	Remarks
2.1 Transfer pump roo	Brick	m2	70	500	35.0	
2.2 Recirculation pump	RC	m2	250	800	200.0	
2.3 Disinfection room	RC	m2	150	800	120.0	
2.4 Electrical room	Brick	m2	150	500	75.0	
2.5 Administration roo	RC	m2	1,300	1200	1560.0	
	PC pileD350	m	840	60	50	
Subtotal					2,040	

Table G.3-10 Breakdown of Construction Cost for Cabanga STF (2/2)

(3) Cabanga (2/2)

3. Ground Leveling, et	Items	unit	Quantities	Unit cost	Cost	Remarks
3.1 Demolishing	Concrete	m3	1160	160.16	185.8	
3.2 Ground Leveling	1) Excavation	m3	3200	2.18	7.0	
	2) Embankment	m3	5300	12.94	68.6	
3.5 Inside road		m2	4920	39.45	194.1	
3.6 Inside drain ditch	U type drain ditch					
	200x200 cast in place	m	1640	30	49.2	
3.7 Fence and gate	Fence	m	860	27	23.2	
3.8 River bank protection		m3	1600	15	24.0	
Subtotal					552	

4. Green Belt	Items	Unit	Quantities	Unit cost	Cost	Remarks
4.1 Green Belt		ha	0.50	10,000	5.0	
Subtotal					5.0	

5. Mechanical & electrical equipment	Items	Unit	Quantities		Remarks
	50% of related civil work cost			3,290	
Subtotal				3,290	
Total				13,655	

Table G.3-11 Breakdown of Construction Cost for Boa Viagem STF (1/2)

(4) Boa Viagem (1/2)

1. Civil structures	Items	Unit	Quantities	Unit cost	Cost	Remarks
1.1 Grit chamber	1) Excavation	m3	2,470	2.18	5.4	
Influent well	2) Backfill	m3	550	8.86	4.9	
	3) Disposal of surplus soil	m3	1,920	10.20	19.6	
	4) Plain concrete	m3	40	116.56	4.7	
	5) Reinforced concrete(B20	m3	460	553.88	254.8	
	6) H steel pile(10"x4"5/8")	m	686	60.00	41.2	
	Breast boad(2"x10")	m2	560	48.00	26.9	
	7) Well point installation	unit	2	1000.00	2.0	
	Well point machine lental	month	6	3900.00	23.4	
1.2 RAFA reactor	1) Reinforced concrete(B20	m3	3,900	553.88	2,160.1	
1.3 Aerated lagoon	1) Excavation	m3	28,000	2.18	61.0	
	2) Embankment	m3	5,500	12.94	71.2	
	3) Disposal of surplus soil	m3	22,500	10.20	229.5	
	4) Mortar	m3	375		0.0	
1.4 Polishing pond	1) Excavation	m3	41,000	2.18	89.4	
	2) Embankment	m3	7,000	12.94	90.6	
	3) Disposal of surplus soil	m3	34,000	10.20	346.8	
	4) Mortar	m3	480	156	74.9	
1.5 Disinfection tank	1) Excavation	m3	280	2.18	0.6	
	2) Backfill	m3	190	8.86	1.7	
	3) Disposal of surplus soil	m3	90	10.20	0.9	
	4) Reinforced concrete(B20	m3	50	553.88	27.7	
1.6 Sludge thickener	1) Excavation	m3	130	2.18	0.3	
	2) Backfill	m3	80	8.86	0.7	
	3) Disposal of surplus soil	m3	50	10.20	0.5	
	4) Reinforced concrete(B20	m3	60	553.88	33.2	
1.7 Treated sewage	1) Pipe D800	m	95	415	39.4	
discharge pipe					0.0	
1.8 Treated sewage	1) Reinforced concrete(B20	m3	5	553.88	2.7	
outfall	2) RC pileD250	m	16	60.00	1.0	
	3) sandbag	m3	91	15.00	1.4	
	4) water mat	m2	68	10.00	0.7	
Subtotal					3,617	

2. Buldings	Items	Unit	Quantities			Remarks
2.1 Influent pump room	RC	m2	120	800	96.0	
2.2 Disinfection room	RC	m2	120	800	96.0	
2.3 Electrical room	Brick	m2	120	500	60.0	
2.5 Administration room	RC	m2	1000	1,200	1,200.0	
Subtotal					1,452	

Table G.3-11 Breakdown of Construction Cost for Boa Viagem STF (2/2)

3. Ground Leveling, etc	Items	unit	Quantities			Remarks
3.1 Ground Leveling	1) Excavation	m3	3,500	2.83	9.9	
	2) Embankment	m3	26,000	12.94	336.4	
3.5 Inside road		m2	8,880	39.45	350.3	
3.6 Inside drain ditch	U type drain ditch					
	200x200 cast in place	m	2,960	30.00	88.8	
3.7 Fence and gate	Fence	m	1,260	27.00	34.0	
Subtotal					820.0	

(4) Boa Viagem (2/2)

4. Green Belt	Items	Unit	Quantities			Remarks
4.1 Green Belt		ha	1.5	#######	15.0	
Subtotal					15.0	

5. Mechanical & electrical equipment	Items	Unit	Quantities		Remarks
	40% of related civil work cost			1,190	
Subtotal				1,190	

Total		7,094

Table G.3-12 Breakdown of Cosntruction Cost for Cordeiro STF (1/2)

(5) Cordeiro (1/2)

1. Civil structures	Items	Unit	Quantitie	Unit cost	Cost	Remarks
1.1 Grit chamber	1) Excavation	m3	1,760	2.18	3.8	
Influent well	2) Backfill	m3	470	8.86	4.2	
	3) Disposal of surplus soil	m3	1,290	10.20	13.2	
	4) Plain concrete	m3	30	116.56	3.5	
	5) Reinforced concrete(B200	m3	350	553.88	193.9	
	6) H steel pile(10"x4"5/8")	m	597	80.00	47.8	Includes pilin;
	Breast boad(2"x10")	m2	480	48.00	23.0	
	7) Well point installation	unit	2	1000.00	2.0	
	Well point machine lental	month	6	3900.00	23.4	
	8) PC pile D350	m	480	60.00	28.8	
1.2 RAFA reactor	1) Reinforced concrete(B200	m3	2,500	553.88	1384.7	
	2) PC pileD350	m	6,930	60.00	415.8	
1.3 Bio-filter	1) Embankment	m3	1,600	12.94	20.7	
	2) Reinforced concrete(B200	m3	680	553.88	376.6	
	3) PC pileD350	m	4,216	60.00	253.0	
1.4 Recirculation tank	1) Excavation	m3	850	2.18	1.9	
	2) Backfill	m3	370	8.86	3.3	
	3) Disposal of surplus soil	m3	480	10.20	4.9	
	4) Plain concrete	m3	70	116.56	8.2	
	5) Reinforced concrete(B200	m3	210	553.88	116.3	
	6) PC pileD350	m	660	60.00	39.6	
1.5 Sedimentation tank	1) Excavation	m3	5,000	2.18	10.9	
(Circular type)	2) Backfill	m3	1,900	8.86	16.8	
	3) Disposal of surplus soil	m3	3,100	10.20	31.6	
	4) Reinforced concrete(B200	m3	600	553.88	332.3	
	5) PC pileD350	m	2,280	60.00	136.8	
1.6 Disinfection tank	1) Excavation	m3	240	2.18	0.5	
	2) Backfill	m3	170	8.86	1.5	
	3) Disposal of surplus soil	m3	70	10.20	0.7	
	4) Reinforced concrete(B200	m3	40	553.88	22.2	
	5) PC pileD350	m	372	60.00	22.3	
1.7 Sludge thickener	1) Excavation	m3	140	2.18	0.3	
	2) Backfill	m3	90	8.86	0.8	
	3) Disposal of surplus soil	m3	50	10.20	0.5	
	4) Reinforced concrete(B200	m3	63	553.88	34.9	
	5) PC pileD350	m	264	60.00	15.8	
1.8 Treated sewage discharge pipe	1) Pipe D800	m	50	415.00	20.8	
					0.0	
1.9 outfall	1) Reinforced concrete(B200	m3	5	553.88	2.7	
	2) RC pileD250	m	16	50.00	0.8	
	3) Sandbag	m3	91	15.00	1.4	
	4) Waterproof sheet	m2	68	10.00	0.7	
Subtotal					3,623.0	

Table G.3-12 Breakdown of Cosntruction Cost for Cordeiro STF (2/2)

2. Buldings	Items	Unit	Quantities			Remarks
2.1 Influent pump roor	RC	m2	100	800	80.0	
2.2 Recirculation pum	RC	m2	120	800	96.0	
2.3 Disinfection room	RC	m2	120	800	96.0	
2.4 Administration roo	RC	m2	900	1,200	1080.0	
	PC pileD350	m	660	60	39.6	
Subotal					1,392.0	

(5) Cordeiro (1/2)

3. Ground Leveling, e	Items	unit	Quantities			Remarks
3.1 Ground Leveling	1) Demolishon of soil	m3	12,000	10.20	122.4	
	2) Sandfill(Replacement)	m3	7,600	23.00	174.8	
3.2 Inside road		m2	5,640	39.45	222.5	
3.3 Inside drain ditch	U type drain ditch					
	200x200 cast in place	m	1,880	30.00	56.4	
3.4 Fence and gate	Fence	m	860	27.00	23.2	
Subtotal					599.0	

4. Green Belt	Items	Unit	Quantities			Remarks
4.1 Green Belt		ha	1.4	10,000	14.0	
Subtotal					14.0	

5. Mechanical & electrical equipment	Items	Unit	Quantities			Remarks
	50% of related civil work cost				1,300.0	
Subtotai					1,300.0	

Total					6,928	

G.3-13 Breakdown of Construction Cost for Prazeres STF (1/2)

(6) Prazeres (1/2)

1. Civil structures	Items	Unit	Quantities	Unit cost	Cost	Remarks
1.1 Grit chamber	1) Excavation	m3	2,470	2.18	5.4	
Influent well	2) Backfill	m3	550	8.86	4.9	
	3) Disposal of surplus soil	m3	1,920	10.20	19.6	
	4) Plain concrete	m3	40	116.56	4.7	
	5) Reinforced concrete(B200)	m3	460	553.88	254.8	
	6) H steel pile(10"x4"5/8")	m	686	80.00	54.9	
	Breast boad(2"x10")	m2	560	48.00	26.9	
	7) Well point installation	unit	2	1000.00	2.0	
	Well point machine lental	month	6	3900.00	23.4	
1.2 RAFA reactor	1) Reinforced concrete(B200)	m3	4,600	553.88	2,547.8	
1.3 Aerated lagoon	1) Excavation	m3	33,000	2.18	71.9	
	2) Embankment	m3	6,900	12.94	89.3	
	3) Disposal of surplus soil	m3	26,100	10.20	266.2	
	4) Mortar	m3	465	156	72.5	
1.4 Polishing pond	1) Excavation	m3	52,000	2.18	113.4	
	2) Embankment	m3	9,700	12.94	125.5	
	3) Disposal of surplus soil	m3	42,300	10.20	431.5	
	4) Mortar	m3	650	156	101.4	
1.5 Disinfection tank	1) Excavation	m3	310	2.18	0.7	
	2) Backfill	m3	190	8.86	1.7	
	3) Disposal of surplus soil	m3	120	10.20	1.2	
	4) Reinforced concrete(B200)	m3	50	553.88	27.7	
1.6 Sludge thickener	1) Excavation	m3	170	2.18	0.4	
	2) Backfill	m3	90	8.86	0.8	
	3) Disposal of surplus soil	m3	80	10.20	0.8	
	4) Reinforced concrete(B200)	m3	80	553.88	44.3	
1.7 Sludge drying bed	1) Excavation	m3	3,800	2.18	8.3	
	2) Disposal of surplus soil	m3	3,800	10.20	38.8	
	4) Reinforced concrete(B200)	m3	1,420	553.88	786.5	
1.8 Treated sewage	1) Pipe D1200,pipe jacking	m	30	4,500.00	135.0	
discharge pipe	RC pipe D1200	m	2,900	535.00	1,551.5	
1.9 Treated sewage	1) Reinforced concrete(B200)	m3	7	553.88	3.6	
outfull	2) PC pileD250	m	16	50.00	0.8	
	3) Sandbag	m3	95	15.00	1.4	
	4) Waterproof sheet	m2	71	10.00	0.7	
sbotal					6,820.0	

2. Buldings	Items	Unit	Quantities			Remarks
2.1 Influent pump room	RC	m2	150	800.00	120.0	
2.2 Disinfection room	RC	m2	150	800.00	120.0	
2.3 Electrical room	Brick	m2	150	500.00	75.0	
2.4 Administration roo	RC	m2	1,000	1200.00	1,200.0	
Subtotal					1,515	

G.3-13 Breakdown of Construction Cost for Prazeres STF (2/2)

(6) Prazeres (2/2)

3. Ground Leveling, et	Items	unit	Quantities			Remarks
3.1 Temporary access r	W=6m,	m2	2,400	39.45	94.7	
3.2						
3.3 Ground Leveling	1) Excavation	m3	15,000	2.83	42.5	
	2) Embankment	m3	11,100	12.94	143.6	
3.4 Inside Road		m2	10,680	39.45	421.3	
3.5 Inside drain ditch	U type drain ditch					
	200x200 cast in place	m	3,560	30	106.8	
3.6 Fence and gate	Fence	m	1,360	27	36.7	
					846	

4. Green Belt	Items	Unit	Quantities			Remarks
4.1 Green Belt		ha	2	10,000	20.0	
Subtotal					20	

5. Mechanical & electrical equipment	Items	Unit	Quantities		Remarks
	40% of related civil work cost			1,370.0	
Subtotal				1,370.0	
Total				10,571	

Table G.3-14 Breakdown of Construction Cost for Curcurana STF (1/2)

(7) Curcurana (1/2)

1. Civil structures	Items	Unit	Quantities	Unit costs	Cost	Remarks
1.1 Grit chamber	1) Excavation	m3	1,910	2.18	4.2	
Influent well	2) Backfill	m3	500	8.86	4.4	
	3) Disposal of surplus soil	m3	1,410	10.20	14.4	
	4) Plain concrete	m3	30	116.56	3.5	
	5) Reinforced concrete(B20(	m3	370	553.88	204.9	
	6) H steel pile(10"x4"5/8")	m	637	80.00	51.0	
	Breast boad(2"x10")	m2	510	48.00	24.5	
	7) Well point installation	unit	2	1000.00	2.0	
	Well point machine lental	montl	6	3900.00	23.4	
	8) PC pile D350	m	180	60.00	10.8	
1.2 RAFA reactor	1) Reinforced concrete(B20(	m3	3,500	553.88	1,938.6	
	2) PC pileD350	m	4,060	60.00	243.6	Includes piling
1.3 Aerated lagoon	1) Excavation	m3	26,000	2.18	56.7	
	2) Embankment	m3	4,500	12.94	58.2	
	3) Disposal of surplus soil	m3	21,500	10.20	219.3	
	4) Mortar	m3	300	156.00	46.8	
1.4 Polishing pond	1) Excavation	m3	38,000	2.18	82.8	
	2) Embankment	m3	5,800	12.94	75.1	
	3) Disposal of surplus soil	m3	32,200	10.20	328.4	
	4) Mortar	m3	400	156.00	62.4	
1.5 Disinfection tan	1) Excavation	m3	280	2.18	0.6	
	2) Backfill	m3	190	8.86	1.7	
	3) Disposal of surplus soil	m3	90	10.20	0.9	
	4) Reinforced concrete(B20(	m3	50	553.88	27.7	
	5) PC pileD350	m	168	60	10.1	
1.6 Sludge thickene	1) Excavation	m3	140	2.18	0.3	
	2) Backfill	m3	90	8.86	0.8	
	3) Disposal of surplus soil	m3	50	10.20	0.5	
	4) Reinforced concrete(B20(	m3	63	553.88	34.9	
	5) PC pileD350	m	112	60	6.7	
1.7 Sludge drying b	1) Excavation	m3	2,200	2.18	4.8	
	2) Disposal of surplus soil	m3	2,200	10.20	22.4	
	4) Reinforced concrete(B20(	m3	830	553.88	459.7	
1.8 Treated sewage	1) RC Pipe D1000	m	1,600	474.00	758.4	
discharge pipe					0.0	
1.9 Treated sewage	1) Reinforced concrete(B20(	m3	5	553.88	2.9	
outfull	2) PC pileD250	m	16	50.00	0.8	
	3) Sandbag	m3	92	15.00	1.4	
	4) waterproof sheett	m2	69	10.00	0.7	
Subtotal					4,790.0	

2. Buldings	Items	Unit	Quantities	Unit costs	Cost	Remarks
2.1 Influent pump r	RC	m2	100	800	80.0	
2.2 Disinfection roo	RC	m2	120	800	96.0	
2.3 Electrical room	Brick	m2	120	500	60.0	
2.4 Administration	RC	m2	900	1200	1,080.0	
Subtotal					1,316.0	

Table G.3-14 Breakdown of Construction Cost for Curcurana STF (2/2)

(7) Curcurana (2/2)

3. Ground Leveling	Items	unit	Quantities	Unit costs	Cost	Remarks
3.1 Temporary acce	W=6m,	m2	5,400	39.45	213.0	
3.2						
3.3 Ground Levelin	2) Embankment	m3	161,000	12.94	2,083.3	
3.4 Inside road		m	7,740	34.19	264.6	
3.5 Inside drain ditc	U type drain ditch					
	200x200 cast in place	m	2,480	30.00	74.4	
3.6 Fence and gate	Fence	m	1,280	27.00	34.6	
Subtotal					2,670.0	

4. Green Belt	Items	Unit	Quantities	Unit costs	Cost	Remarks
4.1 Green Belt		ha	1.3	10,000	13.0	
Subtotal					13.0	

5. Mechanical & el	Items	Unit	Quantities	Unit costs	Cost	Remarks
	40%of related civil work cost				1,050.0	
Subtotal					1,050.0	

Total	9,839

Table G.3-15 Breakdown of Land Acquisition and Compensation

	Place	Unit	Unit cost (R$/m2)	Quantities (m2)	Cost R$1,000
Wastewater treatment plants					
	1 Conceicao	m2	40	82,000	3,280
	2 Janga	m2	-	-	-
	3 Cabanga	m2	-	-	-
	4 Boa Viagem	m2	266	87,000	23,142
	5 Cordeiro	m2	35	40,000	1,400
	6 Prazeres	m2	120	121,000	14,520
	7 Curcurana	m2	10	95,000	950
	Subtotal			425,000	43,292

Land Compensation for House Relocation

(Unit: R$1,000)

Place	Kind of house	Unit	Unit cost (R$/house)	Quantities	Cost R$1,000
Boa Viagem					
House relocation	Brick house	house	11,000	25	275
House relocation	Lumber house	house	8,000	50	400
Total					675

Land Acqusition for New Access Road to Treatment Facilities

Place	Unit	Unit Cost R$/m2	Quantities m2	Cost R$ 1,000
Prazeres	m2	120	2,800	336
Curcurana	m2	10	6,300	63

Table G.3-16 Breakdown of Land Acquisition for Pumping Station

	Types	Unit area (m2)	pcs	Total area (m2)	Unit cost of lamd (R$/m2)	Cost (R$1000)	Remarks
Conceicao	A	80	3	240	40	9.6	
	B	170	1	170	40	6.8	
	C	190		0	40	0	
	D	560		0	40	0	
	E	650		0	40	0	
	Sub total		4	410		16.4	
Janga	A	80	2	160	40	6.4	
	B	170	0	0	40	0	
	C	190	2	380	40	15.2	
	D	560	0	0	40	0	
	E	650	1	650	40	26	
	Sub total		5	1190		47.6	
Cabanga	A	80	6	480	1000	480	
	B	170		0	1000	0	
	C	190		0	1000	0	
	D	560		0	1000	0	
	E	650		0	1000	0	
	Sub total		6	480		480	
Voa Viagem	A	80	1	80	266	21.28	
	B	170	2	340	266	90.44	
	C	190		0	266	0	
	D	560	1	560	266	148.96	
	E	650	1	650	266	172.9	
	Sub total		5	1,630		433.58	
Cordeiro	A	80	3	240	35	8.4	
	B	170	2	340	35	11.9	
	C	190	1	190	35	6.65	
	D	560			35		
	E	650			35		
	Sub total		6	770		26.95	
Prazeres	A	80	2	160	120	19.2	
	B	170		0	120	0	
	C	190	2	380	120	45.6	
	D	560			120		
	E	650	1	650	120	78	
	Sub total		5	1190		142.8	
Curcurana	A	80	11	880	10	8.8	
	B	170			10		
	C	190	1	190	10	1.9	
	D	560			10		
	E	650	0	0	10	0	
	Sub total		12	1070		10.7	
Total			43	6740		1,158	

Table G.3-17 Breakdown of Disbursement Schedule of the Project

Disbursement Schedule(1/2)

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

Table G.3-17 Breakdown of Disbursement Schedule of the Project

Disbursement Schedule(2/2)

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

SUPPORTING REPORT H

ECONOMIC AND FINANCIAL EVALUATION

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SUPPORTING REPORT H: ECONOMIC AND FINANCIAL EVALUATION

PROJECT EVALUATION

I. MASTER PLAN STUDY

CHAPTER H1 GENERAL

H1.1 INTRODUCTION

In this chapter, the bases of two quantitative analyses: (1) financial evaluation, and (2) economic evaluation are discussed, though the projects that will be proposed in this study are to be evaluated in their technical, social and environmental aspects as well. The financial evaluation is to inspect the proposed projects from the financial point of view, involving tests of earning capacity and financial efficiency. The economic evaluation is to examine the proposed projects from the economic point of view, testing the viability of social investment in the national economy. In addition, the socio-economic impacts of the proposed projects are discussed.

The economic evaluation presents the economic efficiency of the proposed projects. In environmental projects, however, it is difficult to quantify all their benefits. In addition, it is usually difficult to identify the people responsible in the case of environmental pollution. Even in the project areas, pollution sufferers usually differ in their living circumstance from those who cause environment pollution. In this context, the economic evaluation does not always provide an appropriate indicator of project viability. The economic evaluation should be considered to present only a limited basis for decision-making in project selection.

In the feasibility study, the proposed projects are discussed from the financial and economic points of view, as in the master plan study. In the financial analysis, project management is discussed from the viewpoint of financial management through financial simulation of the projects. The financial evaluation tests the earning capacity and fund management of the project. Besides, the financial simulation of the proposed project is shown in the financial analysis section. On the basis of the simulation, aspects of management are discussed in this section. The economic evaluation examines the viability of the proposed project in terms of social investment in the national economy. The proposed projects are inspected to see whether or not they are viable from the socio-economic viewpoint. In addition, sensitivity tests for the economic evaluation are introduced because of some uncertainty in the estimation of costs and benefits.

H1.2 PROCEDURE OF FINANCIAL AND ECONOMIC EVALUATION

For the sewerage treatment projects, the proposed projects are evaluated using the two analytical methods mentioned above. The procedure of the financial and economic evaluation is illustrated in Fig. H1-1.

The evaluation is conducted in accordance with the conventional methodology that is commonly applied in the evaluation of development programs in Brazil with finance from the World Bank, Inter-American Development Bank and other international agencies concerned with technical and economic cooperation. The methodology suggests that the project evaluation has two steps for quantifying evaluation factors in general. Firstly, the project costs and benefits are identified and quantified in monetary terms, which arise from implementation of the proposed projects. Then, they are compared and condensed into evaluation factors. The factors are Internal Rate of Return (IRR) as a main indicator, and Net Present Value (NPV) and Benefit-Cost Ratio (B/C) as supplementary indices.

The IRR is defined as a special discount rate that satisfies the following conditions:

1) The present value of cost is obtained through discounting all the costs incurred during the economic life of the proposed project at the special rate.
2) The present value of benefit is obtained through discounting all the benefits accruing from the project during the its lifetime at the special rate.
3) As a result, the present value of cost is equal to the present value of benefit.

In the case of this IRR exceeding the opportunity cost of capital in Brazil, the proposed project could be judged to be viable economically. The NPV shows the magnitude of project incremental benefits. The B/C indicates the gap between the project efficiency and the opportunity cost of capital.

CHAPTER H2 FINANCIAL EVALUATION

H2.1 OVERVIEW OF FINANCIAL EVALUATION

Financial analysis was carried out on the basis of market values of project costs and incomes from the proposed projects. The project costs are estimated in Supporting Report G. These costs reflect the actual present market conditions. The revenue of sewerage treatment services is calculated as a product of a volume of sewage treated and sewage treatment service rates in principle. Finally, the projects are examined in terms of financial efficiency and evaluated taking into account the financial situation.

In the master plan stage, the financial viability of the proposed project is examined by means of evaluation indices of "financial internal rate of return (FIRR)". In financial evaluation, the decisive factor for the proposed project is considered a FIRR of 12% in general. It usually reflects long-term interest rates in financial markets in the country. This rate, however, is not always an absolute standard in financial evaluation. In the case of any financial sources of lower interest rates than 12% being available for the projects, the proposed project could be viable from the financial point of view. Thus, even if the FIRR were not good enough to implement the projects from the financial viewpoint, financial difficulties would be analyzed and identified, and some countermeasures would be proposed in this study.

The evaluation above was done mainly on the supply side. The project management must also be evaluated from the viewpoint of the demand side. Affordability of the proposed projects for their beneficiaries is an important factor for the project to be accepted by the consumers. Through these analyses, this financial study proposes financial solutions and recommendations for each aspect of the projects, if they are not affordable for the consumers.

H2.2 REVENUE FROM SEWAGE TREATMENT SERVICES

The revenue of the proposed project accrues from payment for the sewerage service connections. The wastewater dischargers pay for sewerage service charges in accordance with their wastewater volume discharged. COMPESA laid down the sewerage service tariff as a surcharge on water consumption in their service areas in October 1997. Charging rates are set on the basis of sewage collection systems such as conventional and condominial systems. Their details are shown in Table 2.7-5 in Main Report.

The revenue from sewage treatment services is calculated as a surcharge of water supply charge. The water supply charge is estimated as a product of unit rates set in the tariff and water volume consumed which is counted in accordance with water volume consumed. The surcharge rates of sewerage treatment service are applied to consumers both with and without water meters. Applying these charging rates, the monthly financial results of water supply and sewerage services are summarized for July 1999 on the basis of COMPESA's records. The results are tabulated as follows.

Revenue from Water Supply and Sewerage Services: July 1999

Item	Unit	Water Supply	Sewerage Service	Total
Number of Connection Units Served	1000	1,210	279	-
Volume Supplied/Treated	Million m^3	26.6	3.8	-
Monthly Revenues	R$ Million	11.5	3.2	14.7
Monthly Expenses	R$ Million	16.5	2.6	19.1
Unit Revenue				
Per Connection Unit	R$/Unit	9.50	11.52	-
Per Volume	R$/$m^3$	0.43	0.84	-
Unit Treatment Cost				
Per Connection Unit	R$/Unit	13.64	9.21	-
Per Volume	R$/$m^3$	0.62	0.67	-

The actual charging rates system is complicated as tabulated in Table 2.7-5 in Main Report, so it is difficult to estimate precise revenue from the volume of sewage collected. In this analysis, the charging rate applied is assumed to be R$0.84 per m^3, which is estimated in the above table. Consequently, the revenue from sewage treatment services is calculated as a product of sewage volume collected and the average unit rate of R$0.84 per m^3.

The total daily volume of treated sewage is estimated at 530 thousand m^3/day in the target year 2020. The charged volume of sewage is estimated as the difference between the total volume of sewage and the volume of ground water infiltrating into sewer pipes. The charged volume is calculated at 392 thousand m^3/day or 143 million m^3/year in 2020. Then, the total revenue of the proposed projects is calculated at R$120 million per year, applying the average unit rate of R$0.84 per m^3. These figures have been broken down for each river basin as shown in the table below.

Revenue of the Proposed Project: 2020

Item	Annual Sewage Treatment Volume (Million m^3 per Year)	Annual Revenue from Sewage Treatment Services (R$ Million per Year)
Capibaribe River Basin	36.8	30.1
Beberibe River Basin	22.7	19.1
Jaboatão River Basin	26.5	22.3
Tejipio River Basin	22.1	18.6
Timbo River Basin	22.9	19.2
Other River Basins	12.1	10.1
Total	143.1	120.2

H2.3 COSTS FOR SEWAGE TREATMENT

The financial construction cost of the proposed project consists of the following major items:

(a) Main construction cost
(b) Compensation cost
(c) Engineering service cost
(d) Government administration cost
(e) Contingency cost

The main construction cost comprises (i) expansion works of sewage collection and transport facilities and sewage treatment facilities, (ii) rehabilitation works of existing facilities. The compensation cost is paid to landowners who have land expropriated for sewage treatment plants. Other costs are estimated as some proportion of the main construction cost. The details of cost estimates were described in Supporting Repot G. The financial costs of the proposed project are summarized as follows.

Financial Costs of the Proposed Project

(Unit: R$ Million at 1999 constant prices)

	Description	First Phase	Second Phase	Total
1.	Construction Cost	514.5	120.0	634.5
2.	Compensation Cost	23.6	4.1	27.7
3.	Engineering Services	51.5	12.0	63.5
4.	Administration Cost	51.5	12.0	63.5
5.	Contingency Cost	51.5	12.0	63.5
	Total	692.6	160.1	852.7

These costs are rearranged into the respective river basins as follows.

Financial Costs by River Basin

(Unit: R$ Million at 1999 constant prices)

	Description	First Phase	Second Phase	Total
1.	Capibaribe River Basin	137.7	83.2	220.9
2.	Beberibe River Basin	107.8	14.8	122.6
3.	Jaboatão River Basin	178.9	23.3	202.2
4.	Tejipio River Basin	137.5	4.6	142.1
5.	Timbo River Basin	92.1	1.1	93.2
6.	Other River Basins	38.6	33.1	71.8
	Total	692.6	160.1	852.7

The construction costs are assumed to be disbursed in accordance with the construction schedule from 2003 to 2010 for the first phase and from 2011 to 2020 for the second phase. The disbursement of construction costs is tabulated in cash flow streams as shown in Tables H2-1 to H2-7.

The operation and maintenance (O&M) cost is required annually during the economic life of the proposed projects. The O&M cost was estimated at 7% of the direct construction cost. It is estimated at R$44.4 million in the target year 2020. It is recalculated at R$0.23 per m^3 of sewage treated at 1999 constant prices. The details of the O&M cost are also described in Supporting Report G.

H2.4 FINANCIAL EFFICIENCY

Financial expenditure and revenue during the evaluation period are shown as annual streams in Tables H2-1 to H2-7. The tables also show evaluation indices. The indices are summarized as follows.

Evaluation Indices

	Description	FIRR	B/C*1	NPV*1 (R$ Million)
1.	Capibaribe River Basin	6.9%	0.68	-42
2.	Beberibe River Basin	7.4%	0.70	-27
3.	Jaboatão River Basin	4.7%	0.51	-66
4.	Tejipio River Basin	5.8%	0.58	-41
5.	Timbo River Basin	8.3%	0.74	-18
6.	Other River Basins	7.2%	0.71	-9
	Entire Projects	6.1%	0.58	-225

Note: *1 Discounted at 12%.

The evaluation indices of the entire projects are calculated at 6.1% for FIRR, 0.58 for B/C and minus R$225 million for NPV. The latter two values are the results applying the discount rate of 12%. From the financial point of view, accordingly, the proposed project is not said to be viable, because the FIRRs are lower than the decisive factor of 12%. However, the FIRR of the entire project indicates that the projects could be manageable, if they procure financial sources with an interest rate of less than 6.1%.

If it is desired to have the FIRR of more than 12% only through a revenue increase, the charging rates for all consumers would have to be increased by 73% over present rates. The results of this countermeasure case (named Case 1) are tabulated in Table H2-8. It might not be acceptable for the beneficiaries to be charged the higher rates of sewerage treatment services in the present economic situation. In the future, however, the beneficiaries might accept the higher charge after their living conditions are improved owing to economic development.

On the other hand, it would be possible to make the projects viable if some subsidies for the investment costs were available. The analysis indicates that the projects would be made viable by the covering almost 53% of the capital investment cost with a subsidy. The results of this countermeasure case (named Case 2) are tabulated in Table H2-9.

CHAPTER H3 ECONOMIC EVALUATION

H3.1 OVERVIEW OF ECONOMIC EVALUATION

The projects proposed in this study are evaluated on the basis of two quantitative analyses: (1) financial analysis, and (2) economic analysis. The former was discussed in the previous section. The economic evaluation is to examine the proposed project from the economic point of view, testing the viability of social investment in the national economy. As mentioned before, the financial evaluation is to inspect the proposed projects from the financial point of view, involving tests of earning capacity and financial efficiency. This is the fundamental difference between the two analyses.

H3.2 CRITERIA AND ASSUMPTIONS OF PROJECT EVALUATION

H3.2.1 Criteria of Evaluation

For economic evaluation, the following criteria and assumptions are applied to calculate the evaluation indices.

Criteria of Evaluation

No.	Item	Set-up Conditions and Assumptions
1.	Base Year	Beginning of the year 2002
2.	Construction Period	The construction works in the first phase start in 2002 and continue to 2010. Then, the second phase facilities are constructed from 2011 to 2020.
3.	Disbursement Schedule	Disbursed in accordance with construction schedule
4.	Economic Life	25 years from the completion of the projects in 2020
5.	Evaluation Period	25 years from the completion of the construction works
6.	Timing of Accruing Benefits	The matured benefits will appear after the completion of the respective projects.
7.	Price Level	Costs and benefits of the projects were set down at the beginning of November 1999.
8.	Prevailing Exchange Rate	R$1.90 per US$1.00 at the official rate
9.	Opportunity Cost of Capital	12 % per annum
10.	Growth till Target Year 2020	Based on the projection in Chapter D7 in Supporting Report D.

H3.2.2 Assumptions for Economic Evaluation

In estimating the economic benefit, the following criteria and assumptions are applied to convert the financial market values of project benefits and costs to the economic ones.

(1) Conversion Factor

Market values are usually distorted by transfer payments such as taxes and subsidies. These payments are eventually transferred to the government, which acts on behalf of society. For this reason, they should not be treated as economic costs. These have to be eliminated from the market values of cost and benefit as a whole. In Brazil, the taxes related to construction works are income tax, customs duties, local taxes, etc.

Although all the costs have to be measured as economic costs, i.e., the real costs or "opportunity costs", it is clearly impracticable to trace procurement routes and financial sources for all the project inputs, particularly at the master plan stage. Thus, taking this situation into consideration, the economic costs are assumed to be approximately 94% of the financial costs for local portions. This rate is called the standard conversion factor (SCF).

(2) Shadow Wage

Prevailing wages of skilled workers are considered to reflect an opportunity cost of labor, because such workers are usually in short supply in the labor markets. Therefore, the shadow wage rate of skilled workers is fixed at 1.0. On the other hand, unskilled workers are in excess in the labor markets, due to the conditions of unemployment and underemployment. Thus, the shadow wage rate of unskilled workers is assumed to be 0.5 of the legislated wage rate, referring to the project reports concerned.

(3) Land Value

Land expropriated for treatment plants is purchased by COMPESA applying the financial market value. In economic evaluation, however, land is generally evaluated on the basis of its productivity for crop cultivation, or for example, on the balance of supply and demand for non-productive land such as residential plots. Yet, in the RMR, most land expropriated for the projects is not utilized for productive activities at present and will not be in the future. In this economic evaluation, then, the value of these lands is taken as zero for the evaluation period.

H3.3 PROJECT BENEFITS

H3.3.1 Benefits from Proposed Projects

Two main important goals of the sewerage projects in the RMR are (i) to improve public health and well-being, and to maintain the ecological balance, and (ii) to maintain and develop the tourism industry based on the natural resources of the coastline.

When the former goal is attained, all inhabitants in and around the project areas will be able to enjoy their lives in improved environment. In terms of improvement of public health conditions, the urban poor should receive significant benefits from the projects. They will be relieved of the burdens of living in areas contaminated by polluted streams, rivers and soil in the project areas.

In terms of the latter goal, the natural coastal environment should be maintained through the implementation of the proposed projects. Accordingly, the regional economy of the tourism industry in the State of Pernambuco will be revitalized by means of environment improvement. The State's economy particularly relies on the tourism industry these days after the recent deterioration of manufacturing industries in the state. In fact, the state government intends to promote the tourism industry in the future.

Besides these basic benefits, the sewerage project gives various advantages to the people and to the regional economy in and around the project areas. Fig. H3-1 lists the benefits accruing from the sewerage projects. In the upper part of the figure, direct benefits are listed. Benefits in the lower part are considered as indirect benefits. These benefits have ripple effects on residents, the regional environment and the regional economy. On the other hand, the proposed projects may bring about negative effects on the people and the regional socio-economy. These socio-economic impacts will be discussed in Chapter H4.

H3.3.2 Components of Quantifiable Direct Benefits

The benefits listed in Fig. H3-1 are further classified into two categories. They are quantifiable or tangible, and non-quantifiable or intangible. To identify indicators for economic evaluation, only tangible benefits of direct effects are quantified as project benefits. In this study, the following three benefits are chosen as tangible benefits.

Tangible Benefits With Sewerage Projects

No.	Tangible Benefits	Quantified Benefits
1)	Sewage treatment saving benefits for inhabitants	Elimination of installation and O&M costs of other treatment systems and septic tanks outside the existing sewerage collection service areas
2)	Decrease of medical expenses and losses due to absence from work	Cost reduction of medical expenses for water borne diseases, and Reduction of losses from absence from work due to water borne diseases
3)	Elimination of tourism recession owing to maintenance of tourism resources	Maintaining tourist attractions and promotion of regional industries related to tourism in the RMR

Note: Detailed benefit structure is shown in Fig. H3-1.

Benefits of sewerage projects are generally appreciated with willingness-to-pay of beneficiaries. The willingness-to-pay is broadly used as monetary term for usefulness, which the beneficiaries perceive, brought about by the implementation of the projects. Thus, it includes various factors, not only tangible benefits but also intangible ones. The tangible benefits selected above are only a few components of their willingness-to-pay. In this evaluation study, however, only tangible benefits above are taken into the project benefits. It must be emphasized that if indirect benefits were considered, the results would be more favorable.

Regarding the quantifiable benefits in this evaluation, the quantification procedures of the benefits are illustrated in Fig. H3-2.

H3.3.3 Estimate of Sewage Treatment Saving

Under without-project conditions, sewage treatment in the future is assumed to expand at the pace of the past trends. Table H3-1 shows the growth trend of sewage treatment services in the RMR from 1994 to 1999. During these five years, the sewerage system expanded at a rate of 2.3% per annum on average. This growth rate is assumed to continue even in the future under without-project conditions. The sewerage system includes both sewer network systems established by COMPESA and other treatment systems constructed by developers. The population served by COMPESA was estimated at 722 thousand in 1996. Of this population, however, only 640 thousand or 89% were served with sewage treatment services of COMPESA. In the same year, 106 thousand people used other sewage treatment systems. In total, 746 thousand people are provided with sewage treatment services. Septic tank systems are compulsory for people who are not connected to any other sewage treatment systems, under state law No.7269, June 1981. The septic tanks are only actually installed by people who earn more than middle income. This number of people is estimated at 936 thousand for 1996. Accordingly, the proportions of people with sewage treatment including septic tanks were 57% of the total urban population in the RMR in 1996.

If the population served with sewage treatment services grows at the rate of 2.3%, it will be 2.15 million in the target year 2020. This will include 1.09 million connected to COMPESA systems, 0.18 million to other treatment systems and 0.88 million with septic tank systems, as shown in Table H3-2. The percentage of people served with sewage treatment services will have increased from 57% in 1996 to 59% in 2020. These figures for 2020 are distributed between the river basins as shown in the table below. The details are shown in Table H3-3. Incidentally, a basin population was estimated on the assumption that it increases in proportion to the population growth of the total urban area.

Populations of River Basins in 2020

(Unit: 1000)

	River Basin	With Treatment COMPESA	Other Treatment Systems	Septic Tank Systems	Total
1.	Capibaribe River Basin	238	39	191	468
2.	Beberibe River Basin	192	32	154	378
3.	Jaboatão River Basin	199	33	160	392
4.	Tejipio River Basin	169	28	135	332
5.	Timbo River Basin	144	24	116	284
6.	Other River Basins	151	25	121	297
	Total	1,092	181	877	2,150

Unit costs of these systems are estimated as follows. The unit costs of the sewage treatment system studied in the PQA are based on the estimates of the proposed projects in Supporting Report G. These costs are calculated at R$235 per beneficiary for capital investment and R$12.7 per person per year for O&M in economic terms.

The unit costs of other treatment systems are estimated on the basis of an example in the RMR of 1999, as shown in Table H3-4. The unit costs are calculated at R$120 per beneficiary for capital investment and R$6.00 per person for O&M at market values. These costs are converted to R$113 per person and R$5.60 per person in economic terms, applying a conversion factor of 0.94. The unit costs of septic tank systems are estimated as R$110 per person for the construction cost and R$6.00 per person for the O&M cost in market prices. These are converted to R$103 per person and R$5.60 per person respectively in economic terms.

The benefit of sewage treatment saving is estimated as a product of the population served with sewage treatment and unit costs corresponding to the respective systems up to the target year of 2020. Beyond 2020, the O&M costs of these systems can be eliminated under with-project conditions.

H3.3.4 Estimate of Medical Benefits

For 2020, the population without sewage treatment services was estimated at 1,510 million or 41% of the total population as shown in Table H3-2. Although the ratio of the population without sewerage services to the total population decreased from 43% in 1996 to 41% in 2020, the population numbers increased from 1.25 million in 1996 to 1.51 million in 2020. Consequently, sanitary conditions will not be improved by the target year 2020. Thus, the present medical situation is assumed to continue during the evaluation period.

The public health improvement benefit was estimated as a reduction of medical expenses by beneficiaries and also a reduction of labor opportunity losses due to illness. The amounts of these losses are estimated on the basis of medical data, which were provided by DIRES I, the State Secretariat of Health, and which were derived from household economic survey by IBGE in 1998. Some information not available in Brazil was quoted from foreign sources. The details of this benefit are shown in Table H3-5. The annual medical expenses for water borne diseases were estimated at around R$1.03 per person in 1999 at market prices. The annual labor losses were estimated at around R$1.04 per person. Then, the total annual losses due to illness caused by water borne diseases were estimated at R$2.07 per person at market prices. The losses were re-calculated at R$1.80 per person in economic terms.

H3.3.5 Estimate of Elimination of Tourism Recession

According to information from Secretariat of Economic Development, Tourism and Sports, the number of tourists in the RMR was 1,142 thousand in 1998. This was made up of 78 thousand foreign tourists and 1,064 thousand domestic tourists. Of the total tourists, 456 thousand stayed in accommodation such as hotels and guesthouses in 1998. This number had increased from 331 thousand in 1995, as shown in Table H3-6. Applying this growth trend, the number of tourists in the RMR is estimated at 3,685 thousand for the target year 2020.

As mentioned in Section D4.4 in Supporting Report D, 62% of the tourists evaluated public cleanliness in the RMR as "not good". In this study, sightseeing tourists, who complain of a lack of cleanliness in tourist spots, are assumed not to visit the RMR again. Incidentally, sightseeing tourists were reported as being 57% foreign tourists and 28% domestic tourists. As a result, the reduction in tourists due to sanitation problems was estimated as 669 thousand in 2020, of which 233 thousand are foreign tourists and 436 thousand domestic tourists.

In 1998, tourists spent their money as follows: US$51.4 per day per foreign tourist and US$33.2 per day per domestic tourist on average. They stayed 10.8 days per foreign tourist and 8.6 days per domestic tourist on average. Furthermore, the value added rate of the tourism industry was estimated at 57.3% of gross revenue. Applying these data, the expected losses due to the decrease of tourists visiting the RMR were calculated at R$176 million in 2020 at 1998 constant market prices.

The expected losses in 2020 were distributed between the river basins as shown in the following table. The index for distribution was based on the rates of the expected pollution loads in the respective river basins against the total reduction of pollution load in the RMR. The reduction of pollution load by river basin is tabulated in Table H3-7. The expected reduction rates by river basin are estimated at 21% for the Capibaribe, 23% for the Beberibe, 22% for the Jaboatão, 14% for the Tejipio, 16% for the Timbo and 3% for other rivers.

Since the total economic losses in the RMR were estimated at R$182.1 million in 2020, the expected economic losses in the respective river basins are estimated as shown in the following table, applying the indices above.

Expected Losses due to Reduced numbers of Tourists: 2020

	River Basin	Distribution Index		Economic Losses
		Reduction (kg/day)	% Distribution	(R$ Million)*1
1.	Capibaribe River Basin	10.3	21	38.9
2.	Beberibe River Basin	11.1	23	42.0
3.	Jaboatão River Basin	10.4	22	39.5
4.	Tejipio River Basin	6.8	14	25.7
5.	Timbo River Basin	7.9	16	30.0
6.	Other River Basins	1.6	3	6.0
	Total	48.1	100	182.1

Note: *1 Economic value at 1999 constant prices, which applied a 10% annual increase and a 0.94 conversion factor to the economic price.

H3.3.6 Estimate of Economic Benefits

The total benefits were calculated as the sum of the benefits mentioned above. Finally, the total economic benefits were estimated at R$115.5 million in 2010 and R$196.0 million in 2020. The details of yearly benefits are shown in Tables H3-8 to H3-14.

Total Economic Benefits in 2010

(Unit: R$ Million)

	River Basin	Sewage Treatment Saving	Medical Benefits	Tourism Recession Elimination	Total
1.	Capibaribe River Basin	1.2	1.2	22.3	25.9
2.	Beberibe River Basin	3.0	0.7	17.1	20.8
3.	Jaboatão River Basin	5.8	0.8	19.6	26.2
4.	Tejipio River Basin	4.4	0.8	13.4	18.6
5.	Timbo River Basin	4.0	0.7	16.7	21.4
6.	Other River Basins	0.4	0.2	1.3	1.9
	Total	20.7	4.4	90.4	115.5

Total Economic Benefits in 2020

(Unit: R$ Million)

	River Basin	Sewage Treatment Saving	Medical Benefits	Tourism Recession Elimination	Total
1.	Capibaribe River Basin	1.9	1.3	38.9	42.1
2.	Beberibe River Basin	0.9	1.1	42.0	44.0
3.	Jaboatão River Basin	1.3	1.1	39.5	41.9
4.	Tejipio River Basin	0.9	1.0	25.7	27.6
5.	Timbo River Basin	0.8	0.8	30.0	31.6
6.	Other River Basins	2.0	0.9	5.9	8.8
	Total	7.8	6.2	182.0	196.0

H3.4 ECONOMIC COSTS

The cost estimate of the proposed project was described in Supporting Report G. This estimate, however, was enumerated in market prices, termed the "financial value". In economic evaluation, the financial value has to be converted into economic value. The conversion procedure was discussed in Section H3.2.2. The total economic cost of the proposed project was calculated at R$773.5 million, with R$ 627.2 million in the first stage and R$ 146.3 million in the second stage. The costs for each river basin are broken down as shown in the following table.

Economic Costs per River Basin

(Unit: R$ Million)

River Basin	Direct Cost	Compensation Cost	Engineering Services	Administration Cost	Contingency Cost	Total
Capibaribe	152.3	0.0	16.2	13.8	15.2	197.5
Beberibe	88.5	0.0	9.4	8.0	8.8	114.7
Jaboatão	140.8	0.0	15.0	12.7	14.1	182.5
Tejipio	98.6	0.0	10.5	8.9	9.9	127.8
Timbo	66.0	0.0	7.0	6.0	6.6	85.6
Other	50.4	0.0	5.4	4.6	5.0	65.3
Total	596.5	0.0	63.5	53.9	59.6	773.5

The investment costs are disbursed in accordance with the construction schedule as shown in Fig.3.3-10 in Main Report. The expected disbursements of investment costs by river basin are enumerated in Tables H3-8 to H3-14.

The O&M cost is required annually during the economic life of the proposed project. The O&M unit cost in economic terms was estimated at 7% of direct construction costs. Thus, it was calculated at R$0.215 per m^3. The annual O&M costs are tabulated in Tables H3-8 to H3-14.

H3.5 ECONOMIC EFFICIENCY

Economic costs and benefits during the economic evaluation period are shown as annual streams in Tables H3-8 to H3-14. The tables show evaluation indices as well. The indices are summarized in the following table.

Evaluation Indices

	Description	EIRR	B/C[*1]	NPV[*1] (R$ Million)
1.	Capibaribe River Basin	14.4%	1.16	18
2.	Beberibe River Basin	18.9%	1.56	47
3.	Jaboatão River Basin	13.0%	1.08	10
4.	Tejipio River Basin	11.2%	0.94	-5
5.	Timbo River Basin	18.7%	1.54	34
6.	Other River Basins	3.7%	0.56	-13
	Entire Projects	14.4%	1.18	90

Note: *1 Discounted at 12%.

As shown in the table above, the EIRR of the Tejipio River Basin was slightly less than the opportunity cost of capital of 12%. On the other hand, the other major basins have favorable rates of more than 12%, so these projects are feasible and should be promoted from the economic point of view. Even the Tejipio River Basin has a value approximating the opportunity cost of capital. The EIRRs of the major five river basin projects almost all exceed 12%, so the proposed projects could be viable economically. However, the projects of other river basins were rather lower than 12%, so they are not viable from the economic point of view.

Yet, the economic analyses were based on a lot of assumptions as mentioned in the respective sections. Accordingly, these indices should be considered to be a reference for project promotion. This standpoint is essential in projects for environmental purposes.

CHAPTER H4 SOCIO-ECONOMIC IMPACTS

H4.1 IMPACT ON REGIONAL ECONOMY

It is obvious that the commencement of construction works such as sewage treatment projects stimulates regional economy in the sectors related to construction works as well as the construction sector itself. In general, one unit of construction work could induce 1.50 to 2.00 units of economic effects in the national and regional economy. In other words, construction work would bring about a 50% to 100% ripple effect on related works in various economic sectors in monetary terms. This effect could stimulate the regional economy in the State of Pernambuco.

As mentioned in the socio-economic study in Supporting Report D, about 180 thousand people were unemployed, accounting for 13.4% of the labor force in the RMR in 1997. The investment in the proposed projects would activate the regional economy and at the same time create opportunities for temporary jobs during the construction period. Accordingly, there would be new labor opportunities for the unemployed and underemployed in the region.

H4.2 IMPACT ON PUBLIC FINANCE

The total investment cost was estimated at R$693 million in the first phase and R$160 million in the second phase. The total amount of R$853 million in these two phases accounts for nearly 20% of the public expenditure of the state government in 1999. It also accounts for 65% of the capital expenditure. Although this amount is not disbursed within a year, it is still a heavy burden for the government. The capital expenditure of the government has relied on a foreign project assistance so far. For the implementation of these proposed projects, there would be no way other than depending on foreign financial assistance for capital cost.

The sewerage business is expected to be managed by an independent autonomous entity, in the near future. To put this policy into practice, the following basic principle should be adopted in the management of the water related business.

(1) Under the present charging rates, the revenue from sewage treatment services does not cover the whole annual costs of sewage treatment. It should be increased to cover the whole costs including depreciation of the facilities.

(2) A working fund should be procured by the undertaking entity (COMPESA), not through public finance but through private self-financing options.

(3) Taking into consideration the re-investment and replacement to take place in the near future, any surplus in sewage treatment management should be set by for future use.

H4.3 IMPACT ON HOUSEHOLD ECONOMY

According to the household economy survey (Table D4-1 in Supporting Report D) the utility charge of a family accounted for R$63.5 per month or 6.9% of the total household expenditure in Recife in 1995/96. Supposing that a quarter of this expenditure was used for water and sanitation expenses, the total amount could be estimated as R$15.9 or 1.7% of the total expenditure. If a half of this expense was spent for sanitation purpose, it would amount to R$8.0 per month or 0.9% of the total expenditure in 1995/96. According to Table D4-1 in Supporting Report D, the average household income was nearly 9 times of the minimum wage, so the average household income was calculated at R$1,220 per month in 1999, applying the minimum wage of R$136 per month in 1999. Accordingly, the average household would have spent R$11.0 per month for sewage treatment services in 1999.

In July 1999, the sewage treatment charge was calculated at R$0.84 per m^3 as mentioned in Section H2.2. Supposing that an average family discharged $12m^3$ per month of sewage, it would have spent R$10.1 per month. This amount is less than the expected expense for sewage treatment service mentioned above. In Case 1 discussed in Section H2.4, a 73% higher rate than the present rate is introduced for implementation of the proposed project. In this case, the average family would spend R$17.5 per month or 1.4% of total income on sewage treatment services. It might be difficult for people to accept a higher tariff for sewage treatment services in the present conditions. In the future, however, people may accept the higher tariff after the regional economy grows and they have a higher income.

CHAPTER H5 PROJECT EVALUATION

The project evaluation in each river basin was made based on the following items:

– Urgency :	Total pollution loads in the basin.
– Technical Evaluation :	Reduction in amount of BOD (kg/day).
– Financial/Economic Evaluation :	Value of FIRR/EIRR for the river basin.
– Social Environmental Impact :	Total served population, and the served population in poverty areas.

The results of the project evaluation in each river basin are shown in Table H5-1. The proposed master plan is evaluated as feasible on the whole. By the implementation of 55 sewage subsystems the master plan is expected to produce the following positive effects:

- It will expand the sewerage service area from 8,516 ha to 29,985 ha in 2020 and increase the sewage treatment level from no more than 20 % of the urban population to about 90 % in 2020. By the expansion of sewerage service areas, living and sanitary conditions in the RMR will be improved.
- The FIRR is estimated at 6.1 %, which is lower than the 12% decisive factor. However, the projects could be manageable, if the state government procures financial sources with an interest rate of less than 6.1 %. The financial condition of the operational body will be further improved by increasing tariffs and by utilizing government the capital investment.
- The EIRR is estimated at 14.4 %, so the projects could be viable from the economic point of view. Although the economic analyses were based on a lot of assumptions, these indices should be considered as a reference for project promotion.
- It will improve the sanitary conditions of the poverty areas by developing the sewerage system to provide for some 885,000 inhabitants in these areas.
- The five major river basins (Capibaribe, Beberibe, Jaboatão, Tejipio and Timbo) are to have a high priority for early implementation. The Tejipio is evaluated as unfeasible in economic term but feasible in financial terms.

The result of the comprehensive evaluation by river basin is tabulated as follows:

River basin	Evaluation	
Whole basin (MP)	Very effective	A
Capibaribe:	Very effective	A
Beberibe	Very effective	A
Jaboatão:	Very effective	A
Tejipio:	Effective	B+
Timbo:	Effective	B
Others:	Less effective	C