5.2 Plan of Water Conveyance

5.2.1 Water Demand

(1) Population

Water supply population in the Project areas is in accordance with the Population Projection discussed in the Master Plan Study. Population increase is based on the Strategic scenario proposed by JICA study team.

Table-5.1 Projected Population of Benefited Area: 1997 – 2020

Unit: 1,000 persons

Benefited Area	Census 1996	Projected Population				
		1997	2000	2010	2020	% (*)
Agreste						
Areia Branca	14.0	14.9	22.3	47.1	77.2	7.4
C. do Brito	14.9	15.3	17.7	25.9	36.2	3.8
Itabaiana	72.2	73.8	84.8	123.7	173.2	3.7
Macambira	5.4	5.5	5.9	7.3	9.1	2.2
S. Domingos	8.3	8.5	9.1	11.2	14.1	2.2
Sub-Total	114.8	118.0	139.8	215.2	309.8	4.2
Piauitinga						
Poco Verde	17.6	17.6	17.6	18.5	21.0	0.7
Simão Dias	33.7	34.0	35.1	39.6	46.4	1.3
Lagarto	75.3	76.0	82.8	107.3	139.0	2.6
R. do Dantas	17.8	18.0	18.5	20.6	23.3	1.1
Sub-Total	144.4	145.6	154.0	186.0	229.7	2.0
Grand-Total	259.2	263.6	293.8	401.2	539.5	3.1

Note: * Population Growth Rate between 1996 and 2020.

(2) Total Required Water Supply Volume

Total water supply volume required in the Project areas is in accordance with the Population Projection discussed in the Master Plan.

Table-5.2 Domestic/Industrial Water Supply in Piauitinga and Agreste Areas

Area Covered By	Agreste Integrated Pipeline System		Piauitinga Integrated Pipeline System		Total Supply	
	(m^3/day)	(m^3/s)	(m^3/day)	(m^3/s)	(m^3/day)	(m^3/s)
Water amount necessary to be supplied in 2020	74,286	0.860	79,664	0.922	153,950	1.782
Present Capacity	12,810	0.148	12,130	0.141	24,940	0.289
PROAGUA Project	22,200	0.257	30,200	0.349	52,400	0.606
This Project	39,276	0.455	37,334	0.432	76,610	0.887

5.2.2 Water Conveyance Plan

(1) Pipeline Routing

(a) Agreste Pipeline

Pipeline is installed, as much as possible, along the existing pathways or tracks and the existing pipelines passing from Ribeira through Cajaiba and Carrilho Villages leading to Itabaiana. Pipeline route is also planned so as to reduce the number of summits (high points) and concave sections (low points) in pipeline. The Agreste pipeline route is shown in Design Drawing of Figure-5.6 shown in Section 5.4.

(b) Piauitinga Pipeline

Pipeline is installed, as much as possible, along the existing pathways or tracks which run near the construction site of Pump Station and lead toward Jenipapo. From Jenipapo to Lagarto, the pipeline is laid along the existing roads. Jenipapo, Brasilia, Acuvelho and Urubutinga villages are located along the pipeline route. Pipeline route is also planned so as to reduce the number of summits (high points) and concave sections (low points) in the pipeline. The Piauitinga pipeline route is shown in Design Drawing of Figure-5.6 shown in Section 5.4.

(2) Pump Station, PS

(a) Selection of Location of PS

Water Intake pump station is installed facing the Vaza Barris Reservoir near to Vaza Barris Dam in order to pump up water directly from the Reservoir. Although the Agreste and Piauitinga pipelines run in right and left banks of Vaza Barris River, respectively, the Water Intake Pump Station for both pipelines, WIPS is located jointly in the right bank of the river due to the following reasons:

- Water Intake Pump Station for Vaza Barris Irrigation Project, WIPSI, is constructed in the right bank to facilitate the water supply to the Irrigation Project Area located in the right bank of Vaza Barris River.
- The pump capacity for WIPSI is much larger than those required for WIPS.
- In the case that the pump station WIPS is constructed separately in the right and left banks of the Vaza Barris reservoir, the cost for construction, operation and maintenance of the pump stations, including the construction of substation for electric power supply for the pumps are much higher than three pump stations constructed at the same place in the right bank.

(b) Type of Pumps

Water intake pump is a vertical flow type to cope with the high suction head of 30m and high fluctuation of seasonal change of 20m in water intake level in the reservoir. Number of the water intake pumps is three for normal operation plus one for stand-by considering the assurance of high reliability and redundancy of pump system and high applicability for fluctuation of water supply volume.

Uni-type pump system composed of vertical pumps to cover the whole system is not recommendable when the high total head of the system, which is caused by geographical difference in intake and discharge water levels and high friction head due to long distance pipeline, is expected. In order to mitigate the water hammer effect in the systems and to make the pump system simple, two types in function of pumps are introduced in each System, namely, 1) Water intake pumps composed of vertical pumps, 2) Water lift pumps composed of horizontal pumps. The above two systems are connected with the connecting reservoir as specified in the proceeding section.

(3) Connecting Reservoir

Volume of connecting reservoir is capable of storage of water to be discharged at least in one hour and half of operation of pumps. This duration of time is determined based on the possible operational condition of pumps and the possibility of occurrence of electric power outage. The electric power outage is expected to occur on average once in every

25 days, and its averaged duration of 1.5 hour at Cajaiba S/S. For details of electric power supply condition, refer to Section 5.3.6.

(4) Other Required Facilities

The countermeasures such as air release valves, level invert tee, stop valves and surge tanks are provided where required to mitigate the technical problems caused by the long distance and the frequent vertical ups and downs in the pipelines and to make easy maintenance work of pipelines:

5.3 Design of Water Conveyance Facility

5.3.1 Water Intake Pump Station, WIPS

Piauitinga and Agreste Water conveyance systems are used for domestic and industrial water supply. The construction works is implemented in two phases in each route. Water intake pumps are a vertical type composed of 3 pumps for normal operation and 1 pump for stand-by for each phase. These pumps are used commonly for water supply for both regions.

(1) Design Conditions

< Water Intake Level in the Vaza Barris Reservoir >

- High Water Level : EL. 52.7 m
- Normal Water Level : EL. 47.5 m
- Low Water Level : EL. 35.2 m
- Sedimentation Surface Level : EL. 28.6 m

< Water Intake Volume >

- Phase-1 stage : 0.533m^3/s (0.260 for Piauitinga and 0.273 for Agreste)
- Phase-2 stage : 0.533m^3/s (0.260 for Piauitinga and 0.273 for Agreste)
- Total : 1.066m^3/s (0.520 for Piauitinga and 0.546 for Agreste)

(2) Location of WIPS

WIPS is constructed in the Vaza Barris Reservoir at the right bank of the river. The location of WIPS is selected as shown in Figure-5.3 taking the following technical aspects into consideration:

- To avoid the interference with dam construction work
- To secure the lowest water intake level of EL. 28.6 m
- To secure smooth water intake from the reservoir
- To intake as much as possible the water from Trairas River Basin

(3) Design of Water Intake Pump House

Water Intake Pump House, WIPH, is designed considering the following technical points:

- WIPH is designed as reinforced concrete structure.
- Intake tower is required to assure direct intake from the reservoir by vertical pumps.
- Bridge to WIPH is required for transportation of equipment and materials as well as support for pipelines to the Connecting Reservoir.
- Floor level is almost 5 meters above H.W.L. so as not to be affected by the waves

in the reservoir
- Floor level is taken as EL. 57.5 m.
- Surface water intake is assured during normal operation
- Stop logs are used for surface water intake. Screens are also installed.
- Installation and maintenance of pumps, fittings, accessories, stop logs, screens, etc. is performed by over-head travelling crane.
- Intake tower and spaces for pumps in Phase 2 is constructed in Phase 1 stage.
- Pumps in Phase-2 are installed in dry work by closing water intake tower by stop logs.
- Intermediate stage or floor is required to support the shaft of vertical pumps in position. Intermediate floors at around 10m in height are provided.

Design drawings of Water Intake Pump House are shown in Figure-5.7 in Section 5.4. Technical Description of Water Intake Pumps is described in Table-5.3 and vertical profile of the pipeline is shown in Figure-5.2.

Table-5.3 Technical Description of Water Intake Pump

Pump Name	WIP 1 & 2	
Use	Domestic and Industrial	
Treatment	Raw	
Phase	1	2
Quantity	3 + 1	3 + 1
Total head	41 m	41 m
Actual head	*40 m*	*40 m*
Head loss	*1 m*	*1 m*
Max. Suction head	30 m	30 m
Discharge	0.533 (0.178)	0.533 (0.178)
Pipeline Dia.	700 mm	700 mm
Pipeline Length	80 m	80 m

Note 1 : Discharge of pumps to be a total discharge with 3 pumps in operation. Discharge in ( ) to be per one pump. Unit of discharge : m^3/s

Note 2 : The pipeline in Phase 2 will be constructed beside the pipeline constructed in Phase 1.

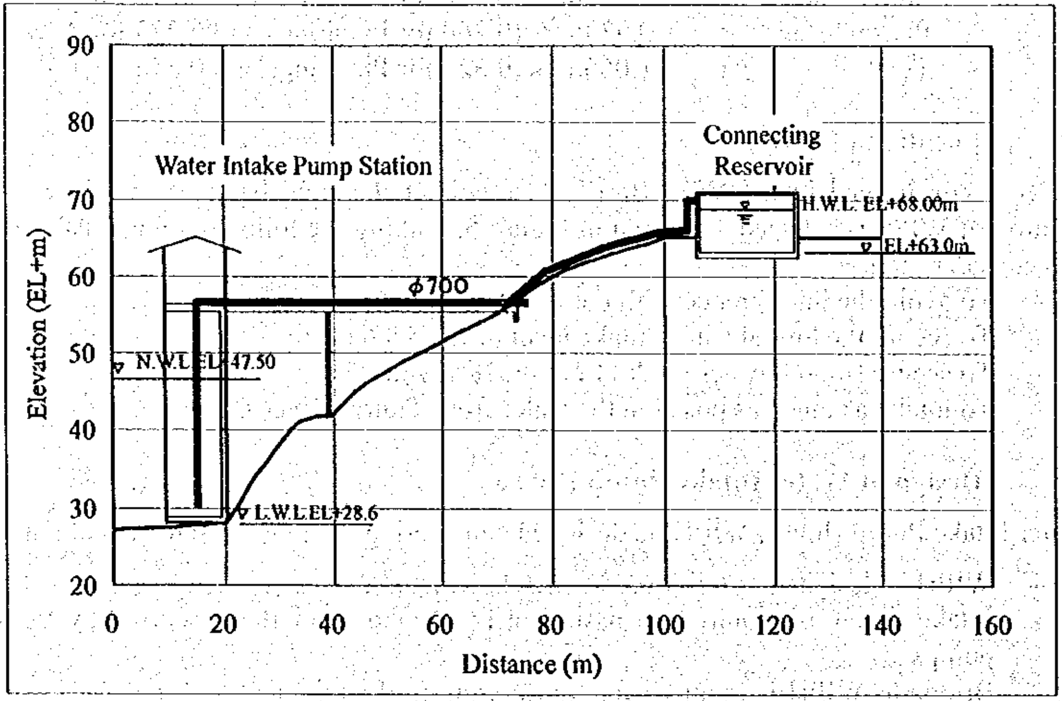


Figure-5.2 Vertical Profile of Pipeline

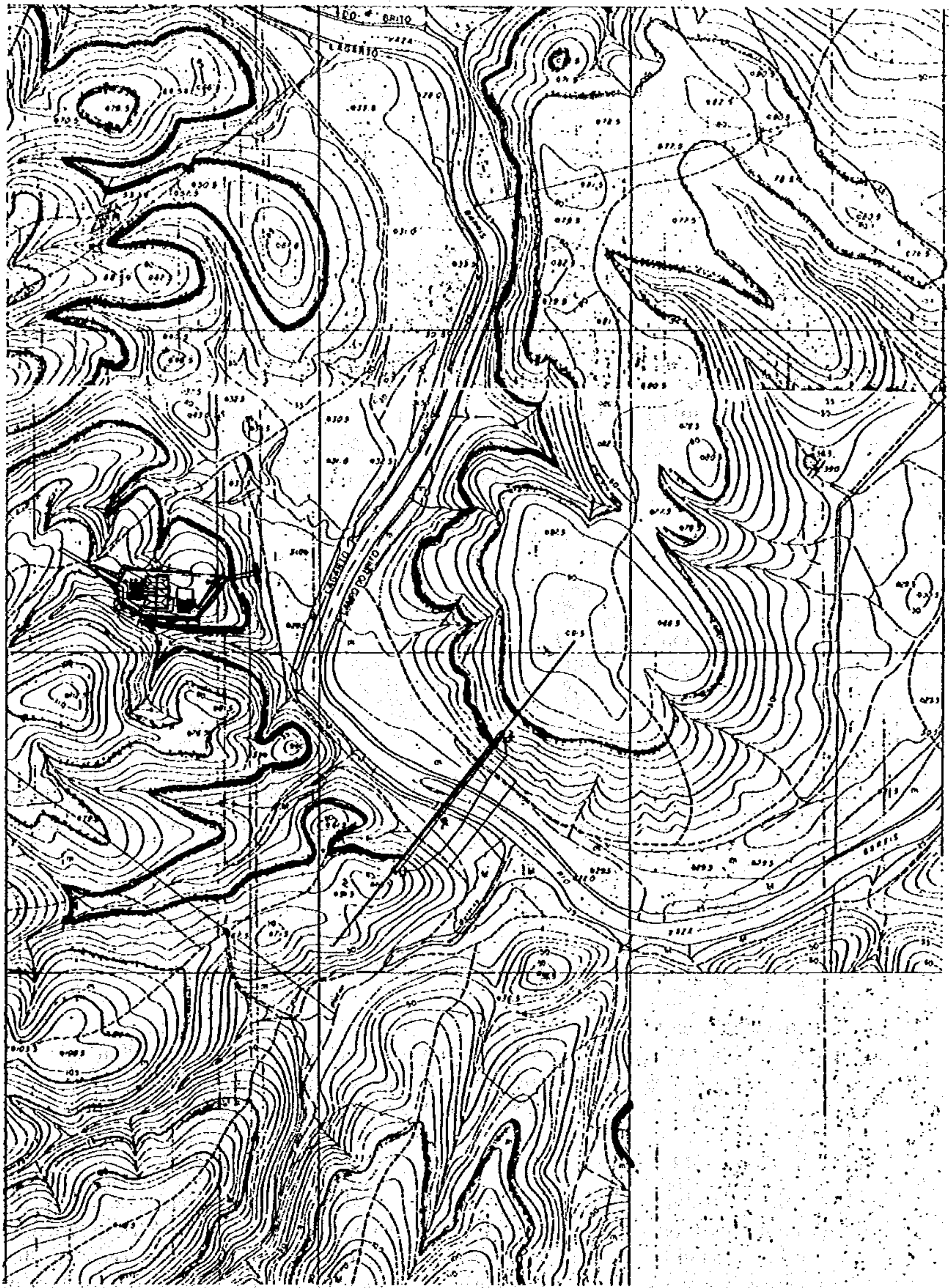


Figure-5.3 Location of WIPS

(4) Method of Operation

The pumps are operated for 24 hours a day. Water intake pumps is operated automatically in accordance with the discharge water level in the connecting reservoir, which is constructed down stream of water lift pump station. Numbers of pumps in operation at water intake pump station is also selected automatically in accordance with the discharge water level in the connecting reservoir. Water intake pumps is also controlled to stop their operation automatically when the suction water level in the dam reservoir falls down to the Sedimentation Surface Level.

The pumps and pipeline to be constructed in Phase 2 is completely the same as those to be constructed in Phase 1. Total discharge volume in Phase 2 is double volume in Phase 1. The electrical stoppage is expected to occur in every 25 days and its duration is 1.5 hours on average according to the registered record in 1998 and 1999 as shown in 5.3.6.

(5) Pump Unit Specification

< Pump >

- Units : 3 + 1R per one construction phase
- Type : vertical mixed flow
- Discharge : 0.178 m^3/s per one pump
- Total head : 41 m

< Electric Motor >

- Rotation : 1160 rpm
- Voltage : 440 V
- Power : 110 kW (150 PS)

5.3.2 Connecting Reservoir

Connecting reservoir is required for smooth conveyance of water from WIPS to the Water Lift Pump Stations and for provision of buffer reservoir against troubles in operation of Water Intake Pumps.

(1) Design Conditions

< Finished Ground Level >

- F.G.L. : EL. 65.0 m

< Required Storage Capacity >

- Phase-1 : Max. (0.260, 0.273)m^3/s x 3,600sec/hr x 1.5hr = 1,500m^3
- Phase-2 : Max. (0.260, 0.273)m^3/s x 3,600sec/hr x 1.5hr = 1,500m^3
- Total : Max. (0.519, 0.546)m^3/s x 3,600sec/hr x 1.5hr = 3,000m^3

(2) Design of Connecting Reservoir

Connecting Reservoir is designed with reinforced concrete. Water Level in the Connecting Reservoir is decided as H.W.L. EL. 68.0 m and L.W.L. EL. 63.0 m based on the finished ground level of EL. 65.0 m. The reservoir is divided into two basins, so that the maintenance work of one basin during operation is secured without interruption of water supply. Therefore, the dimension of one basin of the reservoir is determined as 17.4m(W) x 17.3m(L) x 5.0m(H). The following facilities are provided in the connecting reservoir:

- Inlet and outlet pipes
- Overflow pit and pipe for emergency overflow
- Drain pit for discharge at maintenance work
- Gate valve with float for water level control in the reservoir
- Ventilation pipes

(3) Sequence of Construction and Method of Operation

Connecting Reservoir with the storage capacity of 3,000m³ is required for each Water Conveyance System, namely CR1 for Agreste and CR2 for Piauitinga, after completion of Phase-2 construction work. In Phase-1 construction stage, the Connecting Reservoir CR1 is constructed and is used one basin for Agreste and the other for Piauitinga. In Phase-2, CR2 is constructed for Piauitinga use and CR1 is converted for Agreste use. The conversion work is managed by combination of valve operation.

5.3.3 Water Lift Pump Station

Water lift pumps is composed of horizontal type pumps suitable for high total head with long distance conveyance. Pumps for Agreste and Piauitinga regions is operated separately with 2 pumps for normal operation and 1 pump for stand-by in each route in each phase. Pumps installed in Phase 1 is used continuously in Phase 2 with higher total head than in Phase-1.

(1) Selection of Pipeline Diameter

The study on the selection of combination of different diameters of pipelines and the associated pumps was elaborated considering the technical requirement for the systems. The cases for the Study and the results for Piauitinga pipeline are as shown in Table-5.4 and Table-5.5.

Although CASE-1 gives the lowest construction cost and annual expense, NPV is highest among all cases. This means that CASE-1 is not competitive in the viewpoint of investment. In addition, CASE-1 is not feasible due to financial reason mentioned above. CASE-3 is the most competitive for the investment in spite of its construction cost, annual expense and NPV are higher than in CASE-1.

Table-5.4 Summary of Cases for Study

Case	Phase	Diameter of Pipelines		
		Dam | Brasilia	SE-104	Lagarto
CASE-1	1	φ700 (1 line)	φ700(1 line)	φ700(1 line)
CASE-2	1	φ500(1 line)	φ500(1 line)	φ600(1 line)
	2	φ500(1 line)	φ500(1 line)	φ600(1 line)
CASE-3	1	φ700(1 line)	φ500(1 line)	φ600(1 line)
	2	-	φ500(1 line)	φ600(1 line)

Table-5.5 Result of the Preliminary Study

Unit : millions US$

Case	Investment (R$ million)				Annual Expense			Net Present Value
	Pipeline	Pump Civil	Pump Equipment	Total	Interest	O & M	Total	
CASE-1	14.83	0.92	3.69	19.47	1.747	1.390	3.137	33.748
CASE-2	17.16	1.02	4.07	22.25	1.997	1.636	3.633	33.417
CASE-3	16.57	0.90	3.80	21.27	1.912	1.548	3.460	32.317

(2) Water Lift Pump Station for Piauitinga, WLPS2

(a) Design Conditions

1) Water Intake Level : EL. 68.0 m
2) Water Discharge Volume
   - Phase-1 : 0.260 m^3/s
   - Phase-2 : 0.260 m^3/s
   - Total : 0.520 m^3/s

(b) Design of Water Lift Pump House

WLPS2 is constructed next to the connecting reservoir CR2. Water Lift Pump House is designed as shown in Design Drawing of Figure-5.8 in Section 5.4, taking the following technical points into consideration:

- The house is designed as reinforced concrete frame with masonry wall.
- Reinforced suction pit is provided for smooth intake of water from the connecting reservoir. Internal dimension of suction pit is 1.2m(W) x 17.8m(L) x 6.1m(H). H.W.L. is EL. 68.0 m as same as in the connecting reservoir and bottom level is EL. 62.5 m to secure water flow by gravity from the connecting reservoir.
- Floor level of pump pit is EL. 62.5 m as same as in the suction pit.
- Installation and maintenance of pumps, fittings, accessories, etc. is performed by manual monorail chain block of 2-ton capacity.

Technical description of the Pump System is shown in Table-5.6. Vertical profile of the system is shown in Figure-5.4.

Table-5.6 Technical Description of Pump System

Pump Name	Lift 1		
Use	Domestic and industrial		
Treatment	Raw		
Phase	1*	1*	2
Quantity	2 + 1	2 + 1	2 + 1
Total head	140 m	161 m	161 m
Actual head	*132 m*	*132 m*	*132 m*
Head loss	*8 m*	*29 m*	*29 m*
Suction head	2 m	2 m	2 m
Discharge	0.260 (0.130)	0.519 (0.130)	(0.130)
Pipeline Dia.	700 mm	700 mm	
Pipeline Length	11.1 km	11.1 km	

Note 1 : Discharge of pumps to be total discharge with 2 pumps in operation. Discharge in ( ) to be per one pump. Unit of discharge in m^3/s

Note 2 : Pumps installed in Phase-1 stage to be operated with higher total head in Phase-2 stage.

(c) Method of Operation

In principle, the pumps are operated for 24 hours a day. Water lift pumps is stopped their operation automatically when the water level in the connecting reservoir is lower than three meters below normal water level in the connecting reservoir. The pipeline constructed in Phase-1 is used in Phase-2 with the flow volume 2 times greater than that in Phase-1, which results in the increase in total head in the system. The pumps installed in Phase-1 are operated continuously in Phase-2 with total head higher than that in Phase-1. The pumps installed in Phase-2 are operated parallel with the pumps installed in Phase-1. The condition of electrical stoppage is the same as for the water intake pumps.

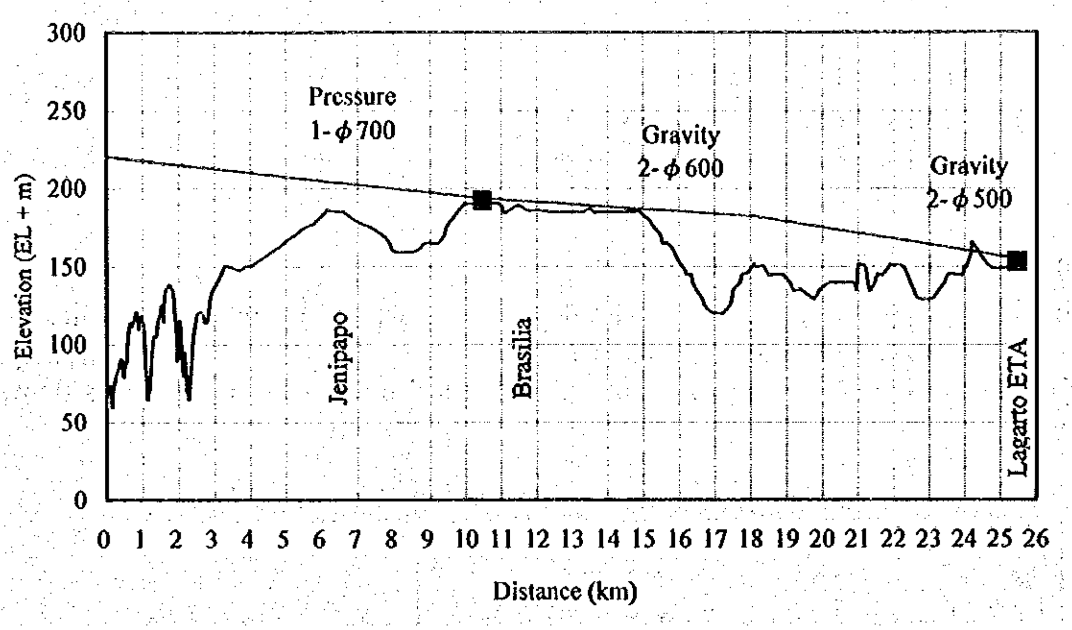


Figure-5.4 Vertical Profile of Piauitinga Pipeline in Phase-2

(d) Water Hammer

In general, water hammer is expected to occur when designing a high head pump, large capacity pump, pump-conveying water to a long distance, etc. Water Lift Pumps have the characteristics that are most likely to cause water hammering.

Water hammer analysis was executed to grasp the occurrence of water hammering in the pump system. Through various trial-and-error water hammer analyses, it is found that the provision of flywheel to the pumps and one-way surge tanks in two locations are effective.

(e) Pump Specification

1) Pump
- Units : 2 + 1R
- Type : horizontal
- Discharge : 0.130 m^3/s per one pump
- Total head : 140 m (Phase-1) and 161 m (Phase-2)
- Flywheel : 100 $kg \cdot m^2$

2) Motor
- Rotation : 1,775 rpm
- Voltage : 440 V
- Power : 294 kW (400 PS)

(3) Water Lift Pump Station for Agreste, WLPS1

(a) Design Conditions

1) Water Intake Level : EL. 68.0m

2) Water Discharge Volume
   - Phase-1 : 0.273 m^3/s
   - Phase-2 : 0.273 m^3/s
   - Total : 0.546 m^3/s

(b) Design of Water Lift Pump House

WLPS1 is constructed next to the connecting reservoir CR1. WLPS1 is designed as same as WLPS2 shown in Design Drawing of Figure-5.8 in Section 5.4. Technical description of the Pump System is shown in Table-5.7. Vertical profiles of the system is shown in Figure-5.5.

Table-5.7 Technical Description of Pump System

Pump Name	Lift 2		
Use	Domestic		
Treatment	Raw		
Phase	1*	1*	2
Quantity	2 + 1	2 +1	2 + 1
Total head	196 m	214 m	214 m
Actual head	*189 m*	*189 m*	*189 m*
Head loss	*7 m*	*25 m*	*25 m*
Suction head	2 m	2 m	2 m
Discharge	0.273	0.546	
	(0.137)	(0.137)	(0.137)
Pipeline Dia.	700 mm	700 mm	
Pipeline Length	8.8 km	8.8 km	

Note 1 : Discharge of pumps to be total discharge with 2 pumps in operation. Discharge in ( ) to be per one pump. Unit of discharge in m^3/s

Note 2 : Pumps installed in Phase-1 stage to be operated with higher total head in Phase-2 stage.

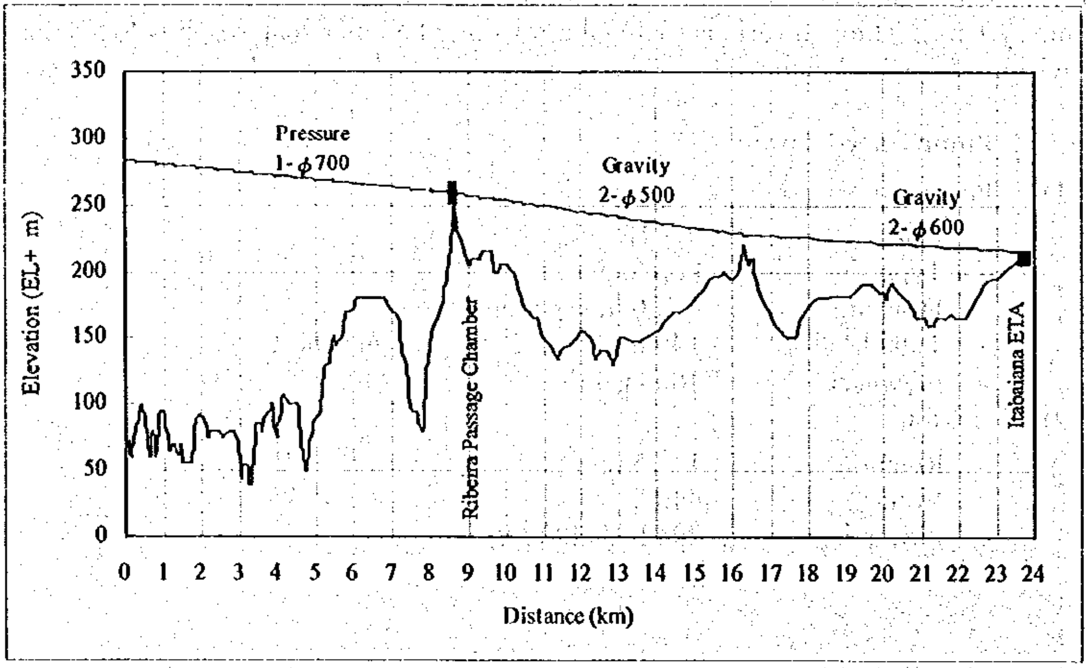


Figure-5.5 Vertical Profile of Agreste Pipeline in Phase-2

(c) Method of Operation

Method of operation in the Agreste system is as same as in the Piauitinga system.

(d) Water Hammer

Water hammer analysis was executed to grasp the occurrence of water hammering in the pump system. Through several trial-and-error water hammer analysis, it is found that the one-way surge tanks in one location is effective.

(e) Pump Specification

1) Pump
- Units : 2 + 1R
- Type : horizontal
- Discharge : 0.137 m^3/s
- Total head : 196 m (Phase-1) and 214 m (Phase-2)

2) Motor
- Rotation : 3,500 rpm
- Voltage : 440 V
- Power : 294 kW (400 PS)

5.3.4 Piauitinga Water Conveyance Pipeline

(1) Characteristics of Pipeline

Characteristics of Pipeline route determined based on the water conveyance plan in chapter 5.2 are as follows:

(a) Design Conditions

- Service Pressure in the Pipeline
- Permissible Service Pressure : 1.58Mpa
- Maximum Service Pressure : 1.58Mpa

(b) Materials

Unless otherwise specified, all pipe materials is ductile cast iron.
Class of Push-on Joint Type pipe is K7 in accordance with the Service pressure in the pipeline.

(c) Length

ϕ 700 : 10,416 m
ϕ 600 : 7,783 m per Phase (total length in two phases 15,566 m)
ϕ 500 : 7,206 m per Phase (total length in two phases 14,412 m)

(d) Ground Elevation

Vertical profile of the pipeline is shown in Design Drawing of Figure-5.9 in Section 5.4.
Lowest elevation : EL. 60 m
Highest elevation : EL. 190 m

(e) Conditions of Ground Surface in Pipeline Route

Type of ground surface and its length is as follows:

- Pasture : 4,324 m
- Bare land : 20,911 m
- Pavement : 80 m
- Over-pass : 90 m

(f) Over-pass

As the result of field survey, the following over-pass of rivers is required:

- Urubu River Crossing (40 m in length)
- Urubutinga River Crossing (6 m in length)
- Machado River Crossing (40 m in length)

(g) Road Crossings

Major road crossings are as follows:

- Crossing with SE-214 at the intersection of road from Jenipapo (20 m in length)
- Crossing with branch road from SE-214 in Brasilia (30 m in length)
- Crossing with SE-104 at intersection of road from Brasilia (10 m in length)
- Crossing just before Lagarto Water Treatment Station (20 m in length)

(2) Connecting Reservoir, CR4

Connecting reservoir is required for smooth conveyance of water from pressurized pipeline of diameter 700 mm to the pipeline of diameter 600 mm by gravity.

(a) Design Conditions

- Finished Ground Level - F.G.L. : EL. 190.0 m
- Water Level in the Reservoir - H.W.L. : EL. 194.0 m
  - L.W.L. : EL. 189.0 m
- Required storage capacity: As same as CR2.

(b) Design of Connecting Reservoir

The dimensions of CR4 are the same as CR1 and CR2. One basin of CR4 with the storage capacity of 1,500m^3 is constructed in Phase-1 and the other basin with the same capacity is constructed in Phase-2.

(3) One Way Surge Tank

(a) Design Conditions

No.	Location (m)	Ground Elevation (EL.m)	W.L. (EL.m)	Cross section Area (m^2)	Height (m)
1	3,300	150.0	> 160.0	10	> 3.0
2	6,200	186.0	> 195.0	10	> 5.0

(b) Design of Surge Tank

One way surge tank is elevated reinforced concrete tank and is constructed in Phase-1.

5.3.5 Agreste Water Conveyance Pipeline

(1) Characteristics of Pipeline

Characteristics of Pipeline route determined based on the water conveyance plan in Section 5.2 are as follows:

(a) Design Conditions (Service Pressure in the Pipeline)

- Permissible Service Pressure : 2.10Mpa
- Maximum Service Pressure : 2.88Mpa

(b) Materials

Unless otherwise specified, all pipe materials is ductile cast iron. Class of Push-on Joint Type pipe is K7 in accordance with the Service pressure in the pipeline.

(c) Length

ϕ 700 : 8,784 m
ϕ 500 : 7,659 m per Phase (total length in two phases 15,318 m)
ϕ 600 : 7,529 m per Phase (total length in two phases 15,058 m)

(d) Ground Elevation

Vertical profile of the pipeline is shown in Design Drawing of Figure-5.10 in Section 5.4. Lowest elevation is EL. 40 m and highest elevation is EL. 240 m.

(e) Conditions of Ground Surface in Pipeline Route

Type of ground surface and its length is as follows:

- Pasture : 19,055 m
- Bare land : 4,138 m
- Pavement : 160 m
- Over-pass : 610 m

(f) Details of Over-pass

As the result of field survey, the following over-pass of rivers is required:

- Vaza Barris Dam Crossing (280 m in length)
- Ribeira River Crossing (40 m in length)
- Moca River Crossing (20 m in length)
- Pedras River Crossing (50 m in length)
- Marsh Crossing (110 m in length)
- Taboca River Crossing (50 m in length)

(g) Road Crossings

Major road crossings are as follows:

- Crossing with BR-235 the intersection of SE-104 from Lagarto (120 m in length)
- Crossing with branch road from BR-235 ate Itabaiana WTS (40 m in length)

(2) Connecting Reservoir, CR3

Connecting reservoir is required for smooth conveyance of water from pressurized pipeline of diameter 700 mm to the pipeline of diameter 500 mm by gravity.

(a) Design Conditions

– Finished Ground Level	- F.G.L.	:	EL. 255.0 m
– Water Level in the Reservoir	- H.W.L.	:	EL. 259.0 m
	- L.W.L.	:	EL. 254.0 m
– Required storage capacity:	As same as CR2.		

(b) Design of Connecting Reservoir

The dimensions of CR3 are the same as CR1 and CR2. One basin of CR3 with the storage capacity of 1,500m³ is constructed in Phase-1 and the other basin with the same capacity is constructed in Phase-2.

(3) One Way Surge Tank

(a) Design Conditions

No.	Location (m)	Ground Elevation (EL.m)	W.L. (EL.m)	Cross section Area (m^2)	Height (m)
1	6,000	180.0	> 188.0	20	> 2.0

(b) Design of Surge Tank

One way surge tank is elevated reinforced concrete tank and is constructed in Phase-1.

5.3.6 Electric Power Supply

(1) Existing Electric Power Supply System

(a) Cajaiba Substation

The existing electric power supply facility near the Project site is Cajaiba Substation (S/S). The electric power for Cajaiba S/S is supplied from Itabaiana S/S, located at Queimadas near Itabaiana City, via 69kV transmission line.

(b) 69 kV Outgoing Switchgear Bay

69 kV outgoing switchgear bay is constructed in the existing Cajaiba S/S to supply electric power to the new Vaza Barris S/S. Specification of equipment and structures is in accordance with ENERGIPE Standard.

1) Composition of equipment: Lightning arresters, disconnecting switches, gas circuit breakers, current transformers, post insulators, potential transformers and cable heads
2) RC Structures: Gantry towers and pedestals
3) Others: Insulators, hard wares, conductors, etc.

(c) Electric Power Failure

The record of duration and stoppage of electric power in Cajaiba S/S in the past four years shows that the electrical stoppage at Cajaiba S/S was occurred in every 25 days and its duration is 1.5 hour in 1998 and 1999 on average.

(2) Vaza Barris Sub-station

The new substation, called Vaza Barris S/S, is constructed for electric power supply to Water Intake Pump Station for the Water Supply Projects to Itabaiana and Lagarto Cities and Vaza Barris Irrigation Area. The electric power is received from Cajaiba S/S.

(a) Electric Power Demand

– Domestic and Industrial Water Supply				
	Water Intake Pumps	110 kW x 3 x 2	=	660 kW
	Conveyance Pumps	300 kW x 2 x 2	=	1,200 kW
	300 kW x 2 x 2		=	1,200 kW
	Subtotal			3,060 kW
– Irrigation Water Supply		2,200 kW x 4	=	8,800 kW
– Building facility, etc.				1,000 kW
– Total				12,860 kW

(b) Components to be constructed and/or installed

In the Vaza Barris S/S, it is constructed the control and electrical building, high voltage and low voltage main transformers, 69kV outdoor switchgear, high voltage and low voltage distribution boards, DC power supply equipment and the control and protection panel for 69kV outdoor switchgear.

(3) Layout Plan

The substation equipment for the Project is installed on the land near the Water Intake Pump Station and the following equipment configuration is adopted.

The 69kV switchgear and the main transformers are installed outdoor. A control building is constructed to install the indoor equipment mentioned above.

(4) Transmission Line

The route for the 69kV transmission line from Cajaiba S/S to Vaza Barris S/S has been selected based on the existing 1:5,000 map and the electrical network map supplied by ENERGIPE. The type of electric poles, bare conductor for overhead transmission lines and other required materials and equipment for transmission lines is in conformity with ENERGIPE standard.

5.4 Design Drawings

The design drawings are shown in Figure-5.6 to Figure-5.10.

1) Figure-5.6 Pipeline Routes
2) Figure-5.7 Water Intake Pump House
3) Figure-5.8 Water Lift Pump House
4) Figure-5.9 Vertical Profile of Piauitinga Pipeline
5) Figure-5.10 Vertical Profile of Agreste Pipeline

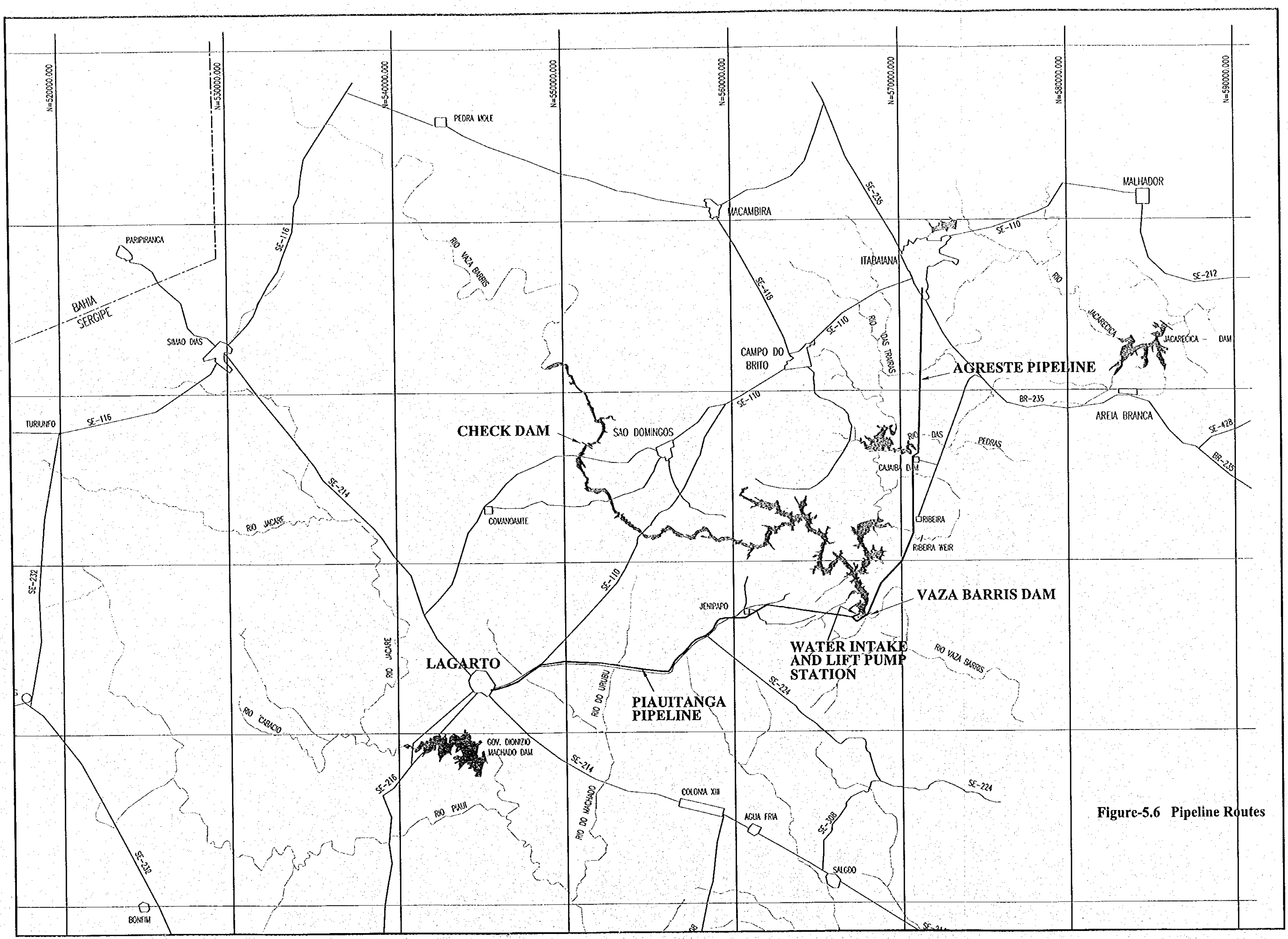


Figure-5.6 Pipeline Routes

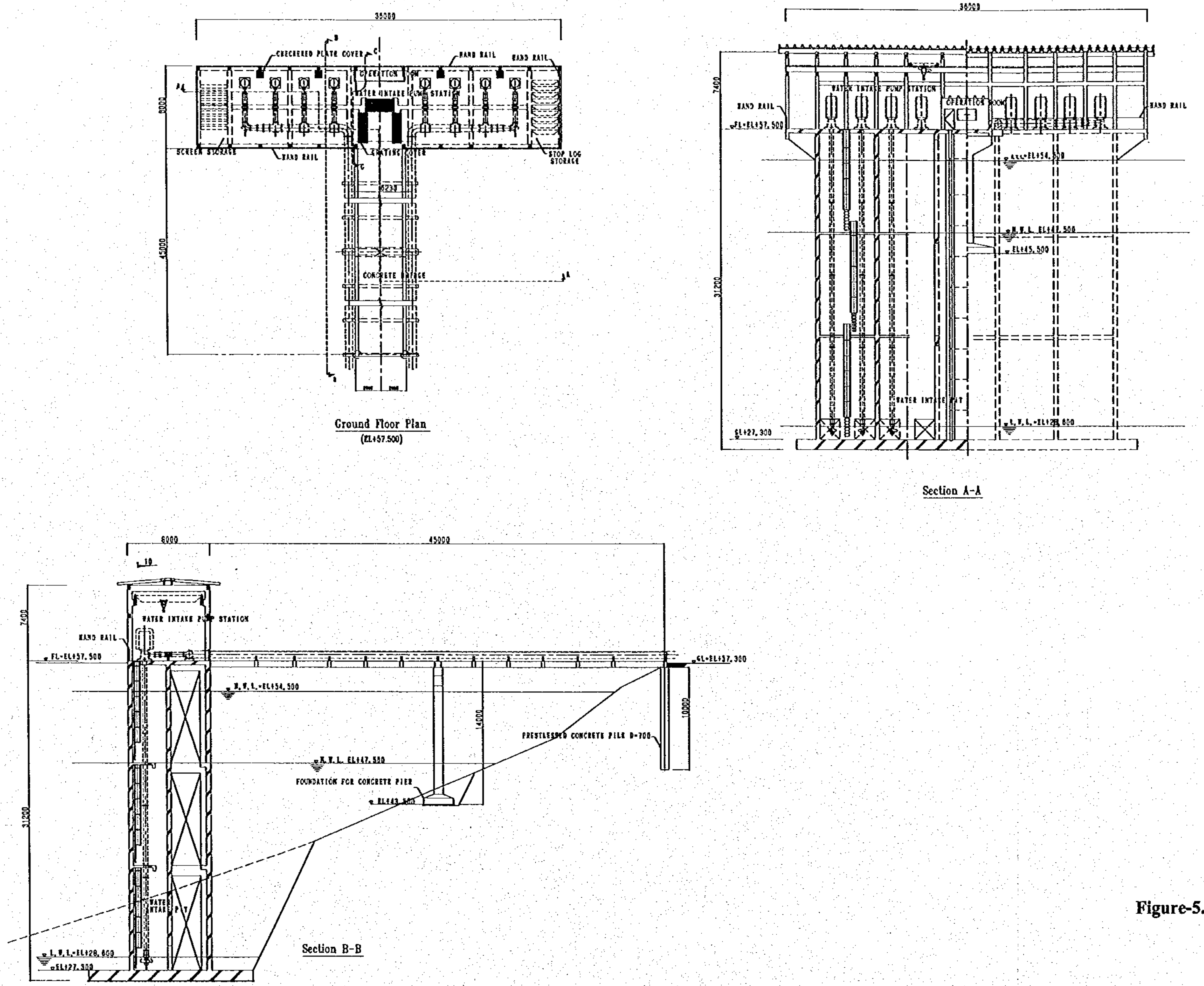
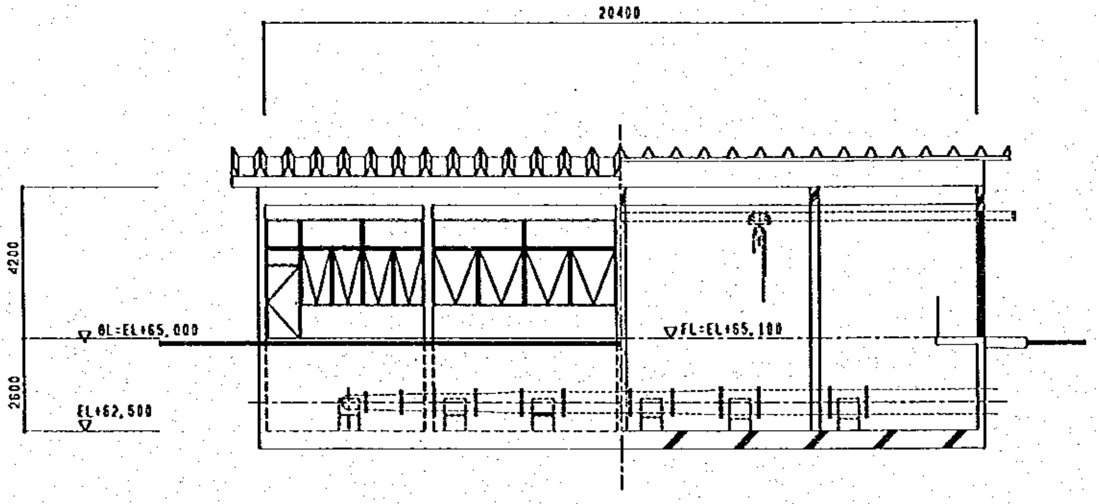
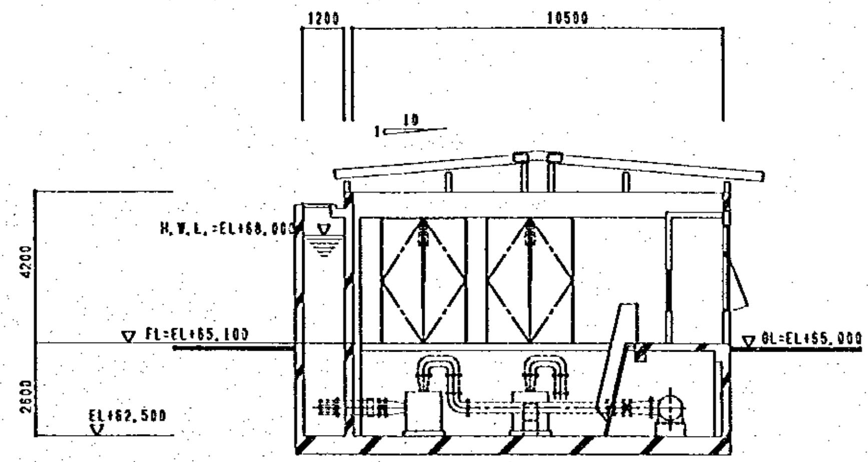


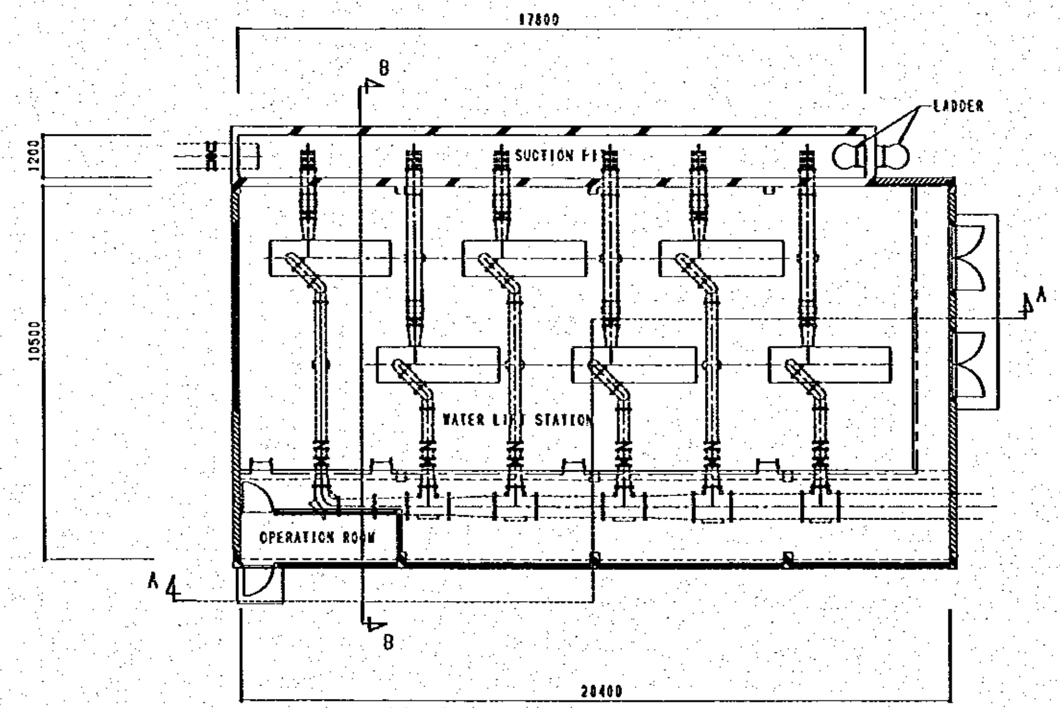
Figure-5.7 Water Intake Pump House



Section A-A S=1:100

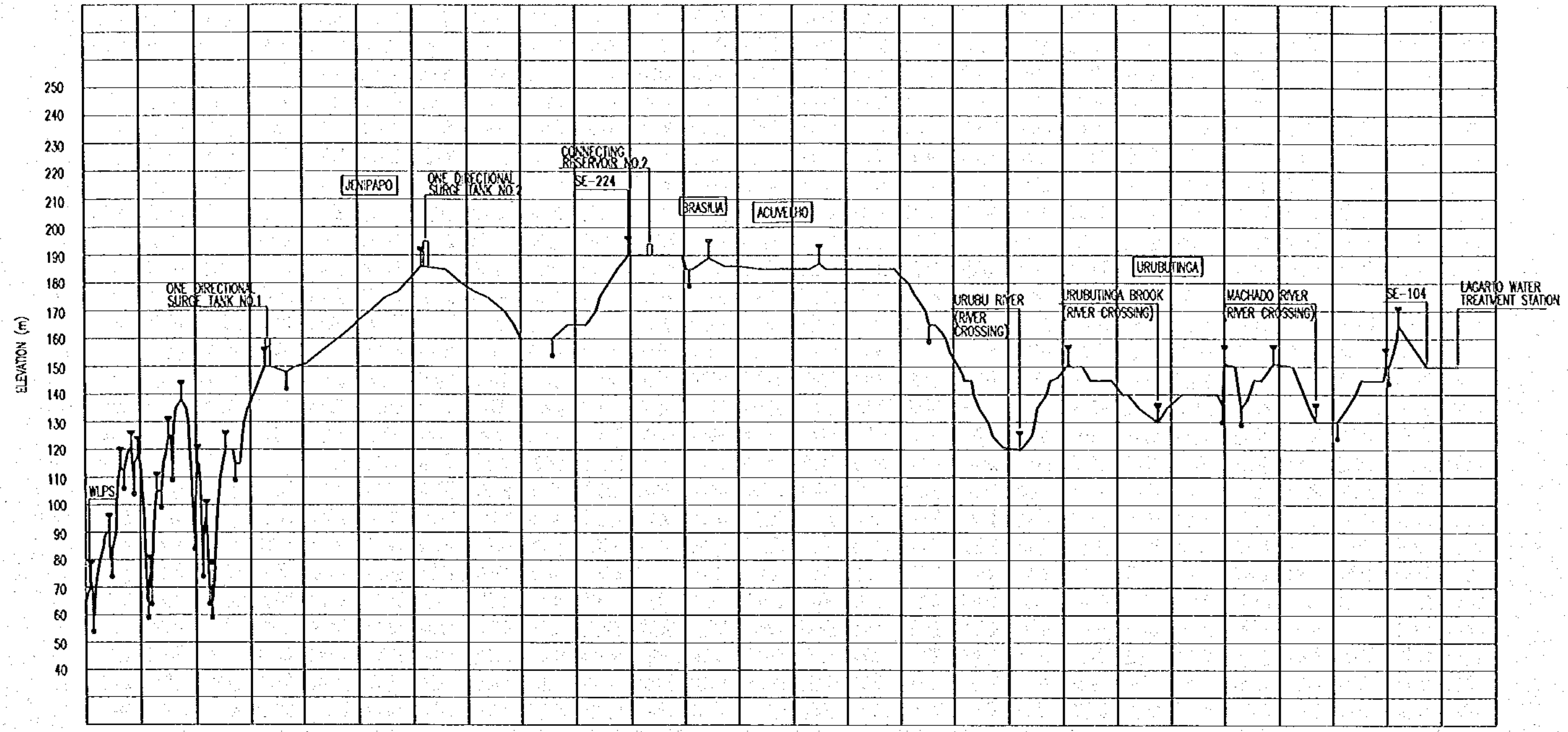


Section B-B S=1:100



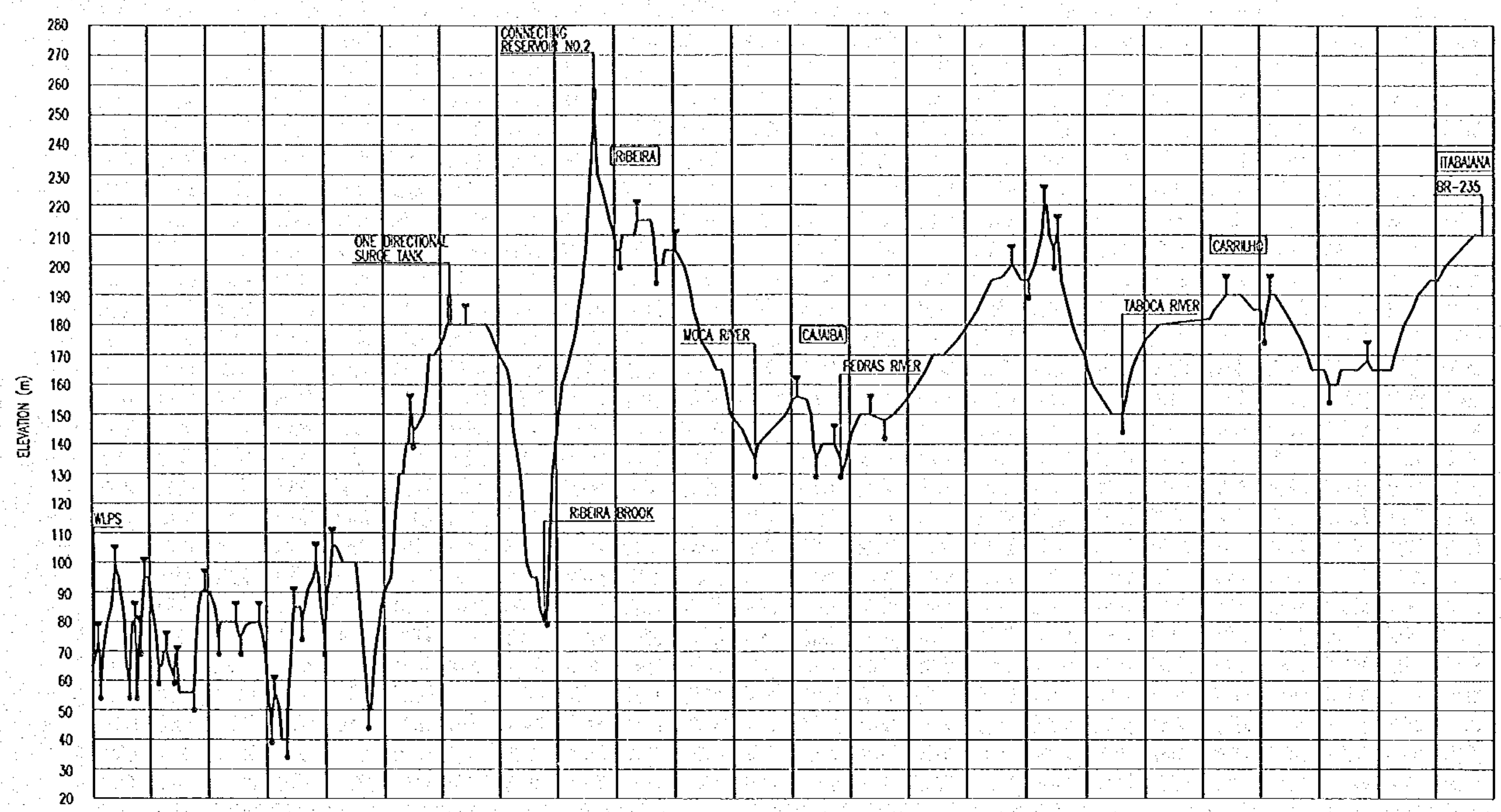
Ground Floor Plan S=1:100

Figure-5.8 Water Lift Pump House



STATION NO.	0	164	307+10	516	905	1265
TOTAL DISTANCE (M)	0	3280	6150	10320	18100	25300
PARTIAL DISTANCE (M)	0	3280	2870	4170	7780	7200
GROUND ELEVATION (M)	65.0	150.0	186.0	190.0	151.0	150.0
INVERT ELEVATION (M)	63.3	148.3	184.3	188.3	149.4	148.5
PIPE	ø700 PRESSURE			ø600 GRAVITY	ø500 GRAVITY	

Figure-5.9 Vertical Profile of Piauitinga Pipeline



STATION NO.	0	306	437	815	1191
TOTAL DISTANCE (M)	0	6120	8660	16300	23820
PARTIAL DISTANCE (M)	0	6120	2540	7640	7520
GROUND ELEVATION (M)	65.0	180.0	255.0	220.0	210.0
INVERT ELEVAION (M)	63.3	178.3	253.3	218.5	208.4
PIPE	φ700 PRESSURE			φ500 GRAVITY	φ600 GRAVITY

Figure-5.10 Vertical Profile of Agreste Pipeline

CHAPTER 6 ENVIRONMENTAL MITIGATION PLAN

6.1 Natural Environment Mitigation

6.1.1 Reforestation

Buffer areas around the reservoir and two dam sites should be created, where reforestation programs should be implemented to replace or to create lost vegetation such as riverside forests. Total 300 hectares, as about 3.3 times of the inundated forest area (approximately 90 ha), or 30,000 trees will be reforested in this project. The items of the reforestation sites are as follows:

– Around Vaza Barris Dam site:	150 hectares
– Around the check dam site:	50 hectares
– Along the reservoir:	100 hectares

A harmonious landscape should be taking into account in the reforestation programs. Plants species must be selected in consideration with adaptability to the environment. It is advisable in the viewpoint of ecology to use local plants in the reservoir area. Therefore, most of the nursery trees should be gathered from existing riverside forests near the reforestation sites. In two dam sites, because it will be difficult to gather sufficient natural nursery trees, artificial nursery will be needed to cover the sites. It is impossible to reforest a circumference of the reservoir wholly. The priority sites are selected as follows:

1) Circumference of the existing forest
2) Riverside of the tributary
3) Flat area or side of the construction road (easy to work)
4) Conspicuous place such as the state road bridge

6.1.2 Reservoir Water Quality

Because the decay of the vegetation left in the reservoir at the time of first water filling might influence to nutrient level in the reservoir water, vegetation in inundated area should be cut and removed in advance. These removed trees might be utilized to reforestation areas. To protect the water quality of the reservoir, settlements around the reservoir should be limited except for the families relocated by this project. The water quality monitoring should be conducted periodically.

6.1.3 Another Environmental Mitigation

The designs of the two pipeline alignments should consider minimizing the changes to natural environment. To minimize soil erosion, slope cutting, land clearing and soil stripping works should be mainly implemented during the dry season. To prevent noise, dust, water pollution, soil contamination and vibration, the contractors should maintain the heavy equipment in good condition and use suitable methods and equipment.

An environmental specialist should be enlisted as part of the site supervisor consultants to control soil erosion, dust, water pollution and inadequate tree cutting, and to monitor and the environmental aspects and the mitigation measures such as reforestation programs.

Environmental monitoring should be conducted to recognize the transition of environmental aspects such as water, fauna and vegetation in both periods during construction and operation. Especially, the long-term transitions of ecosystem and topography in the estuary should be monitored according to the prior plan from before the construction begins. The monitoring data should be open to the public and utilized by scientists, consultants, teachers and fisher persons.

6.2 Social Environment Mitigation

6.2.1 Land Acquisition and Resettlement

The information disclosure should be conducted at an early stage to obtain the agreement of affected population such as the landowners of the reservoir area and people required to relocate. The compensation and relocation plan must be well planned and satisfy these population.

6.2.2 Division of Local Community

The compensation for negative impact on economic activity must be well planned and sufficient. Landowners of pastureland divided by the reservoir should be especially considered. Because the corridor from the end of the reservoir to the check dam, about 9km long, will dry up during dry season, bathing points for the livestock will be lost in the corridor. Constructions of wells or small pools for the livestock should be considered depending on claims from the farmers.

6.2.3 Fishery in the Estuary

To obtain the agreement of fisher persons in the estuary, information disclosure should be conducted at an early stage of the project. Furthermore, not only affected people around the reservoir area but the fisher persons should be made to participate in the public hearing.

Annual monitoring on fishery activities should be conducted to recognize the impacts of the projects on the fishing industry. This monitoring should be conducted according to the prior plan from before the construction began. The monitoring data should be open to the public and utilized by scientists, consultants, teachers and fisher persons.

In general, it is impossible to estimate the exact impacts of a dam project on the ecosystem of a downstream area at the present time. If the serious impacts on the fishery are identified in the future, some compensation might be needed for the fisher persons. Not only economical compensation but also introduction of new fishery technique such as artificial incubation and farming should be considered as part of the compensation. As the dam reservoir must be a good candidate for inland fish culture, artificial fishery in the reservoir could be proposed.

CHAPTER 7 OPERATION AND MAINTENANCE PLAN

7.1 Preparation of Organization

7.1.1 Operating Entities

After completion of the construction works of the Project, the following entities would be in charge of operation. Completed facilities should be handed over to each entity for operation and maintenance.

1) Vaza Barris Multipurpose Dam: A project office under a Water Agency
2) Domestic Water Supply in Urban and Large Rural Areas: DESO
3) Irrigation Water Supply: COHIDRO (or the autarchy as proposed in the Master Plan)

Since DESO and COHIDRO currently operate similar schemes, preparation of operating organization is discussed only for the operation of the multi-purpose facilities.

7.1.2 Establishing Operating Entity for Multi-purpose Facilities

Possible entity in charge of operation and maintenance of the multi-purpose facility would be DESO or COHIDRO, both of which have experience in operation and maintenance of water facilities. However, the project has a characteristic of multi-purpose, and equitable operation and maintenance cannot be fully expected by a single-purpose operator such as DESO or COHIDRO, although they are the public entities, in case that some conflicts between domestic water supply and irrigation arise. SEPLANTEC should promote establishment of a water agency in coordination with Bahia State under permission of federal organs, allocating capable staff with similar experiences in cooperation with DESO and COHIDRO.

Since the Vaza Barris River, which runs in Sergipe and Bahia states, is of federal domain, the competent water agency is the agency for Vaza Barris basin under the National Water Agency (ANA). In case of delay of establishment of the agency, SEPLANTEC can ask ANA to delegate the operation and maintenance in the area of the State to the State Government. Current draft of the law establishing ANA (Art. 2), shows high possibility of the delegation. In case ANA approves the delegation, the functions of operation and maintenance can be placed under SEPLANTEC with the inspection by ANA. SEPLANTEC can conclude an agreement for outsourcing to DESO or COHIDRO for day-to-day operation, as far as equitable management is assured, using their capability of operation of water facility.

A site office should be established with one full-time employee responsible for daily operation and maintenance, according to the operation and maintenance activities as mentioned below. Some inspection, observation and daily operation can be carried out by persons working for intake operation hired by DESO or COHIDRO, concluding a contract with one of these companies. Water quality monitoring can be contracted out to DESO, ADEMA or ITPS. Sounding survey should be conducted by a survey company with a contract.

7.2 Operation and Maintenance Plan

7.2.1 Vaza Barris Dam Facilities

Principles to be applied in operation and maintenance are a) safety, b) efficient water use and equitable water resources allocation, and c) environmental conservation. In order to realize these principles, 1) reporting and communication, 2) operation/inspection/observation/monitoring, and 3) accounting will be carried out. Operation rules should be determined before completion of the facilities. Regarding the item 3), a draft of the operation rule should be prepared with the consultant for design and construction supervision. Since accounting should just follow the rules of cost allocation as described in Section 5.1, items of 1) and 2) of the above are discussed below.

(1) Reporting and Communication

Results of the operation/inspection/observation/monitoring and accounting should be recorded and periodically reported to the organs in charge of inspection of the operation and maintenance by the site office. Methods and frequency of the reporting should be determined before the operation. Forms for reporting should also be prepared.

Communication system in emergent cases, such as drought or deterioration of water quality, should be established before the commencement of the operation. Required communication facilities should also be installed. Periodical check, at least once a year in the beginning of dry season, should be conducted on the system (command-operation lines) and communication facilities.

(2) Operation/Inspection/Observation/Monitoring

Detailed manner of operation and inspection should be discussed after detail specifications of facilities are determined. Operation and inspection of the Vaza Barris Dam facilities are generally discussed below.

(a) Low Flow Control

Assurance of maintenance discharge is inevitable for conservation of river environment of the downstream. Operation of valves for control of the discharge from the outlets of bypass pipeline and low flow discharge pipe should be carried out in a frequency of once in a day to once in a week, corresponding to the water level (discharge) at the check dam. A reliable system for the operation should be established.

(b) Inspection and Maintenance

Safety of the dam and dam facilities are fatally important for the residents along the downstream and users of the reservoir water. Inspection as shown in Table-7.1 below should certainly be carried out.

Since the frequency of inspection at the first stage is high and the results of the inspection of this stage is important for operation and the inspection of the latter stage, the inspection of this stage should be conducted by or with a specialist.

In case extraordinary values are measured in the inspection, more precise and detail inspection should be carried out. Depending on the results of detail inspection some rehabilitation and immediate counter-measures might be required.

Table-7.1 Inspection of Dam Facilities

Inspection Items	Frequency		
	1st Stage: from the start to filling to a certain period of time after bankfull stage	2nd Stage: up to the stable condition of the Dam	Stage 3: later stage
Water Leakage	Daily	Weekly	Monthly
Displacement	Weekly	Monthly	One in three month
Uplift Pressure	Weekly	Monthly	One in three month
Valve Facilities	Monthly	Monthly	Monthly

(c) Observation and Monitoring

< Rainfall and Meteorological Observation >

Accumulation of rainfall and meteorological data and subsequent analysis is important for operation improvement for efficient use of water. Regarding rainfall and meteorological observation, data of the stations in the catchment area and the area near the dam should periodically be collected. Communication system should be established to obtain these data.

< Water Level (Discharge) >

Discharge data is very important for operation and inspection as well as for understanding flow regime of the river. The water level should be measured every day at the points of the main dam and the check dam.

< Reservoir Sediment >

Sediment data is also important to know the available volume of water and to use the water efficiently. Sounding survey should be conducted once in several years (around five years) in the main reservoir.

< Water Quality >

Vaza Barris Reservoir will be the source of water for a large number of populations. Water quality of the reservoir is extremely important. The water quality monitoring at the intake point and at a point of the check dam reservoir should preferably be made once in a month, more frequently than that of monitoring of ordinary Class 1 waters. In order to understand conditions of density strata of the reservoir, water quality at different depth (3 points) of the intake point should preferably be monitored twice a year.

(3) Control of Intake

Intake operation should be controlled under the initiative of SEPLANTEC (SRH) since the reservoir water of the Vaza Barris Dam should be destined to two sectors. Regarding control of intake, a) restriction at the times of droughts and other critical hydrological events, and b) integrated intake management at the times of ordinary conditions and critical conditions are discussed below.

(a) Intake Restriction

In order to optimize the use of limited water in case of drought and other hydrological events, phased intake restriction should be conducted; 1) moderate restriction at the early stage of the drought to secure water for the late stage of a drought, 2) to avoid damage of a sudden restriction with giving some period for preparation to more severe restriction.

Rules for water allocation and the restriction of intake in the critical conditions should be decided by the River Basin Committee and the National Council of Water Resources after submission of a draft by SEPLANTEC (SRH) through ANA. Conflicts between domestic water supply and irrigation water supply should be settled in the Committee and the Council. Introduction of drought charge or seasonal charge into water right charging might give an incentive for efficient allocation at times of droughts.

(b) Integrated Intake Management

The Vaza Barris reservoir will provide water to Itabaiana Integrated Water Supply System and Piauitinga Integrated Water Supply System, as well as to irrigation perimeters near the dam. Both integrated water supply systems have water sources of dam/reservoir, weirs and wells.

The integrated intake management consists of a) to precisely analyze water resource potential in terms of quantity and quality at every sources in ordinary times and drought times and to calculate load factors of the current intake, b) to analyze social and economic losses in every types of water use caused by various level of droughts, and c) to control intake operation for overall efficiency of water use in cases of ordinary situations and droughts. Cooperation with DESO and COHIDRO is inevitable to formulate an operation plan.

A criterion for the optimal intake operation at ordinary times is variable costs for intake and water conveyance to water treatment plants. In case treatment costs vary depending on the water sources, variable costs for the treatments should also be taken into consideration. The optimal operation at ordinary times is that to minimize the variable costs. In drought cases, optimal operation can be made by full use of the potential of all water sources and to minimize economic and social losses caused by intake restriction or to make the level of losses by the restriction same in all sectors of water use.

7.2.2 Domestic Water Supply

Since DESO has been supplying water in the target areas and has enough experiences for domestic water supply, expansion of operation and maintenance in these areas would not be difficult for DESO. As proposed in the Master Plan, however, DESO should expand the operation and maintenance not by increasing its staff but by shifting its staff from the administrative sector as far as possible. Training for the shift should be conducted.

7.2.3 Irrigation Water Supply

Although COHIDRO has enough experiences in operation and maintenance of irrigation schemes, its management seems to have to be improved, as recommended in the Master Plan. A management reform is discussed below, since well-organized irrigation management is essential for the sound management of the Project.

(1) Integrated Approach with Close Coordination

Integrated management is necessary to achieve higher objectives without leaving uncontrollable management factors outside of the operating entities. Brazilian irrigation management, especially those developed in settlement programs, seems to be oriented to integrated management. In some cases irrigation perimeter management includes building social facilities. However, this type of management requires excessive duties on government organs as well as duplications of functions in the same level of the governments, and often causes financial burdens heavier than those levels of the government can afford.

In proposed irrigation management, the role of the government operating entity will be limited to management of water facility. In order not to lose the merits of integrated management, a mechanism of close coordination with supporting entities in charge of agricultural extension, research, and crediting should be established. Periodical meetings among the operating entity of irrigation management, supporting entities and the farmers' association should be encouraged. The merger of COHIDRO and EMDAGRO and increased farmers' participation as described below might help promoting the required close coordination.

(2) Increased Role of Farmer's Associations

For equitable, efficient and flexible water management, role of farmers themselves should be enhanced, although role of government entity is very important at the construction stage and the initial stage of operation. Establishment of water users' association or irrigation association should be promoted with assistance through mobilization and education/ training activities. Increased capability will allow less government involvement in the future. Farmers' participation in water management will often cause not only better efficiency of irrigation management but also better cost recovery, resulting less financial burdens on the government.

However, farmers of the target area do not have any experience in irrigation and water management. Mobilization activities would be examined, referring successful cases in other parts of Brazil and other countries. The establishment of "Irrigation Districts" by CODEVASF, such as that in Petrolina perimeter would be a good example. Consultation with or supports by CODEVASF help organizing sustainable perimeter management.

CHAPTER 8 COST ESTIMATES

8.1 Conditions of Cost Estimates

8.1.1 Price Level and Unit Price

Cost estimation for the Study is based on the costs and prices in Brazilian "Real", R$, at the time of September 1999, namely 1 US$ = 1.92R$ and 1 US$ = 106.95 yen.

Unit prices used for cost estimation of the Projects in the Feasibility Study are determined based on the data base for cost estimation of public works in the Sergipe State provided by CEHOP. The data base was developed by CEHOP in order to achieve the efficient preparation of documents required in the budgeting and tendering process for the Public Works in the State of Sergipe. The soft ware including data base is supplied by CEHOP in the form of CD ROM. The software is developed in a client-server base in a way to make possible also the access through Internet.

Unit prices not covered by the CEHOP data base are obtained by quotations from manufacturers, suppliers or distributors of products required for the Projects or estimation from the prices of the similar projects in the past.

8.1.2 Composition of Project Cost

Project cost is composed of the following cost items:

- Administration Cost (AC)
- Consulting Services Cost (CSC)
- Construction Cost (CC)
- Land Acquisition and Compensation Cost (LACC)
- Contingency (CT)

(1) Administration Cost, AC

Administration cost of the Government covers the cost for supervision and management of the project implementation by the Government staff and is taken as 1% of CSC, CC, LACC and CT.

(2) Consulting Services Cost, CSC

This cost covers the cost for consulting services required in the whole period of the project implementation and is taken as 10% of CC and LACC.

(3) Construction Cost, CC

The cost required for the construction of facilities and other related works including the preparatory works. The cost includes material and equipment cost and labor cost including installation and erection of equipment, etc. as a direct cost and direct and indirect benefit, BDI, as an indirect cost.

(4) Land Acquisition and Compensation Cost, LACC

< Land Acquisition Cost >

This cost covers the cost associated with the acquisition of land for construction of the facilities and their influence area. Inundated area in the reservoir will be measured based on 1:5000 scale map. Unit cost of land is 520 R$/ha established in the Master Plan Study for the region based on the information from INCRA. The same unit rate will be applied for the acquisition of land required for the construction of Water Intake and Lift Pump Stations. The land acquisition in the urban areas is done considering the region and it is calculated by a lot in size of 8m x 25m called "chao de casa", informal popular measuring unit of land with an average unit cost of 3,000 R$/lot.

< Compensation Cost >

This cost covers the cost associated with the compensation for properties such as resettlement of residents, permanent and temporary use of land, etc. The evaluation method of house compensation will be done either by cost reproduction method or by comparison method. The evaluation method of land compensation will be done using the unit cost of land for land acquisition.

(5) Contingency, CT

Contingency includes the physical contingency. 5% of the sum of CSC, CC and LACC will be taken as the physical contingency of the Project cost.

8.1.3 Method of Estimation of the Project Cost

(1) Cost Estimation based on the Result of Facility Design

The cost estimation for the following construction works was made based on the quantities of equipment, materials, labor and other related items calculated from the design drawings of facilities:

< Facilities Related to the Dam >

- Vaza Barris Dam
- Check Dam
- Low Flow Bypass

< Facilities Related to Water Conveyance >

Facilities related to water conveyance from Vaza Barris Reservoir to Agreste and Piauitinga Regions were included in this category.

- Water Intake Pump Station
- Water Lift Pump Stations
- Connecting Reservoirs
- Water Conveyance Pipelines
- Surge Tanks
- Control and Electrical Building
- Substation

(2) Cost Estimation based on the Result in the Master Plan Study

The cost estimation of the Water treatment stations, treated water pump stations and distribution networks for the following municipalities included in Agreste and Piauitinga Integrated Water Supply Systems was made by adjusting the result of cost estimation in the Master Plan Study:

1) Agreste Integrated Water Supply System: Areia Branca, Campo do Brito, Itabaiana, Macambira, Sao Domingos
2) Piauitinga Integrated Water Supply System: Poco Verde, Simao Dias, Lagarto, Richao do Dantas

The price escalation from September 1998 to September 1999 is considered in the adjustment of the construction cost estimated in the Master Plan Study.

8.2 Project Cost

Table-8.1 shows the total project cost included in the Feasibility Study and Table-8.2 shows the costs of the each project.

Table-8.1 Summary of Project Cost

Unit: R$ thousand

Cost Item	Phase-1	Phase-2	Total
1. Administration Cost	2,065	563	2,628
2. Consulting Service Cost	17,877	4,876	22,753
3. Construction Cost	176,253	48,759	225,012
(1) Dam Construction	67,280	0	67,280
(2) Domestic/Industrial Water Supply Facility to Agreste	34,597	23,993	58,590
(3) Domestic/Industrial Water Supply Facility to Piauitinga	36,716	24,766	61,482
(4) Reforestation	719	0	719
(5) Irrigation Water Supply Facilities	36,941	0	36,941
4. Land Acquisition and Compensation Cost	2,536	0	2,536
5. Contingency	9,833	2,682	12,515
Total	208,564	56,880	265,444

Table-8.2 Cost of the each Project

Unit: R$ thousand

Cost Item	Phase-1	Phase-2	Total
Dam Construction	**81,428**	-	**81,428**
1. Administration Cost	806	-	806
2. Consulting Service Cost	6,980	-	6,980
3. Construction Cost	67,280	-	67,280
(1) Dam	30,189	-	30,189
(2) Check Dam	4,260	-	4,260
(3) Low Flow Bypass	32,830	-	32,830
4. Land Acquisition and Compensation Cost	2,523	-	2,523
5. Contingency	3,839	-	3,839
Dom./Ind. Water Supply Facility to Agreste	**40,364**	**27,989**	**68,353**
1. Administration Cost	400	277	677
2. Consulting Service Cost	3,459	2,399	5,858
3. Construction Cost	34,597	23,993	58,590
(1) Conveyance	17,500	12,137	29,637
(2) Treatment and Distribution	17,097	11,856	28,953
4. Land Acquisition and Compensation Cost	5	0	5
5. Contingency	1,903	1,320	3,223
Dom./Ind. Water Supply Facility to Piauitinga	**42,839**	**28,891**	**71,730**
1. Administration Cost	424	286	710
2. Consulting Service Cost	3,671	2,477	6,148
3. Construction Cost	36,716	24,766	61,482
(1) Conveyance	17,723	11,955	29,678
(2) Treatment and Distribution	18,993	12,811	31,804
4. Land Acquisition and Compensation Cost	8	0	8
5. Contingency	2,020	1,362	3,382
Reforestation	**839**	-	**839**
1. Administration Cost	8	-	8
2. Consulting Service Cost	72	-	72
3. Construction Cost	719	-	719
4. Land Acquisition and Compensation Cost	0	-	0
5. Contingency	40	-	40
Irrigation Water Supply Facilities	**43,094**	-	**43,094**
1. Administration Cost	427	-	427
2. Consulting Service Cost	3,694	-	3,694
3. Construction Cost	36,941	-	36,941
4. Land Acquisition and Compensation Cost	Include above	-	Include above
5. Contingency	2,032	-	2,032

8.3 Operation and Maintenance (O&M) Cost

8.3.1 O&M Cost for Dam and Domestic/Industrial Water Supply Facilities

According to the operation and maintenance plan for the Vaza Barris multi-purpose dam facilities, the total O&M cost is estimated as R$ 95 thousand/year as shown in Table-8.3. As for the domestic and industrial water supply facilities, the total O&M cost is estimated as R$ 3,938 thousand in phase-1 and R$ 7,787 thousand in phase-2, as shown in Table-8.4. No increment in administration costs with the Project is estimated as O&M cost estimation in the Master Plan.

Table-8.3 O&M Costs for Multi-purpose Dam Facilities

Unit: R$ thousand/year

Cost Item	Annual Cost
Day-to-day Operation, Observation and Inspection	75
Water Quality Monitoring	10
Sedimentation Analysis	10
Total	95

Table-8.4 O&M Costs for Domestic and Industrial Water Supply Facilities

Unit: R$ thousand/year

Cost Item	Annual Cost	
	Phase-1	Phase-2
Personal Expenses	1,062	2,036
Other Expenses	1,421	2,844
Energy	1,455	2,907
Total	3,938	7,787

8.3.2 O&M Costs for Irrigation Water Supply Facilities

According to "Pre-Feasibility Study of Vaza Barris Irrigation Project / Sergipe, 1999", which was carried out by SEPLANTEC, the O&M costs except water resource development cost, were estimated as shown in Table-8.5.

Table-8.5 O&M costs Vaza Barris Irrigation Project

Unit: R$ thousand/year

Cost Item	Annual Cost
Energy Cost	878
Other O&M Costs	553
Training Cost	142
Total	1,573

According to the above O&M costs, the average O&M costs per area, except the energy costs, are around R$ 155/ha, while the O&M costs per irrigated area, except the energy costs, vary from R$ 231/ha to R$ 558/ha in other perimeters currently managed by COHIDRO. However, this O&M costs, R$ 155/ha would be adequate, considering recommendations proposed in Section 7.2.

CHAPTER 9 PROJECT IMPLEMENTATION

9.1 Institutional Formalities and Organization for Project Implementation

9.1.1 Institutional Formalities for Project Implementation

(1) Jurisdiction

The Vaza Barris river belongs to federal domain, so the Vaza Barris Dam project is also placed under jurisdiction of the federal government. As far as the JICA study team is informed so far, the management of the Sergipe portion of Vaza Barris river will be delegated to the state government under the inspection of the federal organs in the future. For the time being, however, the water resources management for the proposed project is under federal jurisdiction. The project management unit (UGP-PROVABASE) has to implement the project through regulation formalities regarding water resources management under the "National Policy".

In terms of environment assessment, UGP-PROVABASE has to get licenses from the competent agencies at the respective implementation stages. Since the river belongs to the federal domain, the IBAMA is competent to issue licenses from the federal standpoint. On the other hand, the proposed projects are located in state territory, so the ADEMA is also competent to issue licenses from the state standpoint.

In order to procure finances from international or local financial organizations, UGP-PROVABASE has to ask the State House to authorize a permission of finance. After that, the state government gets an approval from the competent agency of foreign loans in the federal government, i.e., External Financial Commission (COFIEX or Comissao de Financiamentos Externos) under Ministry of Planning, Budget and Management (MP or Ministerio do Planejamento, Orçamento e Gestao). Besides, the permission from the Upper House is prerequisite for the project entity to procure international loans, under consideration of allowance of debt services.

Just after the approval from COFIEX, the state government applies for construction license of Vaza Barris Dam through Secretariat of Water Resources (SRH or Secretaria de Recusos Hidricos) under Ministry of Environment, Water Resources and Legal Amazon (MMARHAL or Ministerio de Meio Ambiente, dos Recusos Hidricos e da Amazonia Legal). In addition to the construction license, the state government intends to take over the authorization of water right granting of Vaza Barris river by means of delegation from the federal government. Once the federal government approves this application, the state government (SEPLANTEC) will be able to have a power on granting of water resources use right on Vaza Barris river.

(2) Coordination with PROAGUA

At present, State Unit of PROAGUA Management (UEGP or Unidade Estadual de Gestao do PROAGUA) applies for the two projects within the Sergipe State to the federal government, i.e., UGP (Unidade Gestora de PROAGUA) under MMARHL. They are (a) Project Expansion of Agreste Pipeline Project and (b) Project Expansion of Piauitinga Pipeline Project. Although these projects are around one year behind the original schedule as of September 1999, the UEGP expects that these projects will be implemented just after the approval of the UGP head office and also the World Bank. The state SRH of SEPLANTEC, the counterpart organization to UEGP, is also coordinating these projects prudently, since these projects have close relationship with the proposed project.

(3) Prospect of Formalities

Table-9.1 shows the tasks of the state government, i.e., UGP-PROVABASE, till the time of project completion. The major works are classified into three categories as shown in the table. They are (a) administrative or legal formalities, (b) procurement of finances for project implementation and (c) designing and construction of the project. The timetable for these formalities worked out by UGP-PROVABASE is shown in the table below.

Table- 9.1 Administrative and Financial Formalities

Work Item	1 1999	2 2000	3 2001	4 2002	5 2003	6 2004	7 2005	8 2006
State Government (UGP)								
Project Office (UGP) Establishment	▼							
Administrative & Legal Formalities								
Water Right License		▲	▼					
Construction License		▲	▼					
Environmental License		▲	▼					
Land Acquisition in Project Sites				▬▬				
Procurement of Finances								
Approval of State House	▲	▼						
Approval of Upper House		▲ ▼						
Formulation of I/P		▬						
Approval of International Financial Organs		▲▼						
Study, Design & Construction								
Study (M/P & F/S)	▬	▬						
Designing				▬▬	▬▬			
Construction						▬▬	▬▬	▬▬
JICA								
M/P and F/S	▬	▬						
International Financial Institutes								
Project Identification	▼							
Pledge		▼						
Loan Agreement			▼					

Legend: ▲: Application; ▼: Approval; ——: Execution of Activity

9.1.2 Organization of Project Implementation

(1) Establishment of UGP-PROVABASE

In parallel with the JICA study, Management Unit of the Project of Water Resources Development and Supply in Vaza Barris River (UGP-PROVABASE) was established by the State Decree No.18297 on 1[st] of September 1999. It is subordinated directly the Secretary of SEPLANTEC. Its major competence is as follows.

1) To coordinate and to follow up on the Project of Vaza Barris Multi-purpose Dam and related Projects.
2) To keep institutional linkage with public and private organs concerned.
3) To carry out duties attributed to SEPLANTEC.

(2) Organizational Strengthening of UGP-PROVABASE

At present, the UGP-PROVABASE is assigned to carry out preparation of the Project. In the future, it is expected to manage financial arrangement, a feasibility study for the irrigation component and to compile the environmental impact assessment reports (RIMA), and subsequently to implement the project employing consultants and contractors.

The UGP-PROVABASE takes and should continue to take a core part in project implementation. At present, the UGP-PROVABASE consists of a coordinator and a secretary only. With the development of the project preparation and implementation, the UGP-PROVABASE should be strengthened to meet with a workload. Strong administrative supports to the UGP-PROVABASE, such as legal advisory, matters related to public relation, coordination with federal and state organs and general administrative affairs, should be given by the SEPLANTEC.

At present the State Government or SEPLANTEC has a plan to strengthen the UGP-PROVABASE as follows:

Preparation Stage I (1999):
- Duties: Preparation for the approvals of the federal organs
- Staff: A Coordinator and a secretary

Preparation Stage II (2000):
- Duties: Preparation for "Environmental Impact Assessment Report (RIMA)" and for the application to an international financial institute
- Staff: Adding a civil engineer

Preparation Stage III (2001):
- Duties: Preparation of international bidding for procurement of consultants
- Staff: Adding a document specialist with translators (if necessary)

Implementation State (2002-2006):
- Duties: total management of project implementation
- Staff: Adding a financial staff and technical assistants as required

(a) Major Duties of UGP-PROVABASE

In this section, organization at the implementation stage is discussed. In the implementation stage, major tasks to be managed with 1) land acquisition, 2) designing, 3) construction and its supervision.

Item 1) should be carried out in accordance with relevant laws and regulations such as Decree-Law No. 21st June 1941 and its amendments, with juridical support of the State Government such as legal advisors to SEPLANTEC and Office of the State General Prosecutor. Some involvement of UGP-PROVABASE will be necessary for investigations and negotiations for the land acquisition.

As for 2) and 3), UGP-PROVABASE or SEPLANTEC should hire consultants and conclude contracts with contractors. Bidding procedure should be placed under the inspection of international financial institutes, federal organs in charge and the State Procurement Office. Actual tendering, tender evaluation, negotiations and contract awarding should proceed with the initiative of UGP-PROVABASE. Although the consultants and contractors will undertake most of the engineering works and construction works, some responsibilities will remain to the project office. Check of the results of the works by consultants and contractors is necessary to be done by UGP-PROVABASE. During the construction works, many administrative permissions may be required. Liaison to relevant authorities, such as police, will be necessary.

(b) Organization and Staffing

According to the major duties as described above of UGP-PROVABASE, following organization at implementation stage would be recommendable. The contents and volume of each section will vary according to the development of the project implementation.

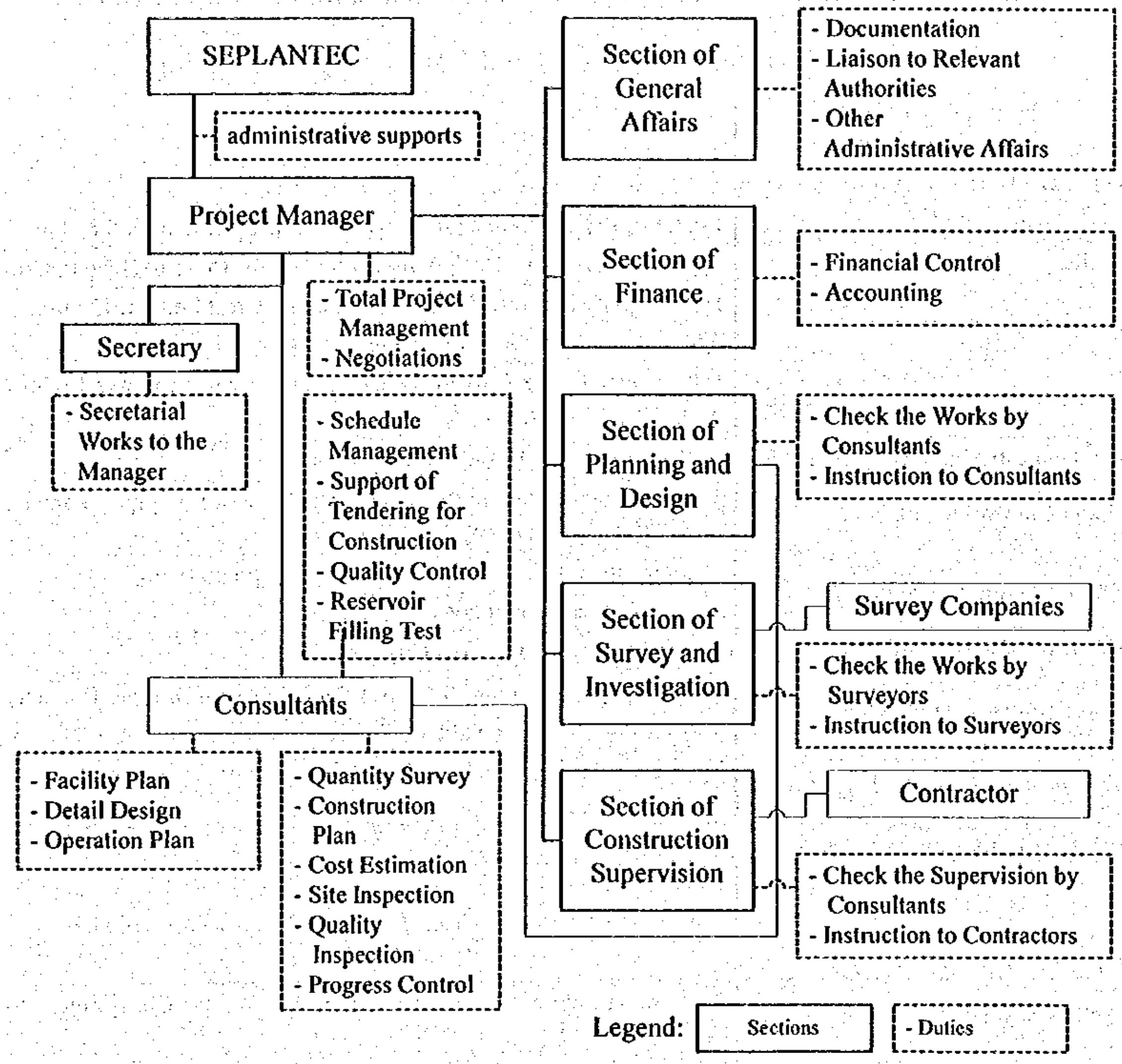


Figure- 9.1 Proposed Organization of UGP-PROVABASE at Implementation Stage

For staffing at the implementation stage, employment of engineers in DESO or COHIDRO is very important because of their experiences in similar projects, especially for the domestic water supply components and the irrigation component. Staff of CEHOP, if available, may take major roles in land acquisition, tendering, and construction supervision because of their abundant experiences in these fields.

Preferably, each section should have a core staff responsible for duties assigned to the section, and short-term assistance should be acquired from relevant sections of the Government, state companies and autarchies.