ブラジル連邦共和国

スアッペ臨海工業開発計画

資料No. 3

10 - PIRAPAMA SYSTEM - MATAPAGIPE DAM

SITUATION PLAN OF THE SOURCES

1) - Dam

2) - Manoel Conçalves Stream

3) - Stone quarry

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11 - PIRAPAMA SYSTEM - MATAPAGIPE DAM

HYDROGRAM OF FLOODS TR= 100 years

1) - Cubic meters per second

2) - Hours

12 - SMALL SYSTEMS

1) - CONVENTIONS

2) - Pond

3) - Marshland

4) - Basin divider (watershed)

5) - Permanent lagoon

6) - Permanent river

13 - PREGO STREAM - BASIN

14 - MANOEL GONÇALVES STREAM - Profile

1) - Junction with the Pirapama

15 - ALGODOAIS STREAM - BASIN

16 - ALGODOAIS STREAM - PROFILE

17 - JASMIM STREAM - BASIN

18- JASMIM STREAM - PROFILE

19 - RIVER MASSANGANA - BASIN

2o - MASSANGANA RIVER - PROFILE

1) - Elevations in meters

2) - Junction with Boa Esperança

21 - SITUATION OF THE DAMS AND THE HYDROMETRIC STATIONS UNDER CONSIDERATION - MASSANGANA BASIN

22 - MASSANGANA SYSTEM - RESERVOIRS

Conventions :

1) - Alternative 1

2) - Alternative 2

3) - Existing weir

4)- Spillway

5) - Dams

6) - Basin Divider

7) - Feeder canal

8) - Basin

9) - Contributor

10) - Hydraulics

11) - Bleeder Canal

12) - Treatment Station

23 - MASSANGANA SYSTEM - BITA RESERVOIR - RIPPL'S DIAGRAM

24 - MASSANGANA SYSTEM - BITA RESERVOIR - AREAS AND VOLUMES DIAGRAM

1) - Elevations in meters

25 - MASSANGANA SYSTEM - BITA RESERVOIR - OPERATIONAL CURVE

1) - Affluencd (10^6 m^3)

2) - Gain or loss (10^6 m^3)

3) - Elevation (m)

4) - Accumulation (10^6 m^3)

26 - MASSANGANA SYSTEM - BITA RESERVOIR - HYDROGRAM OF FLOODS

1) - Cubic meters per second

2) - Hours

27 - MASSANGANA SYSTEM - BITA RESERVOIR - SPILLWAY

1) - Profile of spillway section

28 - MASSANGANA SYSTEM - BITA RESERVOIR - DAM I

1) - Longitudinal profile

2) - Apex = 47.00

3) - Transverse section

29 - MASSANGANA SYSTEM - BITA RESERVOIR - DAM II

1) - Longitudinal Profile

2) - APEX = 47.00

3) - Transverse section

30 - MASSANGANA SYSTEM - BITA RESERVOIR - DAM III

1) - Longitudinal profile

2) - Apex = 47.00

3) - Transverse section

31 - MASSANGANA SYSTEM - BITA RESERVOIR - DAM IV

1) - Longitudinal Profile

2) - Apex = 47.00

3) - Transverse Section

32 - MASSANGANA SYSTEM - UTINGA DE BAIXO RESERVOIR - RIPPL'S DAIGRAM

33 - MASSANGANA - BITA RESERVOIR - VOLUMES AND ARESA DIAGRAM

34 - MASSANGANA SYSTEM - UTINGA DE BAIXO RESERVOIR - OPERATIONAL CURVE

1) - Affluence (10^6 m^3)

2) - Gain or loss (10^6 m^3)

3) - Elevation (m)

4) - Accumulation (10^6 m^3)

35 - MASSANGANA SYSTEM - ÚTINGA DE BAIXO RESERVOIR - FLOOD HYDROGRAM
TR = 100 years

1) - Cubic meters per second
20 - hours

36 - MASSANGANA SYSTEM - UTINGA DE BAIXO RESERVOIR - DAM 1A

1) - Longitudina profile

2) - Apex = 67.00

3) - Transverse section

37 - MASSANGANA SYSTEM - UTINGA DE BAIXO RESERVOIR - DAM 2A

1) - Apex = 67.00

38 - MASSANGANA SYSTEM - UTINGA DE BAIXO RESERVOIR - DAM 2

1) - Longitudinal Profile

2) - Apex = 67.00

3) - Transverse section

39 - MASSANGANA SYSTEM - UTINGA DE BAIXO RESERVOIR - SPILLWAY CANAL C1A

1) - Transverse section

40 - MASSANGANA SYSTEM - UTINGA DE BAIXO RESERVOIR - SPILLWAY CANAL C1A

1) - Transverse section .

41 - MASSANGANA SYSTEM - UTINGA DE BAIXO RESERVOIR - SPILLWAY CANAL C2A

1) - Transverse Sections

42 - MASSANGANA SYSTEM - UTINGA DE BAIXO RESERVOIR - AUXILIARY DAM 3

1) - Longitudinal profile

2) - Apex

3) - Transverse section

43 - MASSANGANA SYSTEM - UTINGA DE BAIXO RESERVOIR - AUXILIARY DAM 4

1) - Apex

2) - Transverse section

44 - MASSANGANA SYSTEM- UTINGA DE BAIXO RESERVOIR - AUXILIARY DAM 5

1) - Apex

2) - Transverse section

45 - SISTEMA IPOJUCA

1) -
2) -
3) -
4) - Conventions
5) - Pond
6) - Marshland
7) - Basin Divider (watershed)
8) - Permanent Lagoon
9) - Permanent river

46 - RIVER IPOJUCA - PROFILE

1) - Limit of 1:25.000 map

47 - IPOJUCA SYSTEM - DAM B1 - RIPPL'S DIAGRAM

48 - IPOJUCA SYSTEM - DAM B - VOLUMES AND AREAS DIAGRAM

49 - IPOJUCA SYSTEM - DAM B1 - PLAN AND SECTION

1) - Transverse Section

2) - Apex

50 - IPOJUCA SYSTEM - ALTERNATIVE B1 - DAM B1

1) - Transvers section
2) - Longitudinal profile
3) - Apex

51 - IPOJUCA- BITA SYSTEM - FEEDER CANAL

1) - Typical fill section

2) - Pumping

3) - Typical cut section

4) - Bita weir

5) - Elements of the curves:

   a - Curve

   b - Radius

   c - Degrees

52 - PIEZOMETRIC MAP OF THE FREE AQUIFEROUS

1) - Hydrologic Conventions
2) - Isopiezometric curve of the surface of the surface of the underground waters of the free aquiferous
3) - Direction of flow of underground waters
4) - Dividing line (watershed)of the underground waters
5) - Line of the (used) limit of the Suape-Nossa Senhora do Ó sedimentary plain.
6) - Limit between the crystalline base and the Cretaceous rocks

7) - Mapping Conventions
8) - River or stream
9) - Canal
10) - Bridge
11) - Paved road
12) - Dirt road
13) - Railroad
14) - City/Village/Sugar Mill
15) - Plantation or farm

VOLUME IV

PART 6 - WATER SUPPLY SYSTEM

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PART 6 - WATER SUPPLY SYSTEM

1.0 OBJECTS

Considering the undertaking under review, the main object of these studies is the short term supply of drinking water to the pioneering industries and populations, as a guarantee of their installations, thus starting to put together the pieces that will constitute the embryo of the Complexo Industrial e Portuário de Suape (CI).

These studies are also intended for the progressive development of the system, so that it should be in a position that will allow it to face the requirements of the CI. While keeping in sight the magnitude of the project, the initial phases, as those concerned with the enlargement of the installations, shall obey technical, financial and aministrative criteria that are adequately adjusted to this development.

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2.0 BASIC DATA

The basic data used are referred to in the reports and demonstrations relative to the survey of the water resources and the hydrological mappings. Special mention must be made of the mappings performed by Aerodata, in the scale of 1:10.000, with contour curves with a spacing of 5 m (1974) and by VASP, in the scale of 1:25.000, with contour curves with a spacing of 10 m. Hydrometric and climatological data, provided by various posts operated by SUDENE, relative to the area under study, were frequently used.

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3.0 PRELIMINARY STUDIES

The preliminary studies are detailed in the text of the specific Report and illustrated with tables and drawings. The detailing of the hydrometric campaign, and the geotechnological study of the Matapagipe Dam are the object of special studies, contained in independent volumes. As a complement, topographic and geotechnical studies were made, in order to reach solutions, and they are shown in the various chapters that make up the present Report.

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4.0 SPRINGS STUDIES

4.1 SURFACE WATERS

4.1.1 GENERAL

The following hydrographic basins either limit or constitute the CI area: Pirapama, Prego, Algodoais, Jasmim, Massangana, Ipojuca and Merepe. Based on the size and the importance of the defluents, we can group them into 3 systems, viz. : Pirapama System, Small Systems and Ipojuca System, the second of thses grouping the rivers Prego, Algodoais, Jasmim and Massangana. The river Merepe will be studied independently, considering its negligible importance as a source of water supply.

The data gathered in stations installed and operated by the Consultant, as well as the use of water level readings in a station operated by SUDENE on the Tabatinga river, make it possible to characterize with reasonable precision the flow rate of the interesting systems, with the exception of the Ipojuca that does not fit into the the general features of the other systems, due to its size, configuration and the variety of the climates of the physiographic regions through which it flows.

The work that is being carried out, both in the field and in the office, is intended to permit the determination of the following elements of the basins, with a higher grade of accuracy:

1 - HYDROGRAPHIC BASINS OF INTEREST TO C.I.

1) - CONVENTIONS

2) - Weir

3) - Marshland

4) - Basin divider (Watershed)

5) - Permanent Lagoon

6) - Permanent river

A Efficiency

B Basic Flow

C High Waters and Floods in the Project

The chapters that follow show approximate data, based on information that is available at present. Adjustments will be made as new data provided by the hidrometric studies are processed and analyzed.

On the basis of available information, it may be said that the smaller basins of the Zona da Mata show an average efficiency that varies between 35 and 45% for average annual rainfalls of 1800 to 2200 mm. For average annual rainfalls of 1.400 to 1.800 mm, the efficiency varies between 25 and 35% and, finally, for the high and medium Ipojuca (Zona do Agreste) where the average annual rainfalls are between 600 and 1.000 mm, the efficiency is reduced to between 10 and 15%.

December and January are the two driest months in this region, and, therefore, it will only be possible to measure the basic flows at this time of the year. Systematic measurements are being carried out, in order to check the variations in the flow, since the beginning of the rainy season, and they will be continued until the basic flow is reached during the dry months.

Th knowledge of the basic flow is of great importance for the proper use of surface waters, especially for the definition of modular utilizations.

Preliminary calculations show the basic figures for the basic flow:

- Ipojuca (Engenho Tabocas) 1,5 m^3/sec

- Ipojuca (Engenho Maranhão) $3{,}0\ m^3/sec$
- Pirapama (Matapagipe) $2{,}0\ m^3/sec$
- Massangana (Engenho Tabatinga) $0{,}3\ m^3/sec$

The high waters and floods in the project, claculated through the triangular hydrogram synthetic method, show the following values over a recurrence period of 100 years:

River Pirapama (Engenho Matapagipe)	700 m^3/sec
River Ipojuca (Engenho Tabocas)	800 m^3/sec
River Ipojuca (Engenho Maranhão)	1.070 m^3/sec
River Bita (Dam Site)	240 m^3/sec
River Utinga de Baixo (Dam Site)	86 m^3/sec
River Algodoais (crossing with the railroad)	100 m^3/sec
River Jasmim (crossing with the railroad)	40 m^3/sec
River Prego (crossing with the railroad)	85 m^3/sec
River Massangana (crossing with the railroad, considering the basin downstream from the dams)	150 m^3/sec

4.1.2 PIRAPAMA SYSTEM

The river Pirapama, located at the north of the CI area, is one of the main bodies of water in the area, with a hydrographic basin of 571 km^2. As a source for water supply, we can mention a sub-basin, that of the river Gurjaú, an affluent of the Pirapama downstream from the city of Cabo, that is one of the main sources of supply for the city of Recife.

The hydrographic basin of the river Gurjaú, upstream from the reservoir for the supply of water to the city of Recife, has an area of 118 km^2, and its regulated flow is estimated at 115.000 m^3/day.

2 - PIRAPAMA SYSTEM - IMPOUNDMENTS STUDIED

1) - Gurjaú Reservoir
2) - Treatment Station for the Supply of Recife
3) - Matapagipe Reservoir
4) - Diversion in Chaneca
5) - Diversion at the half destroyed dam
6 Conventions
7) - Weir
8) - Marshland
9) - Basin Divider (watershed
10) - Permanent Lagoon
11) - Permanent River

.3 - PIRAPAMA RIVER AND MANOEL GONÇALVES STREAM BASIN

4 - PIRAPAMA RIVER - PROFILE

1) - Junction with Manoel Gonçalves Stream

5 - MANOEL GONÇALVES STREAM - PROFILE

1) - Junction with Pirapama River

6 - RIVER GURJAÚ - BASIN

The contribution to the supply of Recife reaches at present 65.000 m^3/day, so that there exists an excess of 50.000 m^3/day that, if not used by Recife, could be utilized for the CI.

A dam on the river Pirapama was studied at the widening of Engenho Matapagipe (Matapagipe Dam). At this point, including the basin of the tributary Manoel Gonçalves, the damming of which would provide a single reservoir, the area of the hydrographic basin reaches 336 km^2. The head of river Pirapama is in Chão dos Pintos, near the borough of Serra Grande, at an altitude of approximately 500 m; between its spring and the widening, it flows for 63 km and shows a form factor of 0.09. The minimum regulated flow is about 340.000 m^3/day in Matapagipe. During this year's months of observation (1974), flows of 2.800 m^3/sec in February as a minimum, and of 66.080 m^3/sec in July as a maximum were recorded.

Due to its nearness and to the existing topographic conditions, the Gurjaú sub-basin shows a possibility for interconnection with the Pirapama basin, either by the evacuation through the Cafofo stream of the water dammed up in Matapagipe, that would in this case flow downstream of the Gurjaú dam, or to the very contributing basin of the latter reservoir, through a small pumping operation further upstream.

Besides the possibility of using the water of the Matapagipe reservoir through the supply system of the Gurjaú, which is already operating, said reservoir , by forced delivery, either through canals or by impounding, downstream, is an important source for the direct supply to the Cabo region, along highways BR-101 and PE-60, and for the surrounding areas and it could also become a reinforcement for the CI area's own reservoirs.

Points of impoundment were prospected, including one, a short distance downstream from the point of junction with the river Utinga de Cima (Pavão), close to the borough of Charneca. A small dam at elevation 30

7 - PIRAPAMA SYSTEM - MATAPAGIPE DAM

RIPPL'S DIAGRAM

8 - PIRAPAMA SYSTEM - MATAPAGIPE DAM

DIAGRAMS OF AREAS AND VOLUMES

TABLE FOR TRACING THE OPERATIONAL CURVE OF RESERVOIRS

WEIR ENG. MATAPAGIPE

BASIN PIRAPAMA PERIOD OCT.62 to SEPT 66

Year	MONTH								
	1	2	3	4	5	6	7	8	9
1962/63	OCTOBER	-116,00	-1,33	11,57	16,07	122,2	-5,8	-	54,5
	NOV	-117,56	-1,35	16,99	15,56	122,3	+0,1	-	54,5
	DEC	-107,12	-1,16	9,30	16,07	114,4	-7,9	-	53,8
	JAN	-46,02	-0,47	6,90	16,07	104,8	-9,6	-	53,0
	FEB	-99,72	-1,03	18,73	14,52	108,0	+3,2	-	53.3
	MARCH	+193,92	+2,31	35,29	16,07	128,0	+20,0	1,5	55,0
	APRIL	+241,98	+2,87	29,93	15,56	128,0	0,0	17,2	55.0
	MAY	+117,20	+1,40	14,29	16,07	127,6	-0,4	-	54,95
	JUNE	+170,30	+1,28	27,09	15,56	128,0	+0,4	12,4	55.0
	JULY	+123,88	+1,48	10,53	16,07	128,0	0,0	3,9	55,0
	AUGUST	+45,10	+0,54	16,49	16,07	128,0	0,0	1,0	55.0
	SEPT	-23,96	-0,29	20,26	15,56	128,0	0,0	4,4	55,0
1963/64	OCTOBER	-120,28	-1,34	7,19	16,07	117,8	-10,2	-	54,25
	NOV	-101,56	-1,21	26,70	15,56	128,0	+10,2	0,0	55,0
	DEC	-39,56	-0,47	20,91	16,07	128,0	0,0	4,4	55,0
	JAN	-5,12	-0,06	14,85	16,07	126,7	-1,3	-	54.9
	FEB	+129,88	+1,55	34,03	15,03	128,0	+1,3	19.3	55,0
	MAR	+169,92	+2,03	29,60	16,07	128,0	0,0	15,8	55.0
	APRIL	+105,58	+1,26	23,77	15,56	128,0	0,0	9,5	55.0
	MAY	+133,40	+1,59	16,25	16,07	128,0	0,0	1,8	55.0
	JUNE	+41,50	+0,50	20,82	15,56	128,0	0,0	5,8	55.0
	JULY	+47,56	+0,57	16,23	16,07	128,0	0,0	0,8	55,0
	AUGUST	+30,40	+0,36	23,89	16,07	128,0	0,0	8,2	55.0
	SEPT	+44,24	+0,53	44,30	15,56	128,0	0,0	29,3	55,0
1964/65	OCTOBER	-123,48	-1,38	7,69	16,07	118,2	-9,8	-	54,2
	NOV	-130,26	-1,35	6,88	15,56	108,2	-10,0	-	53,35
	DEC	-119,46	-1,12	4,93	16,07	96,0	-12,2	-	52,7
	JAN	+5,08	+0,05	16,11	16,07	96,1	+0,1	-	52.2
	FEB	-106,42	-0,91	3,51	14,52	84,2	-11,9	-	52,1
	MARCH	+26,62	+0,23	17,42	16,07	85,8	+1,6	-	51.2
	APRIL	+146,68	+1,35	22,38	15,56	94,0	+8,2	-	52.0
	MAY	+141,40	+1,38	20,83	16,07	100,1	+6,1	-	52.6
	JUNE	+292,00	+3,49	47,85	15,56	128,0	+27,9	7,9	55,0
	JULY	+1,88	+0,02	11,56	16,07	123,5	-4,5	-	54,65
	AUGUST	+35,60	+0,42	35,49	16,07	128,0	+4,5	15,3	55,0
	SEPT	-45,56	-0,52	9,40	15,56	121,3	-6,7	-	54,4
1965/66	OCTOBER	-126,28	-1,35	9,07	16,07	113,0	-8,3	-	53.7
	NOV	-117.16	-1,17	6,51	15,56	103,0	-10,0	-	52.9
	DEC	-91,86	-0,88	13,70	16,07	99,8	-3,2	-	52,55
	JAN	+35,78	+0,33	10,52	16,07	94,6	-5,2	-	52,05
	FEB	+75,68	+0,75	21.14	14,52	102,0	+8,6	-	52.8
	MARCH	-19,78	-0,18	8,96	16,07	94,7	-7,3	-	52,05
	APRIL	+67,38	+0,64	17,74	15,56	97,5	+2,8	-	52,3
	MAY	+153,20	+1,55	21,69	16,07	104,7	+7,2	-	53,0
	JUNE	+153,00	+1,79	32,70	15,56	123,7	+19,0	-	54,7
	JULY	+404,78	+4,83	50,43	16,07	128,0	+4,3	34,9	55,0
	AUGUST	+40,20	+0,48	20,74	16,07	128,0	0,0	5,2	55,0
	SEPT	+77,64	+0,93	33,95	15,56	128,0	0,0	24,3	55,0

1 - Year - Month

2 - Gain or loss - in mm P-E

3 - Gain or loss - (10^6 m^3)

4 - Affluence - (10^6 m^3)

5 - Regulation (10^6 m^3)

6 - Accumulation (10^6 m^3)

7 - Variation in accumulation (10^6 m^3)

8 - Bleeding (10^6 m^3)

9 - Elevation (m)

TABLE FOR THE TRACING OF THE OPERATIONAL CURVEOF RESERVOIRS

WEIR ENG: MATAPAGIPE

BASIN: PIRAPAMA

PERIOD: SEPT. 1966 - OCT: 1970

ANO	MÊS	Perda ou Ganho em (mm) P-L	Perda ou Ganho (10^6 m.c.)	Afluência (10^6 m.c.)	Regularização (10^6 m.c)	Acumulação (10^6 m.c)	Variação de Acumulação (10^6 m.c)	Sangria (10^6 m.c)	Cota (m)
	1	2	3	4	5	6	7	8	9
1966/67	OCTOBER	-124,28	-1,30	7,11	16,07	117,7	-10,4	-	54,20
	NOVEMBER	-141,76	-1,65	23,87	15,56	123,4	+6,7	-	54,70
	DECEMBER	-142,16	-1,60	13,92	16,07	119,7	-3,8	-	54,30
	JANUARY	-123,12	-1,26	4,81	16,07	107,2	-12,5	-	53,25
	FEBRUARY	-85,32	-0,89	17,00	14,52	108,8	+1,6	-	53,40
	MARCH	+277,92	+3,32	33,76	16,07	128,0	+19,2	1,8	55,00
	APRIL	+141,22	+1,68	20,29	15,56	128,0	0,0	6,4	55,00
	MAY	+125,70	+1,50	19,26	16,07	128,0	0,0	4,7	55,00
	JUNE	+156,70	+1,87	24,65	15,56	128,0	0,0	11,0	55,00
	JULY	+172,06	+2,05	19,06	16,07	128,0	0,0	5,0	55,00
	AUGUST	+69,60	+0,84	18,10	16,07	128,0	0,0	2,9	55,00
	SEPTEMBER	-34,96	-0,41	14,66	15,56	126,7	-1,3	-	54,90
1967/68	OCTOBER	-115,48	-1,31	11,93	16,07	121,2	-5,5	-	54,40
	NOVEMBER	-127,76	-1,34	4,35	15,56	108,7	-12,6	-	53,40
	DECEMBER	-117,96	-1,12	5,68	16,07	97,2	-11,5	-	52,30
	JANUARY	-23,42	-0,21	8,69	16,07	89,6	-7,6	-	51,60
	FEBRUARY	-79,52	-0,57	6,65	15,03	80,6	-9,0	-	50.75
	MARCH	+72,36	+0,69	33,36	16,07	98,6	+18,0	-	52,40
	APRIL	+105.92	+1,05	17,72	15,56	101,8	+3.2	-	52.80
	MAY	+97,90	+0,95	13,67	16,07	100,4	-1,4	-	52,60
	JUNE	+3,74	+0,03	7,06	15,56	92,0	-8,4	-	51,20
	JULY	+43,08	+0,39	14,51	16,07	90,8	-1,2	-	51.70
	AUGUST	+19,24	+0,17	10,79	16,07	85,7	-5.1	-	51,30
	SEPTEMBER	-94,32	-0,74	2,93	15.56	72,3	-13,4	-	49,50
1968/69	OCTOBER	-129,78	-0,91	2,23	16,07	57,6	-14,7	-	48,15
	NOVEMBER	-113,76	-0,72	7,07	15,56	48,4	-9,2	-	46,80
	DECEMBER	-138,84	-1,00	30,28	16,07	61,6	+13,2	-	48.65
	JANUARY	-22,92	-0,19	37,01	16,07	82,4	+20,8	-	50.90
	FEBRUARY	-77,46	-0,81	43,18	15,03	109,7	+27,3	-	53.45
	MARCH	-31,42	-0,32	13,84	16,07	107,2	-2,5	-	53,25
	APRIL	-88,92	-0,83	6,01	15,56	96,8	-9,6	-	52.25
	MAY	+78,18	+0,72	12,13	16,07	93,6	-3,2	-	51,95
	JUNE	+116,68	+1,07	14,23	15,56	93,3	-0,3	-	51,93
	JULY	+104,50	+0,96	17,29	16,07	95,5	+2,2	-	52,10
	AUGUST	+13,00	+0,12	13,76	16,07	9,33	-2,2	-	51,92
	SEPTEMBER	-40,36	-0,35	10,42	15,56	87,8	-5.5	-	51,40
1969/70	OCTOBER	-105,56	-0.87	8,74	16,07	79,6	-8,2	-	50,60
	NOVEMBER	-121,20	-0,95	9,93	15,56	73,0	-6,6	-	49,85
	DECEMBER	-108,70	-0,79	7,14	16,07	63,3	-9.7	-	48,87
	JANUARY	-14,42	-0,10	10,90	16,07	58,0	-5,3	-	48,27
	FEBRUARY	+80,92	+0,54	9,44	14.52	53,5	-4,5	-	47,47
	MARCH	+56,78	+0,38	14,50	16,07	52,3	-1,2	-	47.40
	APRIL	+55,40	+0,35	10,57	15,56	47,7	-4,6	-	46.79
	MAY	-11,90	-0,07	9,36	16,07	40,9	-6,8	-	45,40
	JUNE	+251,96	+1,60	20,90	15,56	47,8	+6,9	-	46.70
	JULY	+278,28	+2,00	28,04	16,07	61,8	+14,0	-	49,05
	AUGUST	+41,74	+0,32	23,89	16,07	69,9	+8,1	-	49.60
	SEPTEMBER	-60,68	-0,47	16,42	15,56	70,3	-0,4	-	49,60

1 - Year - Month

2 - Gain or loss - in mm P-E

3 - Gain or loss - (10^6 m^3)

4 - Affluence - (10^6 m^3)

5 - Regulation (10^6 m^3)

6 - Accumulation (10^6 m^3)

7 - Variation in accumulation (10^6 m^3)

8 - Bleeding (10^6 m^3)

9 - Elevation (m)

TABLE FOR THE TRACING OF THE OPERATIONAL CURVE OF RESERVOIRS

WEIR: ENG. MATAPAGIPE
BASIN: PIRAPAMA

PERIOD: OCT. 1970 - SEPT 74

ANO	MÊS	Perda ou Ganho em (mm) P-E	Perda ou Ganho (10^6 m.c)	Afluência (10^6 m.c)	Regularização (10^6 m.c)	Acumulação (10^6 m.c)	Variação de Acumulação (10^6 m.c)	Sangria (10^6 m.c)	Cota (m)
	1	2	3	4	5	6	7	8	9
1970/71	OCTOBER	-119,20	-0,87	10,19	16,07	63,5	-6,8	-	48,85
	NOVEMBER	-124,30	-0,89	14,41	15,56	61,5	-2,0	-	48,60
	DECEMBER	-131,64	-0,91	11,18	16,07	55,7	-5,8	-	47,85
	JANUARY	-113,72	-0,76	14,52	16,07	53,4	-2,3	-	47,60
	FEBRUARY	-67,14	-0,49	25,54	14,52	63,9	+10,5	-	48,90
	MARCH	-68,76	-0,46	5,04	16,07	52,4	-11,5	-	47,40
	APRIL	-24,56	-0,15	10,80	15,56	47,5	-4,9	-	46,75
	MAY	+264,42	+1,78	19,83	16,07	53,0	+5,5	-	47,55
	JUNE	+91,50	+0,61	14,07	15,56	52,1	-0,9	-	47,40
	JULY	+113,46	+0,73	12,27	16,07	49,0	-3,1	-	46,95
	AUGUST	+31,50	+0,24	32,41	16,07	65,6	+16,6	-	49,10
	SEPTEMBER	+11,94	+0,09	20,61	15,56	70,7	+5,1	-	49,65
1971/72	OCTOBER	-84,98	-0,71	26,17	16,07	80,1	+9,4	-	50,70
	NOVEMBER	-94,82	-0,81	20,75	15,56	84,5	+4,4	-	51,10
	DECEMBER	-136,64	-1,09	7,97	16,07	75,3	-10,8	-	50,15
	JANUARY	-42,90	-0,34	17,39	16,07	76,3	+1,0	-	50,25
	FEBRUARY	-76,14	-0,58	7,43	15,03	68,1	-8,2	-	49,40
	MARCH	-21,06	-0,16	14,08	16.07	66,0	-2,1	-	49,15
	APRIL	+198,20	+1,60	24,56	15,56	76,6	+10,6	-	50,30
	MAY	+137,00	+1,25	31,52	16,07	93,1	+16,5	-	51,90
	JUNE	+263,90	+3,02	41,41	15,56	122,0	+24,9	-	54,50
	JULY	+112,08	+1,26	13,10	16,07	120,3	-1,7	-	54.3
	AUGUST	+246,10	+2,94	29,21	16,07	128,0	+7,7	8,4	55,0
	SEPTEMBER	+17,94	+0,21	17,32	15,56	128,0	0,0	2,0	55,0
1972/73	OCTOBER	-85,48	-1,02	18,98	16,07	128,0	0,0	1,9	55,0
	NOVEMBER	-132,16	-1,55	14,27	15,56	125,2	-2,8	-	54,8
	DECEMBER	-124,00	-1,48	23,30	16,07	128,0	+2,8	3,0	55,0
	JANUARY	-98,92	-1,13	11,54	16,07	122,3	-5,7	-	54,5
	FEBRUARY	-49,32	-0,53	7,23	14,52	114,5	-7,8	-	53,85
	MARCH	-44,38	-0,47	14,08	16,07	112,0	-2,5	-	53,65
	APRIL	+168,28	+1,97	26,36	15,56	124,8	+12,8	-	54,75
	MAY	+144,40	+1,72	18,54	16,07	128,0	+3,2	1,0	55,00
	JUNE	+132,60	+1,58	20,67	15,56	128,0	0,0	6,7	55,00
	JULY	+159,88	+1,91	19,37	16,07	128,0	0,0	5,2	55.00
	AUGUST	+60,00	+0,73	18,46	16,07	128,0	0,0	3,1	55,00
	SEPTEMBER	+151,44	+1,81	22,45	15,56	128,0	0,0	8,7	55,00
1973/74	OCTOBER	-95,48	-1,07	8,51	16,07	119,4	-6,6	-	54,25
	NOVEMBER	-130,26	-1,57	19,48	15,56	121,8	+2,4	-	54,45
	DECEMBER	-50,56	-0,56	12,00	16,07	117,2	-4,6	-	54,10
	JANUARY	+13,78	+0,15	10,54	16,07	111,8	-5,4	-	53,60
	FEBRUARY	-32,52	-0,35	17,15	14,52	114,1	+2,3	-	53,80
	MARCH	+149,12	+1,78	36,05	16,07	128,0	+13,9	7,9	55,00
	APRIL	+125,98	+1,50	31,94	15,56	128,0	0,0	17,3	55,00
	MAY	+211,10	+2,52	37,12	16,07	128,0	0,0	23,6	55,00
	JUNE	+180,10	+2,24	45,85	15,56	128,0	0,0	32,5	55.00
	JULY	+101,98	+1,22	60,61	16,07	128,0	0,0	45,8	55,00
	AUGUST	+18,50	+0,23	31,63	16,07	128,0	0,0	15,8	55.00
	SEPTEMBER	+41,94	+0,50	33,00	15,56	128,0	0,0	18,7	55.00

9 - PIRAPAMA SYSTEM - MATAPAGIPE DAM

SITUATION AND SECTIONS

1) - Situation
2) - Dam - Manoel Gonçalves River
3) - Filter
4) - Elevation58.00
5) - Nucleus
6) - Upstream
7) - Section AB - Spillway
8) - Dam - River Pirapama
9) - Filter
10) - Decayed rock
11) - Nucleus
12) - Elevation
13) - Upstream

would make possible an additional supply to the city of Cabo, considering the proximity of the existing treatment and pumping station, and it also would be the nearest location for the pumping and delivery system for the basins that make up the Small Systems, where CI's own reservoirs are located.

Prospection was also carried out at a spot where an old stone and masonry dam, half destroyed, could be rebuilt, close to the city of Cabo a little way upstream from Rhodia industry. It could also be used as a supplement to the area's industrial supply, and as a water line, with its natural flow or with the regulation of its flow through the Matapagipe reservoir.

4.1.3 SMALL SYSTEMS

By Small Systems is meant the complex of diminutive hydrographic basins, tributary of the CI area, that are limited and surrounded by the larger basins of the Ipojuca and the Pirapama. The component basins are the Prego, with an area of 14 km^2, the Algodoais, with an area of 13 km^2, the Jasmim, with an area of 5 km^2, and the Massangana with an area of 62 km^2.

The systems studied initially, becaose of their geographic location between the Matapagipe reservoir and the CI area, were examined in oreder to estimate the possibility of their use as part of the delivery and decantation system of this reservoir, avoiding th use of long mains under pressure. Subsequently, the eventual reservoirs, called operational of the water supplv svstem. demonstarted their capacity to receive as well the waters, either dammed up or impounded on the flow from the river Ipojuca, thus increasing the operating capacity and interconnecting the Small Systems with the Ipojuca and Pirapama systems.

The selection of sites and the alternatives of damming possibilities led to the determination of points located in the Massangana basin, taking into consideration the geological, geotechnical and topographic conditions, and especially their nearness to the CI.

Therefore, a closer examnition will be made of aspects related to the river Massangana, and the studies of the other rivers will be limited to the determination of elements of flood control.

Th river Massangana takes this name when it flows through the ranch of the same name, after its junction with its constituents, the rivers Tabatinga and Cangari. Any possibility for the construction of a dam is restricted to these tributaries, since the junction takes place in lower areas.

The river Tabatinga, whose headwaters are adjacent to the Pirapama and Ipojuca systems, shows favourable damming conditions at high elevations (70m), between the Tabatinga and Utinga de Baixo ranches, with dikes on its tributaries Boa Esperança and Utinga de Biaxo, forming two interconnected reservoirs,impounding the waters of an area of 16 km^2.

Preliminary calculations based on studies carried out in other areas suggest regulated flows of about 16.000 m^3/day. However, the flow measurements performed so far in the rivers Boa Esperança and Utinga de Baixo suggest much larger flows, possibly in excess of 30.000 m^3/day.

The river Cangari's headwaters and course are adjacent to the Ipojuca basin. One of its branches, actually the most important one, was once a part of the Ipojuca system, before being artificially impounded by damming and diversion. A small reservoir on the site, upstream from the Pindorama Ranch, receives the waters of the river Pirajã and those of the river Bita, dominating a hydrographic basin of 20 km^2.

1 - Year - Month

2 - Gain or loss - in mm P-E

3 - Gain or loss - (10^6 m^3)

4 - Affluence - (10^6 m^3)

5 - Regulation (10^6 m^3)

6 - Accumulation (10^6 m^3)

7 - Variation in accumulation (10^6 m^3)

8 - Bleeding (10^6 m^3)

9 - Elevation (m)

TABLE FOR THE TRACING OF THE OPERATIONAL CURVE OF RESERVOIRS

WEIR: BITA — TABLE 11A

BASIN: BITA — PERIOD; OCT 1962 - SEPT 1966

ANO	MÊS	[illegible] mm (mm) P-E	[illegible] (10^6 m.c.)	Afluência (10^6 m.c.)	Regularização (10^6 m.c.)	Acumulação (10^6 m.c.)	Variação da acumulação (10^6 m.c.)	Sangria (10^6 m.c.)	Cota (m)
	1	2	3	4	5	6	7	8	9
1962/63	OCTOBER	-99,93	-,2787	1,14	1,125	13,4	-0,3	-	44,8
	NOVEMBER	-114.81	-,3253	1.76	1,089	13,7	+0,3	-	45,0
	DECEMBER	-114,21	-,3135	1,00	1,125	13,3	-0,4	-	44,8
	JANUARY	-72,27	-,1962	0,76	1,125	12,7	-0,6	-	44,4
	FEBRUARY	-4.57	-,0129	2.48	1.016	13.7	+1.0	0.5	45,0
	MARCH	+124,02	+,3513	4,29	1,125	13,7	0,0	3,5	45,0
	APRIL	+111,13	+,3148	3,04	1,089	13,7	0,0	2,3	45,0
	MAY	-10,30	-.0287	0,90	1,125	13,4	-0,3	-	44.8
	JUNE	+55,20	+,1564	2,19	1,089	13,7	+0,3	1,0	45,0
	JULY	-31,22	-,0899	0,65	1,125	13,1	-0,6	-	44,6
	AUGUST	+12,50	+,0354	1,74	1,125	13,7	+0,6	0,1	45,0
	SEPTEMBER	-90.16	-,2479	0,73	1,089	13,1	-0,6	-	44,6
1963/64	OCTOBER	-131,33	-,3382	0,03	1,125	11,7	-1,4	-	43,5
	NOVEMBER	-122,91	-,3122	1,23	1,089	11,5	-0,2	-	43,4
	DECEMBER	-114,01	-,2259	1,01	1,125	11,1	-0,4	-	43,1
	JANUARY	-26.87	-.0674	1.44	1.125	11.3	+0.2	-	43,2
	FEBRUARY	-26.47	-.0700	2.04	1,052	12.2	+0.9	-	44.0
	MARCH	+93.27	+,2642	3,74	1.125	13,7	+1,5	1,4	45.0
	APRIL	+132,18	+,3745	3,36	1.089	13,7	0,0	2.6	45,0
	MAY	+31,65	+.0897	1,44	1,125	13,7	0,0	0.4	45.0
	JUNE	+110,00	+,3116	3,12	1,089	13,7	0,0	2,3	45,0
	JULY	+48.23	+.1366	1,76	1.125	13.7	0.0	0.8	45.0
	AUGUST	+59.15	+.1676	2,65	1.125	13,7	0.0	1.7	45.0
	SEPTEMBER	-24.31	-,0689	2.32	1,089	13,7	0.0	1.2	45,0
1964/65	OCTOBER	-103.33	-,2979	0,82	1.125	13.1	-0.6	-	44.6
	NOVEMBER	-127.76	-.3424	0,91	1.089	12.6	-0.5	-	44.2
	DECEMBER	-113.91	-.3101	0.83	1.125	12.0	-0.6	-	43.8
	JANUARY	-67.62	-,1718	0.83	1.125	11.5	-0.5	-	43.4
	FEBRUARY	-111.72	-.2691	0.32	1.016	10.5	-1.0	-	42.6
	MARCH	-72,48	-,1698	0,77	1,125	10,0	-0,5	-	42,2
	APRIL	+70,33	+,1706	2,42	1,089	11,5	+1,5	-	43,4
	MAY	+34,53	+,0345	1,48	1,125	12,0	+0,5	-	43,8
	JUNE	+205,35	+,5818	4,73	1,089	13,7	+1,7	2,5	45,0
	JULY	-21.52	-,0600	0.79	1.125	13,3	-0.4	-	44.8
	AUGUST	+27,60	+,0782	2,04	1,125	13,7	+0,4	0,6	45,0
	SEPTEMBER	-37.91	-.1074	1.89	1,089	13.7	0,0	0.7	45.0
1965/66	OCTOBER	-114.93	-,3205	1.14	1,125	13,4	-0,3	-	44.8
	NOVEMBER	-100,46	-,2763	1,01	1,089	13,0	-0,4	-	44.6
	DECEMBER	-119,26	-.3196	0.82	1.125	12,4	-0.6	-	44.7
	JANUARY	+15.63	+,0436	2,08	1,125	13,4	+1,0	-	44.8
	FEBRUARY	-41,57	-,1178	1,73	1,016	13,7	+0,3	0,3	45.0
	MARCH	-55.28	-,1553	1.08	1,125	13,5	-0,2	-	44.9
	APRIL	-3,67	-,0104	1,29	1,089	13,7	+0,2	-	45,0
	MAY	+83,30	+,2360	2,11	1,125	13,7	0,0	1,2	45,0
	JUNE	+250,30	+,7091	5,49	1,089	13,7	0,0	5,1	45,0
	JULY	+161,23	+,4568	3,34	1,125	13,7	0,0	2,7	45,0
	AUGUST	-31,19	-,0869	0,87	1,125	13,4	-0,3	-	44.8
	SEPTEMBER	-19,31	-,0547	2,56	1,089	13,7	+0,3	1.1	45,0

1 - Year - Month

2 - Gain or loss - in mm P-E

3 - Gain or loss - (10^6 m^3)

4 - Affluence - (10^6 m^3)

5 - Regulation (10^6 m^3)

6 - Accumulation (10^6 m^3)

7 - Variation in accumulation (10^6 m^3)

8 - Bleeding (10^6 m^3)

9 - Elevation (m)

TABLE FOR THE TRACING OF THE OPERATIONAL CURVE OF RESERVOIRS

WEIR: BITA

BASIN: BITA

TABLE 11 B

PERIOD: OCT;1966 / SEPT 1970

ANO	MÊS	Perdas/Ganhos em(mm)P-E	Perdas/Ganhos (10^6 m.c.)	Afluência (10^6 m.c.)	Regularização (10^6 m.c.)	Acumulação (10^6 m.c.)	Variação da Acumulação (10^6 m.c.)	Sangria (10^6 m.c.)	Cota (m)
1		2	3	4	5	6	7	8	9
1966/67	OCTOBER	-111,63	-,3070	0,72	1,125	13,0	-0,7	-	44,[illegible]
	NOVEMBER	-110,91	-,3117	2,02	1,089	13,6	+0,6	-	44,9
	DECEMBER	-117,46	-,3230	0,88	1,125	13,0	-0,6	-	44,6
	JANUARY	-99,47	-,2594	0,39	1,016	12,1	-0,9	-	43,[illegible]
	FEBRUARY	-82,72	-,2130	0,90	1,125	11,7	-0,4	-	43,4
	MARCH	+137,37	+,3892	4,53	1,125	13,7	+2,0	1,8	45,[illegible]
	APRIL	+56,53	+,1601	2,21	1,089	13,7	0,0	1,3	45,[illegible]
	MAY	+34,55	+,0979	1,48	1,125	13,7	0,0	0,5	45,[illegible]
	JUNE	+24,20	+,0686	1,67	1,089	13,7	0,0	0,6	45,[illegible]
	JULY	+32,93	+,0933	1,55	1,125	13,7	0,0	0,5	45,[illegible]
	AUGUST	+71,50	+,2026	2,91	1,125	13,7	0,0	2,0	45,[illegible]
	SEPTEMBER	-46,71	-,1323	1,57	1,089	13,7	0,0	0,3	45,[illegible]
1967/68	OCTOBER	-91,38	-,2589	1,79	1,125	13,7	0,0	0,4	45,[illegible]
	NOVEMBER	-133,71	-,3757	1,31	1,089	13,5	-0,2	-	44,9
	DECEMBER	-108,06	-,2934	0,63	1,125	12,7	-0,8	-	44,4
	JANUARY	-73,37	-,1913	0,73	1,125	12,1	-0,6	-	43,8
	FEBRUARY	-55,02	-,1455	1,39	1,052	12,3	+0,2	-	44,0
	MARCH	+31,71	+,0861	1,52	1,152	12,8	+0,5	-	44,4
	APRIL	+25,87	+,0702	1,09	1,089	12,8	0,0	-	44,4
	MAY	+54,25	+,1434	1,11	1,125	12,9	+0,1	-	44,5
	JUNE	+70,99	+,1927	0,78	1,089	12,8	-0,1	-	44,4
	JULY	+0,93	+,0025	0,69	1,125	12,4	-0,4	-	44,[illegible]
	AUGUST	+17,34	+,0469	1,32	1,125	12,6	+0,2	-	44,[illegible]
	SEPTEMBER	-74,92	-,1981	1,11	1,089	12,4	-0,2	-	44,[illegible]
1968/69	OCTOBER	-118,44	-,3050	0,96	1,125	11,9	-0,5	-	43,[illegible]
	NOVEMBER	-84,46	-,2145	0,84	1,089	11,4	-0,5	-	43,[illegible]
	DECEMBER	-138,09	-,3371	0,89	1,125	10,8	-0,6	-	42,[illegible]
	JANUARY	-21,55	-,0519	0,81	1,125	10,4	-0,4	-	42,[illegible]
	FEBRUARY	-43,56	-,1039	0,89	1,016	10,2	-0,2	-	42,[illegible]
	MARCH	-11,02	-,0258	0,90	1,125	10,0	-0,2	-	42,2
	APRIL	-39,67	-,0917	0,79	1,089	9,6	-0,4	-	42,[illegible]
	MAY	+34,03	+,0809	1,56	1,125	10,1	+0,5	-	42,4
	JUNE	+87,48	+,2194	1,94	1,089	11,2	+1,1	-	43,2
	JULY	+144,85	+,3983	2,61	1,125	13,1	+1,9	-	44,[illegible]
	AUGUST	-12,15	-,0341	1,52	1,125	13,5	+0,4	-	44,9
	SEPTEMBER	-11,16	-,0314	1,12	1,089	13,5	0,0	-	44,9
1969/70	OCTOBER	-96,16	-,2644	0,98	1,125	13,1	-0,4	-	44,[illegible]
	NOVEMBER	-141,50	-,3792	0,88	1,089	12,5	-0,6	-	44,[illegible]
	DECEMBER	-97,70	-,2516	0,31	1,125	11,9	-0,6	-	43,[illegible]
	JANUARY	-51,62	-,1311	0,77	1,125	11,4	-0,5	-	43,[illegible]
	FEBRUARY	-107,08	-,2657	0,91	1,016	11,0	-0,4	-	43,0
	MARCH	-7,47	-,0187	1,42	1,125	11,3	+0,3	-	43,2
	APRIL	+56,40	+,1491	1,79	1,089	12,2	+0,9	-	44,[illegible]
	MAY	+56,05	+,1522	1,49	1,125	12,7	+0,5	-	44,4
	JUNE	-38,24	-,1003	2,20	1,089	13,7	+1,0	-	45,[illegible]
	JULY	+263,28	+,7459	2,98	1,125	13,7	0,0	2,6	45,[illegible]
	AUGUST	+44,14	+,1250	1,69	1,125	13,7	0,0	0,7	45,[illegible]
	SEPTEMBER	-53,73	-,1522	1,68	1,089	13,7	0,0	0,4	45,[illegible]

1 - Year - Month

2 - Gain or loss - in mm P-E

3 - Gain or loss - (10^6 m^3)

4 - Affluence - (10^6 m^3)

5 - Regulation (10^6 m^3)

6 - Accumulation (10^6 m^3)

7 - Variation in accumulation (10^6 m^3)

8 - Bleeding (10^6 m^3)

9 - Elevation (m)

TABLE FOR THE TRACING OF THE OPERATIONAL CURVE OF RESERVOIRS

WEIR: BITA

BASIN: BITA

TABLE 11C

PERIOD OCT. 1960/ SEPT 1974

ANO	MÊS	Perda ou ganho em (mm) P-E	Perda ou Ganho (10⁶ m.c)	Afluência (10⁶ m.c)	Regularização (10⁶ m.c)	Acumulação (10⁶ m.c)	Variação de acumulação (10⁶ m.c)	[illegible]	Cota (m)
*	1	2	3	4	5	6	7	8	9
1970/71	OCTOBER	-118,06	-,3316	1,34	1,125	13,6	-0,1	-	44,9
	NOVEMBER	-123,25	-,3527	1,09	1,089	13,2	-0,4	-	44,6
	DECEMBER	-140,34	-,3010	1,05	1,125	12,7	-0,5	-	44.4
	JANUARY	-79,02	-,2996	1,10	1,125	12,5	-0,2	-	44,1
	FEBRUARY	-111,79	-,2996	1,43	1,016	12,6	+0,1	-	44,2
	MARCH	-98,96	-,2617	1,02	1,125	12,2	-0,4	-	44,0
	APRIL	-69,21	-,1805	1,13	1,089	12,1	-0,1	-	43,8
	MAY	+118,27	+,3323	2,32	1,125	13,6	+1,5	-	44.9
	JUNE	+24,10	+,0683	1,84	1,089	13,7	+0,1	0,7	45,0
	JULY	+66,71	+,1890	2,03	1,125	13,7	0,0	1.1	45,0
	AUGUST	+17,90	+,0507	1,99	1,125	13,7	0,0	0,9	45,0
	SEPTEMBER	-42,56	-,1206	1,71	1,089	13.7	0.0	0,5	45.0
1971/72	OCTOBER	-27,43	-,0777	2,52	1,125	13,7	0,0	1,3	45.0
	NOVEMBER	-102.37	-.2900	1.82	1.089	13,7	0,0	0.4	45.0
	DECEMBER	-132,44	-.3752	1.54	1,125	13.7	0.0	0.0	45.0
	JANUARY	-74,20	-.2102	1.37	1,125	13.7	0.0	0,0	45.0
	FEBRUARY	-55,94	-,1585	1,33	1,052	13,7	0.0	0,1	45,0
	MARCH	-66.46	-,1833	1,60	1,125	13,7	0.0	0.3	45.0
	APRIL	+156,90	+,4445	2,65	1,089	13,7	0.0	2,0	45.0
	MAY	+102.75	+.2911	3.12	1,125	13,7	0,0	2.3	45.0
	JUNE	+180,75	+,5121	3,99	1,089	13.7	0,0	3,4	45.0
	JULY	+20,98	+.0594	1.49	1,125	13,7	0.0	0.4	45.0
	AUGUST	+92.85	+,2630	2.85	1.125	13,7	0.0	2,0	45,0
	SEPTEMBER	-39,91	-,1131	2,40	1,089	13,7	0.0	1.2	45.0
1972/73	OCTOBER	-83,13	-,2355	1,34	1,125	13,7	0,0	0,5	45.0
	NOVEMBER	-131,76	-,3702	1,32	1,089	13.6	-0,1	-	44.9
	DECEMBER	-81.71	-,2279	1.15	1,125	13,4	-0.2	-	44.9
	JANUARY	-76,42	-,2131	1,26	1,125	13.3	-0.1	-	44.7
	FEBRUARY	-7.77	-,0220	1.87	1,016	13.7	+0,4	0,4	45.0
	MARCH	-57,73	-,1635	1,65	1,125	13,7	0,0	0,4	45.0
	APRIL	+36,88	+,1045	3,26	1,089	13.7	0,0	2,3	45.0
	MAY	+103,10	+,2921	2,30	1,125	13,7	0,0	1,5	45.0
	JUNE	+65,10	+,1844	2.62	1,089	13,7	0.0	1.7	45.0
	JULY	+16,98	+,0481	2,22	1,125	13,7	0,0	1.1	45.0
	AUGUST	+58,90	+,1669	3,16	1,125	13,7	0,0	2.2	45.0
	SEPTEMBER	-8,56	-,0243	2,55	1,089	13,7	0.0	1.4	45.0
1973/74	OCTOBER	-74,43	-,2109	1,24	1,125	13,7	0,0	0,4	45,0
	NOVEMBER	-141,76	-,3954	1,15	1,089	13,4	-0,3	-	44.8
	DECEMBER	-118,01	-,3343	1,82	1,125	13,7	+0,3	0.1	45.0
	JANUARY	+34.63	+,0981	1,74	1,125	13,7	0.0	0,7	45.0
	FEBRUARY	-62,32	-,1766	1,85	1,016	13.7	0,0	0,7	45.0
	MARCH	+43,52	+,1233	3,21	1,125	13,7	0,0	2,2	45,0
	APRIL	+75,53	+,2140	2,33	1,089	13,7	0,0	1,5	45,0
	may	+192,50	+,5454	4,09	1,125	13,7	0,0	3,5	45.0
	june	+81,75	+,2316	3,45	1,089	13,7	0,0	2,6	45,0
	JULY	+62,98	+,1784	3,65	1,125	13,7	0,0	2,7	45,0
	AUGUST	+34,80	+,0986	2.09	1,125	13,7	0,0	1,1	45.0
	SEPTEMBER	-29.81	+,0845	2.29	1,089	13,7	0,0	1,3	45,0

1 - Year - Month

2 - Gain or loss - in mm P-E

3 - Gain or loss - (10^6 m^3)

4 - Affluence - (10^6 m^3)

5 - Regulation (10^6 m^3)

6 - Accumulation (10^6 m^3)

7 - Variation in accumulation (10^6 m^3)

8 - Bleeding (10^6 m^3)

9 - Elevation (m)

TABLE FOR THE TRACING OF THE OPERATIONAL CURVE OF RESERVOIRS

WEIR: UTINGA DE BAIXO — TABLE 12-A

BASIN: UTINGA DE BAIXO — PERIOD; OCT. 62 / SEPT. 66

ANO	MÊS	Perdas/Ganho em (mm) P-E	Perdas/Ganho (10^6 m.c.)	Afluência (10^6 m.c.)	Regularização (10^6 m.c.)	Acumulação (10^6 m.c.)	Variação de acumulação (10^6 m.c.)	Sangria (10^6 m.c.)	Cota (m)
1		2	3	4	5	6	7	8	9
1962/63	OCTOBER	-99,93	-,330	0,887	0,937	9,7	-0,4	-	64,8
	NOVEMBER	-114,81	-,388	1,37	0.907	9,8	+0,1	-	64,8
	DECEMBER	-114,21	-,379	0,779	0.937	9,3	-0,5	-	64,5
	JANUARY	-72,27	-,236	0,592	0,937	8,7	-0,6	-	64,2
	FEBRUARY	-4,57	-,015	1,93	0,847	9,8	+1,1	-	64,8
	MARCH	+124,02	+,424	3,34	0,937	10,1	+0,3	2,5	65,0
	APRIL	+111,13	+,380	2,37	0,907	10,1	0,0	1,8	65,0
	MAY	-10,30	-,035	0,698	0,937	9,8	-0,3	-	64,8
	JUNE	+55,20	+,169	1,71	0,907	10,1	+0,3	0,7	65,0
	JULY	-31,22	-,105	0,508	0,937	9,6	-0.5	-	64,7
	AUGUST	+12.50	+,043	1.35	0.937	10,1	+0.5	-	65.0
	SEPTEMBER	-90.16	-,301	0,570	0,907	9,4	-0,7	-	64,6
1963/64	OCTOBER	-131,33	-,416	0,021	0,937	8,1	-1,3	-	63,8
	NOVEMBER	-122,91	-,384	0,959	0,907	7,8	-0,3	-	63,6
	DECEMBER	-114,01	-,351	0,784	0,937	7,3	-0,5	-	63,4
	JANUARY	-26,87	-,083	1,12	0,937	7,4	+0,1	-	63,4
	FEBRUARY	-26,47	-,084	1,59	0,877	8,0	+0.6	-	63,6
	MARCH	+93,27	+,319	2,91	0,937	10,1	+2,1	0,2	65,0
	APRIL	+132,18	+,452	2,62	0,907	10,1	0,0	2,2	65,[illegible]
	MAY	+31.65	+,108	1.12	0,937	10.1	0.0	0.3	65.0
	JUNE	+110.00	+,376	2.43	0,907	10.1	0,0	1,9	65.0
	JULY	+48,23	+,165	1,37	0,937	10,1	0,0	0,6	65,[illegible]
	AUGUST	+59,15	+,202	2,07	0,937	10.1	0.0	1,3	65.0
	SEPTEMBER	-24.31	-.083	1.85	0.907	10.1	0.0	0.9	65.0
1964/65	OCTOBER	-108.33	-,362	0,642	0,937	9.4	-0,7	-	64,6
	NOVEMBER	-127,76	-,417	0,712	0,907	8,6	-0,6	-	64,2
	DECEMBER	-118.91	-.377	0.647	0.937	8.1	-0.5	-	63,8
	JANUARY	-67,62	-.211	0.646	0,937	7,6	-0,5	-	63.3
	FEBRUARY	-111,72	-,332	0,248	0,847	6,7	-0,9	-	63,0
	MARCH	-72,48	-,212	0,601	0,937	6,2	-0,5	-	62,7
	APRIL	+70,33	+,217	1,88	0,907	7,4	+1,2	-	63,4
	MAY	+34.53	+,108	1.15	0,937	7.7	+0,3	-	63.6
	JUNE	+205,35	+,702	3,68	0,907	10,1	+2.4	1,1	65.0
	JULY	-21,52	-,072	0,614	0,937	9,7	-0.4	-	64,7
	AUGUST	+27,60	+,094	1,59	0,937	10,1	+0,4	0.3	65,0
	SEPTEMBER	-37,91	-,130	1,47	0,907	10,1	0,0	0,4	65,0
1965/66	OCTOBER	-114,93	-,386	0,888	0,937	9,7	-0,4	-	64,7
	NOVEMBER	-100,46	-,334	0,788	0,907	9,2	-0,5	-	64,5
	DECEMBER	-119,26	-,386	0,638	0,937	8.5	-0,7	-	64,1
	JANUARY	+15,63	+,052	1,62	0,937	9,2	+0.7	-	64,5
	FEBRUARY	-41,57	-,140	1,35	0,847	9,6	+0,4	-	64,7
	MARCH	-55,28	-,184	0,841	0,937	9,3	-0,3	-	64.5
	APRIL	-3,67	-,012	1,00	0,907	9,4	+0,1	-	64,6
	may	+83,30	+,285	1,65	0,937	10,1	+0.7	0.3	65,0
	JUNE	+250,30	+,856	4.27	0,907	10,1	0,0	4,2	65,0
	JULY	+161,25	+,551	2,60	0,937	10,1	0,0	2,2	65,0
	AUGUST	-31,15	-,105	0,600	0,937	9,7	-0,4	-	64,[illegible]
	SEPTEMBER	-19,31	-,066	1,99	0,907	10,1	+0,4	0,6	65,0

OPERATIONAL RESERVOIRS

SOLUTION 1 — MASSANGANA SYSTEM - CANGARÍ BASIN

ACCUMULATION ELEVATION 45,00 m

WORK	VOLUME OF EARTH m^3	VOLUME OF STONE m^3	COST OF WORK	DISPOSSESSION			TOTAL COST
				AREA Ha	UNIT PRICE	COST	
Dam I	72.315	3.360	520.858				520.858
Dam II	84.087	3.360	595.845				595.845
Dam III	7.400	480	55.994				55.994
Dam IV	9.915	480	71.760				71.760
Spillway Canal	20.250	47.250	464.530				464.530
				172	1.500	259.000	
						TOTAL	1.966.987

1 - Year - Month

2 - Gain or loss - in mm P-E

3 - Gain or loss - (10^6 m^3)

4 - Affluence - (10^6 m^3)

5 - Regulation (10^6 m^3)

6 - Accumulation (10^6 m^3)

7 - Variation in accumulation (10^6 m^3)

8 - Bleeding (10^6 m^3)

9 - Elevation (m)

TABLE FOR THE TRACING OF THE OPERATING CURVE OF RESERVOIRS

WEIR: UTINGA DE BAIXO

TABLE 12-B

BASIN; UTINGA DE BAIXO PERIOD OCT, 1966/SEPT 1970

ANO	MÊS	Perda no Lago em (mm)	Perda no Lago (10^6 m³)	Afluência (10^6 m³)	Regularização (10^6 m³)	Acumulação (10^6 m³)	Variação da Acumulação (10^6 m³)	Sangria (10^6 m³)	Cota (m)
1		2	3	4	5	6	7	8	9
1966/67	OCTOBER	-111,63	-,373	0,564	0,937	9,4	-0,7	-	64,6
	NOVEMBER	-110,91	-,373	1,37	0,907	9,5	+0,1	-	64,7
	DECEMBER	-117,46	-,385	0,688	0,937	8,9	-0,6	-	64,3
	JANUARY	-99.47	-,315	0,275	0,937	7,9	-1,0	-	63,7
	FEBRUARY	-82.72	-,255	0.703	0,847	7.5	-0,4	-	63,4
	MARCH	+137.37	+,470	3,92	0,937	10,1	+2,6	0,5	65,0
	APRIL	+56,53	+,193	1,72	0,907	10,1	0,0	1,1	65,0
	MAY	+34.55	+,118	1,15	0,937	10,1	0,0	0,3	65,0
	JUNE	+24,20	+,083	1.30	0,907	10,1	0,0	0,5	65,0
	JULY	+32.93	+.113	1,21	0,937	10,1	0,0	0,4	65,0
	AUGUST	+71.50	+,245	2,27	0,937	10,1	0,0	1,6	65,0
	SEPTEMBER	-46.71	-,160	1,22	0,907	10,1	0,0	0,2	65,0
1967/68	OCTOBER	-91,38	-,313	1,39	0,937	10,1	0,0	0,1	65,0
	NOVEMBER	-133,71	-,452	1,02	0,907	9,8	-0,3	-	64,8
	DECEMBER	-108.06	-.357	0.494	0.937	9.0	-0,8	-	64,4
	JANUARY	-73,37	-.238	0,570	0.937	8,4	-0,6	-	64,1
	FEBRUARY	-55,02	-,178	1,08	0,877	8.4	0,0	-	64,1
	MARCH	+31,71	+,103	1,18	0,937	8,7	+0,3	-	64,2
	APRIL	+25,87	+,034	0,820	0,907	8,6	-0,1	-	64,1
	MAY	+54,25	+,177	0,865	0,937	8,7	+0,1	-	64.2
	JUNE	+70,99	+,231	0,607	0.907	8,6	-0,1	-	64,1
	JULY	+0.93	+.003	0.536	0,937	8.2	-0,4	-	63,9
	AUGUST	+17,34	+,056	1,02	0,937	8,3	+0,1	-	64.0
	SEPTEMBER	-74,92	-,238	0.862	0,907	8,0	-0.3	-	63.8
1968/69	OCTOBER	-118,44	-,365	0.750	0,937	7,4	-0,6	-	63,4
	NOVEMBER	-84,46	-,256	0,654	0,907	6,9	-0,5	-	63,2
	DECEMBER	-133,09	-,405	0.659	0.937	6,2	-0.7	-	62.7
	JANUARY	-21,55	-,061	0,630	0,937	5,8	-0,4	-	62,4
	FEBRUARY	-43,56	-,121	0,696	0,847	5,5	-0,3	-	62,2
	MARCH	-11,02	-,030	0.759	0.937	5.3	-0,2	-	62.0
	APRIL	-39,67	-,106	0,611	0,907	4,9	-0,4	-	61,7
	MAY	+34,03	+,092	1.21	0,937	5,3	+0.4	-	62.0
	JUNE	+87,48	+,252	1,51	0,907	6,2	+0,9	-	62,7
	JULY	+144,85	+,452	2.03	0,937	7.7	+1,5	-	63.6
	AUGUST	-12,15	-,039	1,18	0,937	7,9	+0,2	-	63,7
	SEPTEMBER	-11.16	-,035	0,874	0,907	7.8	-0.1	-	63.6
1969/70	OCTOBER	-96,16	-,296	0,764	0,937	7,3	-0,5	-	63.4
	NOVEMBER	-141.50	-,420	0,683	0,907	6,7	-0,6	-	63.0
	DECEMBER	-97,70	-,281	0,630	0,937	6.1	-0,6	-	62.6
	JANUARY	-51.62	-,143	0.602	0,937	5.6	-0,5	-	62.2
	FEBRUARY	-107.08	-,285	0,712	0.847	5,2	-0,4	-	61.8
	MARCH	-7,47	-,020	1,11	0,937	5,4	+0,2	-	62,0
	APRIL	+56,40	+,162	1,39	0,907	6,0	+0,6	-	62,5
	MAY	+56,05	+,164	1,16	0,937	6,4	+0,4	-	62,3
	JUNE	-38,24	-,116	1,71	0,907	7,1	+0,7	-	63,2
	JULY	+263,20	+,879	2,32	9,37	9,4	+2,3	-	64,6
	AUGUST	+44,14	+,151	2,09	9,37	10,1	+0,7	0,6	65.0
	SEPTEMBER	-53,73	-,164	1,30	0,907	10.1	0,0	0,2	65,0

1 - Year - Month

2 - Gain or loss - in mm P-E

3 - Gain or loss - (10^6 m^3)

4 - Affluence - (10^6 m^3)

5 - Regulation (10^6 m^3)

6 - Accumulation (10^6 m^3)

7 - Variation in accumulation (10^6 m^3)

8 - Bleeding (10^6 m^3)

9 - Elevation (m)

TABLE FOR THE TRACING OF THE OPERATIONAL CURVE OF RESERVOIRS

WEIR: UTINGA DE BAIXO

TABLE 12-C

BASIN: UTINGA DE BAIXO — PERIOD OCT. 70/ SEPT. 74

ANO	MÊS	Precipitação em(mm)P-E	Perdas (10⁶ m.c)	Afluência (10⁶ m.c)	Regularização (10⁶ m.c)	Acumulação (10⁶ m.c)	Variação de acumulação (10⁶ m.c)	Sangria (10⁶ m.c)	Cota (m)
	1	2	3	4	5	6	7	8	9
1970/71	OCTOBER	-110,00	-,399	1,05	0,937	9,8	-0,3	-	64,8
	NOVEMBER	-123.25	-.426	0,850	0,907	9,3	-0,5	-	64,5
	DECEMBER	-140.34	-.458	0.817	0,937	8,7	-0,6	-	64,2
	JANUARY	-79.82	-,256	0,855	0,937	8,4	-0,3	-	64,0
	FEBRUARY	-111.79	-,349	0.635	0.847	7,3	-0,6	-	63,4
	MARCH	-98.96	-,305	0.798	0,937	7,4	-0,4	-	63,4
	APRIL	-69,21	-,210	0,379	0,907	7,2	-0,2	-	63,2
	MAY	+119.27	+.380	1,81	0,937	8,4	+1,2	-	64,0
	JUNE	+24.10	+,079	1,43	0,907	9,0	+0,6	-	64,3
	JULY	+66,71	+,227	1,58	0,937	9,9	+0,6	-	64,9
	AUGUST	+17,90	+,061	1,55	0,937	10,1	+0,2	0,5	65,0
	SEPTEMBER	-42,56	-,146	1,33	0,907	10,1	0,0	0,3	65.0
1971/72	OCTOBER	-27,43	-,094	1,96	0,937	10,1	0,0	0,9	65,0
	NOVEMBER	-102,37	-.350	1,41	0,907	10,1	0,0	0,2	65,0
	DECEMBER	-132,44	-,450	1,20	0,937	9,9	-0,2	-	64,9
	JANUARY	-74,20	-,251	1,07	0,937	9,8	-0,1	-	64.8
	FEBRUARY	-55,94	-,189	1,04	0,877	9,8	0,0	-	64,8
	MARCH	-66,46	-,226	1,25	0,937	9,9	+0,1	-	64,9
	APRIL	+156,90	+,537	2,06	0,907	10.1	+0,2	1.5	65,0
	MAY	+102,75	+,351	2,43	0,937	10,1	0,0	1,8	65.0
	JUNE	+180,75	+,618	3,11	0,907	10,1	0,0	2,8	65.0
	JULY	+20.98	+,072	1,16	0,937	10,1	0.0	0,3	65.0
	AUGUST	+92.85	+.318	2.22	0.937	10,1	0,0	1.6	65.0
	SEPTEMBER	-39.91	-.137	1,87	0.907	10.1	0.0	0.2	65.0
1972/73	OCTOBER	-83.13	-,284	1,43	0,937	10,1	0,0	0,2	65.0
	NOVEMBER	-131,76	-,445	1,03	0,907	9.8	-0,3	-	64.8
	DECEMBER	-81.71	-,273	0,898	0,907	9,5	-0,3	-	64.6
	JANUARY	-76.42	-,254	0,981	0.937	9,3	-0,2	-	64,5
	FEBRUARY	-7,77	-,026	1,45	0,847	9,9	+0.6	-	64.9
	MARCH	-57,73	-,196	1,28	0,937	10,0	+0,1	-	64.9
	APRIL	+36,88	+,126	2,54	0,907	10,1	+0,1	1,7	65,0
	MAY	+103,10	+,353	1,79	0,937	10,1	0,0	1,2	65.0
	JUNE	+65,10	+,223	2,04	0,907	10,1	0,0	1,8	65,0
	JULY	+16,98	+,058	1,73	0,937	10,1	0,0	0,9	65.0
	AUGUST	+58,90	+,201	2,46	0,937	10,1	0,0	1,7	65.0
	SEPTEMBER	-8,56	-,029	1,98	0.907	10,1	0,0	1,0	65.0
1973/74	OCTOBER	-74,43	-.255	1,35	0,937	10,1	0,0	0.2	65.0
	NOVEMBER	-141,76	-,476	0,899	0,907	9,6	-0,5	-	64.7
	DECEMBER	-116,01	-,399	1,42	0,937	9,7	+0,1	-	64.8
	JANUARY	+34,63	+,110	1,35	0,937	10,1	+0,4	0,1	65.0
	FEBRUARY	-62.32	-,213	1,44	0,847	10.1	0,0	0.4	65.0
	MARCH	+43,52	+,149	2.50	0,937	10,1	0.0	1,7	65.0
	APRIL	+75,53	+,258	1,81	0,907	10,1	0,0	1,2	65,0
	MAY	+192,50	+,658	3,10	0,937	10,1	0,0	2,9	65.0
	JUNE	+81,75	+,280	2,60	0,907	10,1	0,0	2,1	65.0
	JULY	+62,98	+,215	2,84	0,937	10,1	0,0	2,1	65,0
	AUGUST	+34,80	+,119	1,63	0,937	10,1	0,0	0.8	65,0
	SEPTEMBER	-29,81	-,102	1,70	0,937	10.1	0.0	0.8	65.0

OPERATIONAL RESERVOIRS

MASSANGANA SYSTEM - UTINGA DE BAIXO BASIN

STORAGE ELEVATION - 65,00

SOLUTION 1-A

WORK	VOLUME OF EARTH m^3	VOLUME OF STONE m^3	COST OF WORK Cr$	DISPOSSESSION AREA (ha)	DISPOSSESSION UNIT PRICE	DISPOSSESSION COST	TOTAL COST
Dam 1-A	128.573	2.987	872.537				872.537
Dam 2-A	35.325	1.995	260.770				260.770
Dam 2	11.188	252	75.783				75.783
Canal C 1-A	23.125	-	72.844				72.844
Canal C 2-A	4.910	-	15.467				15.467
Aux. Dam 3-A	1.144	-	7.287				7.287
Aux. Dam 4-A	1.160	-	7.390				7.390
Aux. Dam 5-A	1.467	-	9.345				9.345
				232	1.500	348.000	348.000
Feeder Canal	38.531	525 *	225.805				225.805
						TOTAL	1.895.228

* Concrete lining

Regulated flows of about 20.000 m^3/day or in excess of 36.000 m^3/day could be expected for the same reasons as above.

The last reservoir, called Bita for reasons of predominance, has its main dam located at the closest convenient point from the gravitational center of the CI, and constitutes a key spot for the leadoff of the delivery, treatment and distribution system of the water of asuperficial nature. The previous reservoir, called, also by predominance Utinga de Baixo, allows the bleeding of the excess of its waters into the Pirajá basin, thus increasing the regulating capacity of the Bita reservoir. The water stored in Utinga de Baixo can easily be delivered by an open canal to the water intake (downstream) of the Bita dam.

The Bita reservoir, whose spillway discharges into the Ipojuca basin, allows the highwaters of the river Massangana, in a large part of its basin.(36 km^2) to be diverted from the original area to the area dominated by the Ipojuca which, due to its size, easily absorbs these excesses.

Finally, the Bita reservoir, due to its location, is the one that can most easily receive additional water from the Ipojuca system.

4.1.4 IPOJUCA SYSTEM

The river Ipojuca forms one of the largest hydrographic basins in the State, with an area of 3.539 km^2, and it is the longest river - 245 km. Its spring is between the Serra das Porteiras and the Serra das Guaibas, in the county of Arcoverde - PE, at an altitude of about 800 m; its course shows a form factor Of 0,05, and its regulated flow can reach 1.000.000 m^3/day.It flows into the sea in the port area of Suape, and the last 7 km of its course qre in the CI area.

1 - Year - Month

2 - Gain or loss - in mm P-E

3 - Gain or loss - (10^6 m^3)

4 - Affluence - (10^6 m^3)

5 - Regulation (10^6 m^3)

6 - Accumulation (10^6 m^3)

7 - Variation in accumulation (10^6 m^3)

8 - Bleeding (10^6 m^3)

9 - Elevation (m)

TABLE FOR THE TRACING OF THE OPERATIONAL CURVE OF RESERVOIRS

WEIR: ENGENHO MARANHÃO

BASIN: ENGENHO MARANHÃO PERIOD: FEB. 1967/ SEPT 1970

ANO	MÊS	Perda ou Ganho em (mm) P-E	Perda ou Ganho (10^6 m.c.)	Afluência (10^6 m.c.)	Regularização (10^6 m.c.)	Acumulação (10^6 m.c.)	Variação de acumulação (10^6 m.c.)	Sangria (10^6 m.c.)	Cota (m)
	1	2	3	4	5	6	7	8	9
1	FEBRUARY	-82.72	-0.14	18,31	14.52	13,00	0,0	3,65	27.0
	MARCH	+137,37	+0,23	105,58	16,07	13,00	0,0	89,74	27,0
9	APRIL	+56.53	+0.10	154,77	15.56	13,00	0.0	139.31	27,0
	MAY	+34.55	+0,06	154.57	16,07	13,00	0.0	138,56	27,0
6	JUNE	+24.20	+0,04	99,97	15,56	13,00	0,0	84,45	27.0
7	JULY	+32.93	+0,06	110,94	16,07	13,00	0,0	94,93	27.0
	AUGUST	+71.50	+0,12	91,07	16,07	13,00	0,0	75,12	27,0
	SEPTEMBER	-46,71	-0,08	59,62	15,56	13,00	0,0	43,98	27,0
	OCTOBER	-91,38	-0,15	46.07	16,07	13,00	0,0	29,85	27.0
1	NOVEMBER	-131,71	-0,22	24,49	15,56	13,00	0,0	8,71	27,0
	DECEMBER	-108,06	-0,18	21,27	16,07	13,00	0,0	5,02	27,0
9	JANUARY	-73,37	-0,12	19,12	16,07	13,00	0,0	2,55	27,0
6	FEBRUARY	-55,02	-0,09	15,03	15,03	12,9	-0.1	-	27.0
	MARCH	+31,71	+0,05	39,42	16,07	13,0	+0.1	23,30	27.0
7	APRIL	+25,07	+0,04	39,97	15,56	13.0	0.6	24,45	27.0
	MAY	+54,25	+0,09	57,99	16,07	13,0	0,0	47,01	27.0
/	JUNE	+70,99	+0,12	56.04	15,56	13,0	0,0	40,62	27.0
6	JULY	+ 0,93	+0,01	90,82	46,07	13,0	0,0	74,76	27,0
	AUGUST	+17,34	+0,03	52,95	16,07	13,0	0,0	39,32	27,0
8	SEPTEMEBR	-74,92	-0,13	33,10	15,56	13,0	0,0	17,41	27.0
	OCTOBER	-118,44	-0,20	22,71	16,07	13.0	0,0	6,44	27.0
1	NOVEMBER	-84,46	-0,14	17,68	15,56	13,0	0,0	1,93	27,0
	DECEMBER	-138,09	-0,22	15,29	16,07	12,00	-1,0	-	26.5
9	JANUARY	-21,55	-0,04	24,16	16,07	13.00	+1,0	7.05	27.0
	FEBRUARY	-43,56	-0,07	14,64	14,52	13,0	0.0	0,05	27.0
6	MARCH	-11,02	-0.02	148,38	16,07	13,00	0,0	132,29	27,0
	APRIL	-39,67	-0,07	37,97	15,56	13.00	0,0	22,34	27.0
8	MAY	+34,03	+0,06	49,97	16,07	13,00	0,0	33,96	27,0
/	JUNE	+87,40	+0,15	129,29	15,56	13,00	0,0	113,88	27,0
	JULY	+134,85	+0,19	491,14	16,07	15,00	0,0	475,26	27,0
6	AUGUST	-12,15	-0,02	164,05	16,07	13,00	0,0	147,96	27,0
9	SEPTEMBER	-11,16	-0,02	54,87	15,56	13,00	0,0	39,29	27,0
	OCTOBER	-96,16	-0,16	35,65	16,07	13,00	0.0	19,42	27,0
1	NOVEMBER	-141,50	-0,24	27,76	16,07	13,00	0,0	11,96	27,0
	DECEMBER	-97,70	-0,16	24,94	16,07	13,00	0,0	8,71	27.0
9	JANUARY	-51.62	-0,07	25,77	16,07	13,00	0,0	9,63	27.0
6	FEBRUARY	-107,08	-0,18	21,63	14,52	13,00	0,0	6,93	27.0
9	MARCH	-7,47	-0,01	84,16	16,07	13,00	0,0	65,03	27.0
	APRIL	+56,40	+0,09	48,57	15,56	13,00	0,0	33,10	27.0
/	MAY	+56,05	+0,09	40,85	16,07	13,00	0,0	24,37	27.0
7	JUNE	-38,24	-0,06	78,28	15,56	13,00	0,0	62,66	27,0
0	JULY	+263,28	+0,44	249,09	16,07	13,00	0,0	233,46	27.0
	AUGUST	+44,14	+0,07	229,19	16,07	13,00	0,0	213,19	27.0
	SEPTEMBER	-55,73	-0,09	84,50	15,56	0,0	0,0	68,85	27,0

TABLE FOR THE TRACING OF THE OPERATIONAL CURVE OF RESERVOIRS

WEIR: ENGENHO MARANHÃO

BASIN: ENGENHO MARANHÃO.

PERIOD: Oct. 1970/SEPT 1974

	1	2	3	4	5	6	7	8	9
1970/71	OCTOBER	-118,00	-0,20	53,57	16,07	13,00	0,0	37,30	27,0
	NOVEMBER	-120,25	-0,21	40,95	15.56	13.00	0.0	25.18	27.0
	DECEMBER	-140,34	-0,23	35,94	16,07	13,00	0,0	19,64	27,0
	JANUARY	-79,82	-0,13	33,13	16,07	13,00	0,0	16,93	27,0
	FEBRUARY	-111,79	-0,19	27,51	14,52	13,00	0,0	12,80	27,0
	MARCH	-98,96	-0,17	31,90	16.07	13,00	0.0	15,66	27.0
	APRIL	-69,21	-0,12	64,20	15,56	13,00	0,0	48,48	27,0
	MAY	+118,27	+0,20	80,27	16,07	13,00	0,0	64,40	27,0
	JUNE	+24,10	+0,04	74,49	15,56	13,00	0,0	58,97	27,0
	JULY	+66,71	+0,11	98,86	16,07	13,00	0,0	82,90	27,0
	AUGUST	+17,90	+0,03	55,30	16,07	13,00	0,0	39,26	27,0
	SEPTEMBER	-42.56	-0,07	34,99	15,56	13,00	0,0	19,36	27.0
1971/72	OCTOBER	-27,43	-0,05	43,12	16,07	13,00	0,0	27,03	27,0
	NOVEMBER	-102,37	-0,17	19,88	15,56	13,00	0,0	4,15	27,0
	DECEMBER	-132,44	-0,22	18.51	16.07	13,00	0.0	2.22	27,0
	JANUARY	-74,20	-0,11	14,03	16,07	10,85	-2,1	-	25.8
	FEBRUARY	-55,94	-0.07	13,23	15,03	8,98	-1.9	-	24.7
	MARCH	-66,46	-0,11	27,67	16,07	13.00	+4,0	7,47	27,0
	APRIL	+156,90	+0.26	33,96	15,56	13.00	0,0	18,65	27.0
	MAY	+102,75	+0,17	58,47	16,07	13,00	0,0	42,57	27,0
	JUNE	+180,75	+0,30	109,60	15,56	13,00	0,0	93,34	27,0
	JULY	+20.98	+0,04	72,05	16,07	13,00	0.0	56,02	27.0
	AUGUST	+92,85	+0,16	76,07	16,07	13,00	0,0	60,16	27,0
	SEPTEMBER	-39,91	-0,07	56,35	15,56	13,00	0,0	40,72	27,0
1972/73	OCTOBER	-85,13	-0,14	32,27	16,07	13,00	0,0	16,08	27,0
	NOVEMBER	-131,76	-0,22	23,17	15,56	13,00	0,0	7,59	27,0
	DECEMBER	-81,71	-0,14	21,96	16,07	13,00	0,0	5.75	27,0
	JANUARY	-76,42	-0.13	24,16	16,07	13,00	0,0	7.96	27,0
	FEBRUARY	-7,77	-0,01	15,48	14,52	13.00	0.0	0,95	27.0
	MARCH	-57,73	-0,10	16,98	16,07	13,00	0,0	0,81	27.0
	APRIL	+36,88	+0,06	55,21	15,56	13,00	0,0	39,71	27,0
	MAY	+103,10	+0,17	44,46	16,07	13,00	0.0	28.56	27.0
	JUNE	+65,10	+0,11	66,87	15,56	13,00	0,0	51,42	27,0
	JULY	+16,98	+0,03	88,92	16,07	13,00	0,0	72,88	27,0
	AUGUST	+58,90	+0,10	58,39	16,07	13,00	0,0	42.42	27,0
	SEPTEMBER	-0,56	-0,02	73,09	15,56	13.00	0.0	57.51	27.0
1973/74	OCTOBER	-74,43	-0,12	39,27	16,07	13,00	0,0	23.08	27.0
	NOVEMBER	-141,76	-0,24	23,02	15,56	13,00	0.0	7,22	27,0
	DECEMBER	-118,01	-0,20	21,64	16,07	13,00	0,0	5,37	27,0
	JANUARY	+34,63	+0,05	14,84	16,07	11,82	-1,2	-	26,5
	FEBRUARY	-62,32	-0,10	68,87	14,52	13,00	+1,2	55,07	27,0
	MARCH	+45,52	+0,08	109,01	16,07	13,00	0,0	93.02	27,0
	APRIL	+95,53	+0,16	239,11	15,56	13,00	0,0	223,71	27,0
	MAY	+192,50	+0,32	110,22	16,07	13,00	0,0	94,47	27,0
	JUNE	+81,75	+0,14	106,48	15,56	13,00	0,0	91,06	27,0
	JULY	+67,98	+0,11	164,96	16,07	13,00	0,0	149,00	27,0
	AUGUST	+34,80	+0,06	77,89	16,07	13,00	0,0	61,63	27,0
	SEPTEMBER	-29,81	-0,05	69,47	15,56	13,00	0,0	53,86	27,0

1 - Year - Month

2 - Gain or loss - in mm P-E

3 - Gain or loss - (10^6 m^3)

4 - Affluence - (10^6 m^3)

5 - Regulation (10^6 m^3)

6 - Accumulation (10^6 m^3)

7 - Variation in accumulation (10^6 m^3)

8 - Bleeding (10^6 m^3)

9 - Elevation (m)

TABLE FOR THE TRACING OF THE OPERATIONAL CURVE OF RESERVOIRS

WEIR: ENGENHO MARANHÃO

BASIN: ENGENHO MARANHÃO. PERIOD: Oct. 1970/SEPT 1974

	1	2	3	4	5	6	7	8	9
	OCTOBER	-118,00	-0,20	53,57	16,07	13,00	0,0	37,30	27,0
1	NOVEMBER	-120,25	-0,21	40,95	15.56	13.00	0.0	25.18	27.0
9	DECEMBER	-140,34	-0,23	35,94	16,07	13,00	0,0	19,64	27,0
	JANUARY	-79,82	-0,13	33,13	16,07	13,00	0,0	16,93	27,0
7	FEBRUARY	-111.79	-0,19	27,51	14,52	13,00	0,0	12,80	27.0
0	MARCH	-98,96	-0,17	31,90	16.07	13,00	0.0	15,66	27.0
/	APRIL	-69,21	-0,12	64,20	15,56	13,00	0,0	48,48	27,0
	MAY	+118,27	+0,20	80,27	16,07	13,00	0,0	64,40	27,0
7	JUNE	+24,10	+0,04	74,49	15,56	13,00	0,0	58,97	27,0
1	JULY	+66,71	+0,11	98,86	16,07	13,00	0,0	82,90	27.0
	AUGUST	+17,90	+0,03	55,30	16,07	13,00	0,0	39,26	27,0
	SEPTEMBER	-42.56	-0,07	34,99	15,56	13,00	0,0	19,36	27.0
	OCTOBER	-27,43	-0,05	43,12	16,07	13,00	0,0	27,03	27,0
	NOVEMBER	-102,37	-0,17	19,88	15,56	13,00	0,0	4,15	27,0
1	DECEMBER	-132.44	-0,22	18.51	16.07	13,00	0.0	2.22	27,0
9	JANUARY	-74,20	-0,11	14,03	16,07	10,85	-2,1	–	25.8
7	FEBRUARY	-55.94	-0,07	13,23	15.03	8,92	-1.9	–	24.7
1	MARCH	-66,46	-0,11	27,67	16,07	13,00	+4,0	7,47	27,0
/	APRIL	+155,90	+0.26	33,96	15,56	13.00	0,0	18,65	27.0
	MAY	+102,75	+0,17	58,47	16,07	13,00	0,0	42,57	27,0
7	JUNE	+180,75	+0,30	103,60	15,56	13,00	0,0	93,34	27,0
2	JULY	+20.98	+0,04	72,05	16,07	13,00	0.0	56,02	27.0
	AUGUST	+97,85	+0,16	76,07	16,07	13,00	0,0	60,16	27,0
	SEPTEMBER	-39,91	-0,07	56,35	15,56	13,00	0,0	40,72	27,0
	OCTOBER	-65,15	-0,14	32,27	16,07	13,00	0,0	16,06	27,0
	NOVEMBER	-131,76	-0,22	23,17	15,56	13,00	0,0	7,39	27,0
1	DECEMBER	-81,71	-0,14	21,96	16,07	13,00	0,0	5.75	27,0
	JANUARY	-76,42	-0,13	24,16	16,07	13,00	0,0	7,96	27.0
9	FEBRUARY	-7,77	-0,01	15,49	14,52	13,00	0.0	0,95	27.0
7	MARCH	-57,73	-0,10	16,98	16,07	13,00	0,0	0,81	27.0
2	APRIL	+36,88	+0,06	55,21	15.56	13,00	0,0	39,71	27,0
/	MAY	+103,10	+0,17	44,46	16,07	13,00	0.0	28.56	27,0
/	JUNE	+65,10	+0,11	66,87	15,56	13,00	0,0	51,42	27,0
7	JULY	+16,98	+0,03	88,92	16,07	13,00	0,0	72,88	27,0
3	AUGUST	+58,90	+0,10	58,39	16,07	13,00	0,0	42.42	27,0
	SEPTEMBER	-8,56	-0,02	73,09	15,56	13.00	0.0	57.51	27.0
	OCTOBER	-74,43	-0,12	39,27	16,07	13,00	0,0	23,03	27,0
	NOVEMBER	-141,76	-0,24	23,02	15,56	13,00	0.0	7,22	27,0
1	DECEMBER	-118,01	-0,20	21,64	16,07	13,00	0,0	5,37	27,0
9	JANUARY	+34,63	+0,05	14,84	16,07	11,82	-1,2	–	25,5
	FEBRUARY	-62,32	-0,10	68,97	14,52	13,00	+1,2	53,07	27,0
/	MARCH	+45,52	+0,08	109,01	16,07	13,00	0,0	93.02	27,0
3	APRIL	+95,53	+0,16	239,11	15,56	13,00	0,0	223,71	27,0
/	MAY	+192,50	+0,32	110,22	16,07	13,00	0,0	94,47	27,0
	JUNE	+81,75	+0,14	106,48	15,56	13,00	0,0	91,06	27,0
	JULY	+62,98	+0,11	164,96	16,07	13,00	0,0	149,08	27,0
4	AUGUST	+24,00	+0,06	77,89	16,07	13,00	0,0	61,68	27,0
	SEPTEMBER	-29,01	-0,05	69,47	15,56	13,00	0,0	53,36	27,0

Therefore, the river Ipojuca acquires a great importance when a large industrial consumption of water is foreseen, and it becomes a precious source.

The effects of the floods in the low, lagoonal areas that have acted as natural reservoirs and that will certainly increase in value due to the CI undertaking, will have to be kept under control and are the object of a special study in the Flood Control chapter, in which a solution for a dam at Engenho Crauassũ is offered.

. The studies made toward the operation of the reservoir as a flood control element show the possibility , when using the non-operated reserve for this object, of expecting flows of about 500.000 m^3/day, easily diverted through the use of pumps and a feeder canal into the Bita reservoir.

4.1.5 QUALITY OF THE WATERS

.A sample collecting campaign was carried out at strategic sites, in places close to the location where the water is to be used, or close to polluting centers, in order to gain better qualitative knowledge of the springs that interest the CI.

Seasonal and local factors, as well as the already existing industrie, alter consider-bly the quality of the water of some springs, especially those of the river Ipojuca.

The analyses made in 1967 and 1968, like those made recently lead to the belief that the waters of the springs studied, when properly controlled, will not present major problems as far as their treatment is concerned, and should show physical, chemical and bacteriological characteristics that are acceptable by international standards.

The low pH, the apparent colour, the iron content that is at times somewhat high, the high content of sodium chloride in the river Ipojuca during the rainy season could be corrected.

CECPA (Comissão Estadual de Controle de Poluição das Águas - State Commission for the Control of Water Pollution) is working on the contention of polluting agents, so that these waters should regain and maintainthe characteristics that are recommended by international standards.

4.2 UNDERGROUND WATERS

4.2.1 GENERAL

The studies that were carried out led to a preliminary diagnostic about the underground water resources that are liable to be used.

The existence of exploitable underground water, for specific use in limited areas ou to face consumption emergencies, through tubular wells, was dicovered.

Tests that were carried out with two wells that were drilled in the borough of Nossa Senhora do Õ, at the South of the CI showed flows of 100 and 140 m^3/hour, at the respective depths of 63 anf 80 m, static levels of 8.30 and 8.00 and dynamic levels of 17.80 and 18.30 m, and the cost of the water produced by these wells was estimated at CR$ 0,11 per cubic meter.

North of the CI, in the Jaboatão industrial area, along highway BR-101, several wells were drilled. Those wells, distant from the Suape area, have a lower output than those of Nossa Senhora do Õ. Their depth varies between 8o and 100 m, and the flow is between 6 and 18 m^3/hour; the static level varies in surge up to 5 m and the dynamic level varies between 2 and 56 m.

In the neighbourhood of the city of Cabo (CERMIC works), an area closer to Suape, a hole was drilled to a depth of 150 m, with no result; it should be mentioned that in spite of the great depth, the crystalline base was not reached.

The factors above show the non-generalization of results in the area under study, and more detailed research will be necessary before valid conclusions can be reached.

4.2.2 A SURVEY OF THE WATER POINTS

The water points surveyed, 41 (forty one in number), although they do not represent the total that exist in the area, allowed a good definition of the hydrogeological situation. The following table shows a synopsis of the data obtained, including depth, elevation above sea level, static level, diameter, location and observations concernin the quality (taste) and the seasonal variations of the water level.

The profiles of the wells drilled in Nossa Senhora do Ô provide the following information:

1.) The aqüiferous material used is a sandstone, medium to coarse, generally with little clay, in conglomeratic horizons, locally badly selected, varying in colour from reddish to brown. Occasional interspersions of sandy clay exist.

2.) The wells, although they are close to each other, do not use the same thickness of aquiferous material and filters, and for this reason they have different specific capacities and dynamic levels; however, the quotients of the specific capacities by the respective thicknesses of the aquiferous materials used are practically the same - 0,46 and 0,48 $m^3/h/m/m$, showing the uniformity of behaviour of the aquiferous material.

4.2.3 PIEZOMETRIC MAPPING

Using as a basis the elements provided by the survey of the water points, more specifically that of the eleveations of the static levels, it was possible to make a map of the isopiezometric curves of the surface of the free aquiferous.

SURVEY OF THE WATER POINTS

Nº REF.	TYPE *	DEPTH (m)	DIAMETER m	ELEVATION m	N.E (m)	PIEZOMETRIC ELEVATION (m)	SITE	REMARKS
01	o	4,80	2,00	4,00	2,82	1,18	Vila Usina Salgado	Dry in Summer
02	⌖	63,00	6"	6,50	4,50	2,00	Cidade N.Sra. do Ó	To be installed
03	⌖	00,00	6"	6,50	4,50	2,00	" " " " "	" " "
04	d	-	4,00	2,00	3,11	-1,11	Faz. Merepe	Brackish Water
05	o	-	1,00	2,00	0,30	1,70	" "	Fresh Water
06	o	2,00	2,00	1,00	0,85	0,15	" "	Polluted fresh water
07	o	1,30	1,00	1,00	0,37	0,63	" "	Fresh water
08	o	1,50	1,10	1,00	0,60	0,40	" "	" "
09	o	2,00	0,43	1,00	0,80	0,20	Faz.Mario Papa	Level falls o.5 m in Summer
10	o	1,50	3,00	1,00	0,60	0,40	" " "	
11	o	2,00	0,85	1,00	0,50	0,50	" " "	Drinking water

TABLE IV.1

SURVEY OF THE WATER POINTS (Cont.)

Nº REF.	TYPE *	DEPTH (m)	DIAMETER (m)	ELEVATION (m)	N.E. (m)	PIEZOMETRIC ELEVATION (m)	SITE	REMARKS
12	o	2,50	0,86	1,00	1,10	-0,10	Faz.Merepe	
13	o	2,00	0,90	4,00	0,86	3,14	Usina Salgado	Level falls a little in summer
14	o	1,00	0,80	4,00	0,60	3,40	" "	
15	o	0,88	0,60	4,00	0,00	4,00	" "	
16	o	5,00	1,00	6,00	1,00	5,00	Engenho Merces	Fresh water, dries up in Summer
17	o	2,50	1,00	3,00	1,50	1,50	Praia de Cocaia	
18	o	2,50	1,00	2,00	1,50	0,5	" " "	
19	o	2,50	1,00	2,00	1,50	0,5	" " "	Chalybeate water
20	o	2,50	1,00	2,00	?	?	" " "	" "
21	o	2,50	1,50	4,00	?	?	" " "	" "
22	o	?	?	4,00	?	?	" " "	" "

TABLE IV.1 (cont.)

SURVEY OF THE WATER POINTS (cont.)

Nº REF.	TYPE. *	DEPTH (m)	DIAMETER (m)	ELEVATION (m)	N.E. (m)	PIEZOMETRIC ELEVATION (m)	SITE	REMARKS
23	o	10,00	2,50	10,00	0,00	10,00	Engº Mercês	Fresh water
24	o	1,60	1,20	10,00	0,00	10,00	Engº Massangana	" "
25	o	?	1,00	6,00	0,00	6,00	" "	" "
26	o	2,00	0,40	8,00	0,00	8,00	" "	Fresh Water
27	♂	--	--	4,00	0,00	4,00	Usina Salgado	Fresh Water
28	♂	--	--	25,00	0,00	25,00	Engº Massangana	
28A	⌖	10,00	6"	20,00	--	?	" "	Fresh Water
29	♂	---	--	25,00	--	25,00	" "	Fresh water
30	♂	---	---	10,00	--	10,00	" "	Fresh Water
31	♂	---	---	10,00	--	10,00	" "	Fresh water
32	♂	---	--	10,00	--	10,00	" "	Fresh water

TABLE IV.1 (cont.)

Nº. REF.	TYPE *	DEPTH (m)	DIAMETER (m)	ELEVATION (m)	N.E. (m)	PIEZOMETRIC (m)	SITE	REMARKS
33	♂	-	-	2,00	-	2,00	Sitio Ant.Gomes	
34	o	1,30	1,00	3,00	0,80	2,20	Suape	
35	o	1,90	1,00	3,00	0,00	3,00	Suape	Hard rock in bottom
36	♂	-	-	5,00	-	5,00	Gaibu	Contact Barreira/Gr.
37	o	0,[illegible]0	1,00	5,00	0,20	4,00	Estr.Gaibu-Suape	Fresh water
38	-ϕ-	6,50	-	3,00	2,50	0,50	Praia Itapuama	
39	-ϕ-	6,50	?	3,00	2,50	0,50	Praia Itapuama	
40	o	2,00	1,00	5,00	0,00	5,00	Praia Itapuama	Fresh water
								-ϕ- =Tubular well
							SYMBOLS OF THE WATER POINTS	o =Water hole
								♂ = Spring

The lowest isopiezometric curve consideed for the map was the 1,0 m curve and the highest was the 10 m curve. This lower curve is close to the line that marks the limit of the Suape - Nossa Senhora do Ó sedimentary plain.

A study of the map leads to the following conclusions:

- The general flow is ins the direction of the ocean.
- In the dry zones, or the valed inlaid in the sedimentary package of the Cabo formation, there is a flow toward the interior of the vale from its slope.
- the hydraulic gradientof the underground waters, although it has not been numerically defined, proves to be much higher in the occidental part of the plain, in the foothills that mark its limits.
- a watershed of underground waters occurs, which is shown on the piezometric map, in the region of Santo Agostinho, as far as the city of Cabo.From this watershed, the waters drain to the NE and SE, respectively the high region of Barreiras plain Suape - Nossa Senhora do Ó.

4.2.4 THE AQUIFEROUS SYSTEM

The present condition of the studies makes possible the identification in the CI area of three aquiferous units, two being free and one confined. In statigraphic order, the existing aquiferous are as follows:

a) free aquiferous of the sedimentary deposits, dunes, and non-confined part of the Cabo formation.

b) free aquiferous of the plio-pleistocene sediments of the Barreiras Group.

c) confined aquiferous of the Cabo Formation.

The confined aquiferous of the Cabo Formation stands out in order of importance, with a possible thickness of 150 to 200 m.and with renewals provided by direct fluvial infiltration of drainage waters (from the rivers) and by drainage from the free aquiferous. Taking as a basis the spring at the lowest existing elevation of the Cabo Formation, and the same isopiezometric reference noted in the Nossa Senhora do Ó wells, we can see that the flow of the underground aquiferous is toward the sea.

The second most inportant aquiferous is free and it is represented lithologically by alluvial deposits of little depth and by deposits of beach and contineneta1 sands (dunes). Due to the topographical situation, this aquiferous.is exposed to the advance of high tides (superficial salinization) and, locally the surface of the phreatic blends with the marshes that are, in final analysis its natural issue to the East. This aquiferous could be used only in special and favorable conditions, with local restrictions to face any impotant water requirement in the CI region.

The third aquiferous unit was individualized at the North of the Massangana river, and it is fundamentally represented by the sediments of the Barreiras group that form extensive tablelands, half dried up and crossed by thalwegs with a general E - W direction. The flow is probably towards the East, as show the resurgences (springs) that exist along the coast.As a whole, the phreatic surface is much higher than the previous unit. It is possible that this aquiferous should constitute a recharging element for the others. The refill of this one is furnished by that part of the atmospheric precipitation that infiltrates.

4.2.5 HIDROCHEMICAL CHARACTERISTICS

The nine (9) chemical analysis of collected waters showed the results tabulated below.

The analysesof the waters of the Cabo Formation show that they are slightly acid, and, in general, only lightly mineralized. The indication of traces and even the presence of nitrates and traces of ammonia does not actually eliminate the condition of potableness of the water, but it is an indication that it should be used cautiously, and bacteriological analyses should be performed. The analysis of the Nossa Senhora do Ő well shows higher than average quantitatives in relation to the aquiferous tested, which leads to the assumption that the free aquiferous was not properly insulated during the construction of the well. It should be remembered that the city of Nossa Senhora do Ő does not have a sewers network and that it is a region of intensive sugar-cane culture, where fertilizers are ued in the soil.

The analyses of the water of the Barreiras Group show very low mineralization and relative acidity, and there are besides traces of nitrates and ammonia.

The waters from the dunes and silt are the most mineralized of all, although they are still within acceptable potableness limits. It is known, however, that this aquiferous is the most vulnerable to contamination by man and, in certain places, to the advance of the sea.

[redacted] CHEMICAL ANALYSES OF THE WATERS OF THE SUAPE REGION AND SURROUNDINGS

SITE	ORIGIN	Nº REF.	pH	CONDUCTIVITY (mMho)	CHLORIDE (mg/l)	Ca+Mg. (mg/l)	Na+K (mg/l)	NITRATE	NITRITE	AMMONIA
N.Sra. do Ó	Tub. well	02	7,8	2.500	200,7	79,0	101,4	Traces	Absent	Absent
Us.Salgado	Spring	27	5,9	92	22,0	2,4	12,6	Traces	Absent	Absent
Eng.Massangana	Tub. well	28-A	6,8	167	19,0	12,2	21,2	Present	Absent	Traces
Eng.Marcês	Big water hole	23	5,9	70	15,0	3,5	5,0	Absent	Absent	Traces
B) In the Bareeiras Group										
St. Ant.Gomes	Spring	33	5,3	72	25,0	11,0	6,9	Traces	Absent	Traces
Gaibu	Spring	36	5,7	96	23,0	11,0	10,6	Traces	Absent	Absent
C) In dunes and Alluvium										
Us.Salgado	Water Hole	01	7,0	220	32,0	11,4	30,9	Absent	Absent	Absent
Cupe	Water hole	04	8,1	816	129,0	75,7	105,4	Present	Present	Absent
Cocal	Water hole	17	6,5	123	14,0	3,3	5,0	Traces	Traces	Absent

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5.0 ESTIMATE OF REQUIREMENTS

5.1 GENERAL

In order to make an estimate of the requirements, we shall study independently the water needs for the following units:

1 - Cabo sub-area, including the zone North of the green barrier that stands between the port zone and the city of Cabo, with the exception of the beaches.

2 - Nossa Senhora do Ó sub-area, including the residential zone of the city of the same name.

3 - Refinery sub-area including the site reserved for the installation of the refinery.

4 - CI sub-area, including all of the zone of the Industrial Complex, excepting those mentioned in the items above.

As regards the consumption of the various units, quantitatives shown in the tables were determined, taking as a basis the type of, and the areas occupied by the industries, ports and auxiliary services, as well as the level and population of residential areas.

5.2 CABO SUB-AREA

The estimated requirements, with maximum occupation, reach close to 70.000 m^3/day, that is 0,70 m^3/sec, distributed as follows:

ZONE	ÁREA HA	CONSUMPTION M^3/DAY/INHABITANT	CONSUMPTION M^3/DAY
INDUSTRIAL ZONES			
ZI - 3	633,00	30	18.990
ZI - E	176,67	30	5.300
RESIDENTIAL ZONES			
ZRE - Cabo	274,00	20	5.480
ZRE - Ponte dos Carvalhos	168,38	20	3.370
ZR.3- Novas áreas oeste Cabo	341,67	20	6.830
ZR.3- Nocas áreas Gurjaú	211,67	20	4.230
ZR.3- Novas áreas BR-101	661,00	20	13.220
ZR.3- Novas áreas Boa Vista	567,00	20	11.340
TOTAL			68.760

5.3 NOSSA SENHORA DO Ó SUB-AREA

For this area, the growth of which is limited to a population of 16.661 inhabitants, for an occupied area of 135,00 ha, the maximum estimated requirement for a consumption of 150 l/day/inhab. reaches 2.500 m^3/day, that is o.o28 m^3/sec.

5.0 REFINERY SUB-AREA

Although it is included in the CI sub-area, which we shall study later, it was decided to consider independently the estimated requirements of the refinery, due to its great improtance in the water supply system. In accordance with a study made in other refineries, a daily water consumption of 43,200 m^3 , that is about 0,5 m^3/sec, was estimated for conditions of maximum expected production.

5.5 CI SUB-AREA

I.C.

In this sub-area, the maximum daily water consumption may reach 240.000 m^3, that is about 2,8 m^3/sec, in accordance with the distribution below:

ZONE	POPULATION	AREA	UNIT CONSUMPTION	TOTAL M^3/DAY CONSUMPTION
INDUSTRIAL ZONES		5.760	*	251.800
ZI.1- Ind. related with the port		2.045	50 m^3/ha/dia	102.250
ZI.2- Ind. not related with the Port		1.905	50 m^3/ha/dia	95.250
ZI.3- Independent Ind.		1.425	30 m^3/ha/dia	42.750
ZI.4- Ind. for Service support		385	30 m^3/ha/dia	11.550
PORT ZONES		790.00		11.366
ZP-1- Collective Port		703.33	10 m^3/ha/dia	7.033
ZP-2- Fishing Port		86.67	50 m^3/ha/dia	4.333
ADMINISTRATIVE ZONE		152.00		1.520
ZCA - 1		73.33	10	733
ZCA - 2		33.67	10	337
ZCA - 3		45.00	10	450
RESIDENTIAL ZONES	113.500			18.450
ZR-2 - Boasica	81.400	626.67	170 l/hab/dia	13.840
ZR-4 - Pontal do Cupe	4.500		150 l/hab/dia	675
Praia de Gaibú	3.400		200 l/hab/dia	680
Praia de Pedras				
Petras	3.300		150 l/hab/dia	495
Praia de Itapuama	2.200		150 l/hab/dia	330
Praia do Paiva	2.800		150 l/hab/dia	420
ZRE- Ipojuca	8.400		150 l/hab/dia	1.260
ZRP- Camp	7.500		100 l/hab/dia	750
SUB-TOTAL				283.136
MINUS REFINERY				43.200
TOTAL SUB-ÁREA CI				239.936

* Ha/dia - hab/dia = inhabitants/day

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6.0 CONCEPTION OF THE WATER SUPPLY SYSTEM

6.1 GENERAL

The study of the available springs, along with the flow estimates at the selected points of impoundment, the requirements, positioned in space and time, and the convenience of investors lead, without any doubt, to a set of variables with an infinite number of combinations. In this case, the planner is dominated by conditionals that cannot be measured a priori, where the assumptions of kind, size, date etc. of installation of the industries are still subordinated to imponderable factors.

Thus, still more than in future projections of already existing or at least embryonic undertakings, a careful selective process is justified in order to reach extremely flexible solutions of modular implementation, able to respond, with financial opportunity, sufficient quantities, and operation within the stated limits of time, to requests of any speed or size.

Besides, so large an undertaking, within the boundaries of the metropolitan area of Recife cannot be viewed singly and the mutual reflection CI-Great Recife must be considered, so as to facilitate its integration into areas that will inevitably, in the future, blend into one single city.

Therefore, the present plans concerning the water supply of Great Recife could not be ignored, as neither could the planned uses of the common springs and, when adding new impacts to the city of Cabo, primarily, and, secondarily, to the city of Ipojuca and the boroughs of Nossa Senhora do Ó and Ponte dos Carvalhos, it would be impossible to forget the consequences of those impacts on the expansions of the

6.2 CONCEPTUALIZATION OF SUB-AREAS

The geotopographical conditions, the existing planningg and, as a consequence or lucky coincidence, the available hydric resources, lead to the selection of three separate areas, among those considered and occupied under the master plan.

The first of these is the area close to the city of Cabo, along the BR-101 and PE-60 highways, which is already developing due to large industries, already installed or under installation, and there is little doubt that a structure based on so important a port as that of Suape will increase considerably the rhythm of this development; it is characterized by the pre-existence of a water supply system and by a planning of its expansion. It is therefore necessary to coordinate the Master Plan of the CI with th water supply plan of the city of Cabo.

The second area lies South of the agricultural and forest zone that makes up the green barrier between the industrial and harbour zone of the Suape and the city of Cabo; this area is limited to the East by the ocean, and to the West by highway PE-60; to the South, by the parallel that passes approxi,ately at Cupe point. At present, the main feature of this area is the non-existence of Plans or Programs, except those covered by this study, with exclusive springs, and with no restrictions apart from those imposed by the CI.

Finally, small in size, but fundamentally important for the project, we have the borough of Nossa Senhora do Ó, with a water supply system in its final phase of installation, with an expansion plan, that will i na short time , within predetermined limitations, fell the effect of the creation of the CI to which it will be indissolubly integrated.

6.3 THE CABO SUB-AREA

The Cabo sub-area has the Pirapama system as a natural hydric source. Compesa made a contract for the establishment of the Master Plan for the water supply of the city of Cabo, and they will be given the studies concerning the influence of the Suape on the region consideredand especially on the sub-area, as well as the studies made in the Pirapama basin.

6.4 THE CI SUB-AREA

We gave the name of CI sub-area to the area that is the main object of this study, not only because of its location and function within the master plan, but especially because it is the region in which the springs, the mains, the treatment and the supply of water are exclusively programmed from the point of view of the installation of the port and of the industries. As was previously mentioned, this exclusive character cannot leave aside the unavoidable co-ordination of the CI water supply system with the neighbouring systems, especially the one of Great Recife.

When this study was started, on the basis of the data and the facts that were then available, only the superficial source of the river Pirapama was considered, in the tributary area of the Engenho Matapagipe, where there even existed a final project for the construction of a concrete dam. The first studies were aimed in that direction, while looking for better hydrological, topographical and geotechnical solutions. The existing pluviometric and fluviometric data were collected, but due to the almost complete lack of information, TRANSCON began operating in February 1974 the following hydrometric stations:

Nº	Name of Station	TYPE	DATE INSTAL.	TOWN	REMARKS
1	Engenho Serra Grande	Pluviometro	15.2.74	Vitória de Santo Antão	Installed by SUDENE, Operated by TRANSCON
2	Engenho Cachoeira Tapada	"	15.2.74	Escada	Installed and operated by TRANSCON
3	Engenho Capim do Dentro	"	17.2.74	Cabo	
4	Engenho Matas	Pluviometro Pluviógrafo	17.2.74	Cabo	"
5	Engenho Cabruncru	Pluviometro	12.2.74	Escada	"
6	Granja São Severino	"	15.2.74	Cabo	"
7	Engenho Matapagipe	linimetro linigrafo	12.1.74	Cabo	"
8	Rua D'água	linimetro	16.2.74	Cabo	"

Sixty one (61) flow measurements were taken at Engenho Matapagipe station, and forty eight (48) at the Rua d'āgua station.

Under the respect of maps, the only one that was available was a map issued by the Army Geographical service at the scale of 1:25 000, that proved entirely inadeqpate for detailed studies. The mapping of the hydraulic basin of the reservoir was started, at the scale of 1:10.000 with a spacing of 5 m between the contour curves; this mapping was carried out to elevation 60, since it was most improbable that the water level could be located above elevation 55.

Regarding geology and geotechnics, an accurate study was made, and is part of a specific report.

The basic elements mentioned allowed the revision of the previous project, with the use, as a preliminary plan of a solution consisting in earth dams on the rivers Pirapama and Manoel Gonçalves that was without any doubt cheaper, as well as more operational as regards water level, for the regulation of the flows.

The development of the studies led to the investigation of economically viable solutions concerning the delivery of water from the Matapagipe reservoir to the CI, over a distance of almost 17 km, the high elevations of the watersed between the Pirapama basin and the small basins of the Prego, Alsodoais and Massangana standing between these two regions.

Among the possibilities considered, the most interesting seemed to be the delivery through the very bed of the river, the impoundment near Charneca, the pumping to the Prego or Algodoais basin, and sucessive dammings and diversions to the Massangana basin where, dominating the gravitational center of the CI, a last dam would allow the treatment and distribution with the minimum use of large diameter mains under pressure.

Studies were undertaken concurrently to provide a better knowledge of the characteristics of the river Ipojuca, through the collection and analysis of pluviometric data from the Caruarū, Arcoverde and Escada stations, also through the reactivation of the limnimetric station of the Engenho Maranhão, installed by SUDENE on June 10,1971.

Besides daily observation of the measuring rod, 15 flow measurements were taken at this station. The study of the control of the highwaters of the Ipojucaled to a solution that allows, with the utilization of the work projected as a flood leveler, the regulation of the flow of 500.000 m^3/day, which are easily pumped and delivered through an open canal to the last reservoir of the Massangana system. It was also found that simple expedients, like the fitting of a sluice to the discharge pipe of the flood regulating dam and the increase in the highest elevation of the dam would allow, without impairment of the control function, the expansion of the regulated flow up to its limit, estimated at 1.000.000 m^3/day.

These conclusions led to the displacement of the main studies in favour of the rivers Ipojuca and Massangana instead of the Pirapama, considering that those two rivers represent a sufficient reserve for such large undertakings as the CI, at a lower cost, and, mainly, because the construction of a large work for flood control is unavoidableon the river Ipojuca, as are smaller works with the same object for the river Massangana.

These works therefore have several purposes, conversely to those of the Pirapama, since, as far as CI is concerned, the latter river presents no flood problems.

The reservoirs on the rivers Brego and Algodoais, as mere receivers and deflectors of the waters pumped from the Pirapama lost their main purpose, and remained, for more detailed studies, the reservoirs of the Massangana basin.

TRANSCON set up limnimetric stations in the Massangana basin, viz. at Engenho Boa Esperança, on May 26, 1974, Engenho Tabatinga, on May 26, 1974, Engenho Utinga de Baixo, om May 16, 1974 and Engenho Boa Esperança (upstream) on June 2, 1974. These four stations have performed, respectively, 6, 14, 10 and 10 flow measurements.

The analysis of the fluviometric and pluviometric data showed that the basin of the Massangana had a high efficiency of about 40%.

Considering the pemmissible topographical conditions, two favourable sites were chose for the construction of a dam. A small reservoir exists at present on the first site, the dam of which could be increased in height, making possible a regulation of 420 l/s at elevations between 40 and 45 m. This suggests the possibility of installing downstream a processing station, and it would also provide the necessary elevation for the distribution by gravity to almost the whole of the CI. The second reservoir, on another branch (the river Tabatinga) would hold water between elevations 59,5 and 65, regulating 400 l/s, delivered by a feeder canal to the same processing station.

It can be seen that the reservoirs, which were at first intended to be opertaional within the system, play the part of an important source of water supply, all the more so because through comparatively inexpensive work and because of the speed at which they can be executed, guarantee the water supply of the CI sub-area for a long time.

Besides, by bleeding the second reservoir into the basin of the first, and bleeding the latter into the Ipojuca basin, a large volume of highwaters and floods are diverted from the pioneering part of both the port and industries; the increase provoked in the Ipojuca basin will be easily absorbed thanks to the projected works in that area for much larger volumes originating for the very basin of the Ipojuca.

6.5 THE SUB-AREA OF NOSSA SENHORA DO Ó

The su-area of Nossa Senhora do Ó has an imoortant function in the settlement of the pioneering populations. With 3.519 inhabitants, it has an estimated vegetative growth to 4.136 , 4.690, 5.185 and 6.261 inhabitants in the years 1980, 1985, 1990 and 1995 respectively; however, the impact of the CI will push these figures up to 7.136, 11.290, 12785 and 14861 inhabitants at the same period. It is believed that a last figure of 16.661 will not be exceeded due to a lack of physical area.

This sub-area has a water supply plan that is about to be initiated, fed by two wells for the impoundment of underground water, whose combine minimum flow is 4.500 m^3/day, sufficient for the estimated population.

6.6 THE PROPOSED SYSTEM

6.6.1 IMPOUNDMENT

The Cabo su-area will have its impoundment system defined by Compesa, from the Pirapama system. The surveys and the mapping, geotechnical and hydrological studies shown in separate reports allowed the preparation of a preliminary porject for the Matapagipe Da, including the interconnection of the reservoir with the present Gurjáu system.

These documents will certainly help Compesa to make their decisions in the future.

The studies of the physical and territorial occupation took into consideration the impacts of the CI os the expansion of Cabo, that will create a complementary demand for 68.760 m^3/day of water, thus distributed:

INDUSTRIAL ZONES:	24.290 m^3/day
ZI - 3	18.990 m^3/day
ZI - E	5.300 m^3/day
RESIDENTIAL ZONES	44.470 m^3/day
ZRE - Expansion of Cabo	5.480 m^3/day
ZRE - Expansion of Ponte dos Carvalhos	3.370 m^3/day
ZR3 - A - New areas West of Cabo	6.830 m^3/day
ZR3 - B - New areas in the Gurjaú	4.230 m^3/day
ZR3 - C - New areas BR-101 Ponte dos Carvalhos	13.220 m^3/day
ZRs - C - New areas Boa Vista	11.340 m^3/day

In the same way, the Nossa Senhora do Ó sub-area has its source for impoundment of underground water through 2 wells, the features of which are thoroughly studied in the hydrogeological studies report; these studies will help for the complementation of the system, up to the limits set in the Master Plan. It may be stated that these two wells will attend staisfatorily the needs of the expected population, the maximum demand estimated at the time of total occupation being 2.500 m^3/day.

The water supply system of the CI su-area has for impoundment the Massangana and the Ipojuca systems, through the Bita, Utinga de Baixo and Ipojuca reservoirs, this last being the main componsnt of the flood control system.

The Bita reservoir is formed by 4 earth dams, that retain and elevate the waters of the river Cangarí, an affluent of the Massangana, up to elevation 45; the excess water bleed at this elevation into the Ipojuca basin. The reservoir will be oper-ted above elevation 40, at which is the water inletm and a regulated flow of 420 l/sec is obtained, or say 36.300m^3/day.

The Utinga de Baixo resevoir is formed by 5 earth dams, that retain and elevate the water of the rivers Utinga de Baixo and Boa Esperança, branches of the river Tabatinga, an affluent of the Massangana. The water from these branches, when rising to the maximum elevation of 65 m, are interconnected and blend into a single reservoir, that operates from elevation 59,5, where the water inlet is located. The regulated flow reaches 400 l/sec, or 36.400 m^3/day.

The excess water is diverted through the spillway into the basin of the river Pirajã, a branch of the Cangarí, thus reinforcing the accummulation of the Bita reservoir.

The Ipojuca reservoir is a result of work projected in the Master Plan of the Flood Control System. On the other hand, this reservoir makes it possible to increase the basic flux of the river, estimated at 3 m^3/sec, to 6 m^3/sec, taking into consideration only the volume accumulated between elevation 24,7 of the water inlet, and elevation 27, where the free discharge of the reservoir starts, that is without the introduction of new complements to barrage under study for the control of floods. This discharge, which is the equivalent of 500.000 m^3/day, attends amply the estimates of the total demand of the CI area, valued at 283.136 m^3/day, 7o.900 m^3 of which will be

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This demand is distributed as follows:

Industrial Zones	251.800 m^3/day
Port zones	11.366 m^3/day
Central Administrative Zone	1.520 m^3/day
Residential Zones	18.450 m^3/day

6.6.2 PROCESSING

The water of the Bita reservoir are delivered through a closed canal to the Processing Station at a distance of about 850 m from the water inlet, on the way to the zone of consumption.

The possibilty of supplying raw water (includingwater submitted to partial processing) to the industries, when requested. This distribution of raw water, not dimensioned originally, may assume very large proportions since, besides its industrial use, it can also be utilized for such services as the washing of wharves or ships, as well as in the fire prevention network. Whatever the case, only the Chemical Plant will be relieved, since it is indispensable, even for the protection of the mains themselves, that the water be decanted and filtered.

The processing Station will be built on the modular system, each module having a capacity of 75.000 m^3/day, which means that only one module will br built in the first stage, others being added, until a total of 4 modules is reached, which will be sufficient for maximum occupation.

A module, with a capacitu for 75.000 m^3/day, includes a Chemical Plant, a Device for the Rapid Mixture of Coagulants, 5 Floculators, 5 Decanters and 10 Half Filters, with a total area of 250 m^2 and a filtering speed of 300 m^3/m^2/day.

6.6.3 DELIVERY AND DISTRIBUTION RESERVOIR

Considering the area and the estimated demands, the studies les to the delivery of virgin water to two reservoirs the first one dominating the central and northern zones of the CI sub-area, including the bhacheaches, and the second one dominsating the southern zone, including the Boasica reseidential area.

It was assumed that the needs of the refinery would be taken care of by exclusive mains, starting at the ETA.

Th total daily demand of the system, estimated at 283.200 m^3 can be distributed as follows:

Refinery	43.200 m^3/day
Southern Resevoir	60.000 m^3/day
Central-Northern Reservoir	180.000 m^3/day

The delivery to the refinery was planned in a single stage, with mains of 600 mm in diameter over an extension of 4.500 m.

The delivery to the central, northern and southern reservoirs was planned in successive stages, each module having a flow of 30.00 m^3/day and an extension of 4.500 m.

The ETA reservoir was designated as R.1.

Th reservoir that feeds the central-northern zone was designated as R-2, and it shall have, for each delivered module of 30.000 m^3/day, a capacity of 10.000 m^3, (1/3 of the daily volume. The balance of the system is guaranteed by a peak reservoir designated as R-3 (central zone) and R-4 and R-5 (northern zone, including beaches).

The reservoir that feeds the southern zone, designated as R-6 will also have a capacity of 10.000 m^3/ for each delivered module of 30.000 m^3/day. The balance of the distribution system will be obtained through peak reservoirs R-7 (metallurgical zone), R-8 (Basica) and R-9 (Nossa Senhora do Ó), the last ones named interconnecting the systems for the impoundment of both superficial and underground waters.

TOMO II
PARTE 6
VOLUME 4

7.0 PHYSICAL PLAN OF THE WORKS OF THE FIRST STAGE

7.1 GENERAL

For the organization of the water supply system, the first stage includes the following occupations, with their respective requirements:

INDUSTRIAL ZONE	72.250
- Refinery	43.200 m^3/day
- Aluminium	1.200 m^3/day
- Fertilizers	24.000 m^3/day
- Cement	3.850 m^3/day
- Tyres	-
ADMINISTRATIVE ZONE	1.520 m^3/day
RESIDENTIAL ZONES	5.675 m^3/day
- ZR-1 - Nossa Senhora do Ó	2.230 m^3/day
- ZR-2 - Boasica	2.765 m^3/day
- ZR-4 - Praia de Gaibú	680 m^3/day

Thus, the consumption to be faced reaches 80.000 m^3/day in the first stage, 2.230 m^3/day will be provided by the wells of Nossa Senhora do Ó, and the remaining 77.770 m^3/day by the Massangana-Ipojuca system.

As was seen in the preceding chapters, the regulated capacity of the planned reservoirs reaches 570.900 m^3/day, viz.:

Bita Reservoir	36.300 m^3/day
Utinga de Baixo Reservoir	34.600 m^3/day
Ipojuca Reservoir	500.000 m^3/day

In accordance with the general conception of the system (cghapter 6), the capcities of the Bit and Utinga de Baixo reservoirs will be totally used before those of the Ipojuca reservoir, the contribution of which will be a reinforcement, due to its topographical situation. It should be noted that the water from the Ipojuca reservoir is pumped before it enters the canal, and its cost is therefore higher that that of the Bita and Utinga de Baixo reservoirs, that flows by gravity.

The necessary contribution from the Ipojuca in this first stage is: 77.770 - (36.300 + 34.600) = 6.870 m^3/day.

It should still be noted that in this stage, the consumption planned for Basica, 2.765 m^3/day, can be provided at a lower cost by underground water; this decision depends upon the result of studies that are scheduled to start next month.

7.2 IMPOUNDMENT

7.2.1 SURFACE WATER

The following are the works for impoundment, in the first stage:

- Bita Reservoir, described in item 4.1.3, able to provide a regulated flow of 36.300 m^3/day

- Utinga de Baixo Reservoir, also described in item 4.1.3, able to provide a regukated flow of 34.600 m^3/day.

- Feeder-canal Utinga de Baixo-Bita, for the delivery of 34.600 m^3/day (400 l/sec), connecting the inlets of the two reservoirs.

- Feeder canal Ipojuca Bita, delivering the pumped water to the Bita reservoir, which it enters by the spillway. The capacity, at this stage, would be the same through pumping. However, as an open air, concrete lined canal is concerned, its cost would be only slightly affected if it were built for its final capacity (Master Plan), estimated at 2.5 m^3/sec, and this recommends that it should be dimensioned for this capacity.

The Ipojuca reservoir was not taken into consideration; since it was studied in the volume dealing with flood control, and was designed with that object in mind, its use as a water supply source being therefore a by-product.

7.2.2 UNDERGROUND WATER

Underground water constitutes the source of supply for Nossa Senhora do Ó. The pumping tests carried out at the two existing wells showed they had sufficient capacity to cover the final consumption of the first stage, and, actually of the maximum planned occupation.

Assumptions, yet to be confirmed by prospections that are about to be undertakern, suggest that, for the first stage, two wells with an identical capacity with thos of Nossa Senhora do Ó may provide sufficeiently for the requirements of Boasica.

The confirmation of this assumption leads to the following worsk:

Drillling, lining and equipment of 2 tubular wells, with estimated flows of 100 m^3/hour each, equivalent to 2 x 100 x 16 hours, or 3.200 m^3/day.

Two elevating stations, for the pumping of the water from the wells, with an installed power of 50 HP each.

Two elevating mains, for the delivery of the pumped water to the reservoir, 8 inches in diameter, and an extension of 300 m.

A distribution reservoir, supported, with a 1.000 m^3 capacity.

7.3 TREATMENT

The treatment station shall be dimensioned for a capacity of 75.000 m^3/day. The élements that constitute the treatment system are as follows:

- Feeder Canal from the Bita outlet to the ststion, with a capacity of 75.000 m^3/day (870 l/sec); for the same reasons as above, the canal shall be dimensioned for its final capacity of 3.300 l/sec.

  - 5 Floculators
  - 5 Separators
  - 10 half filters with a total area of 250 m^2
  - Chemical Plant
  - Installation for cleaning of filters
  - Treated water reservoi (R-1)
  - Disinfection

For underground waters, provisions for chlorination are made at the pumping ststion

7.4 MAINS AND DISTRIBUTION RESERVOIR

It is assumed that the consumption of the refinery will be satisfied by special mains, starting at the treated water reservoir or at an intermediate stage of treatment. Thus, the distribution to be considered will be 75.00 less 43.200 = 31.800 m^3/day.

The requirements of the areas that will be occupied in the first stage indicated the need of the following work, for delivery and reserve.

- ETA maîns - Refinery, with a çapacity for 43.200 m^3/day

- ETA mains - Reservoir Nº 2, (R-2) with a capacity for 31.800 m^3/day.

- Reservoir Nº 2 (R-2), with a capacity for 10.000 m^3/day 2 x 5.000 m^3)

- Peak Reservoir, Nº 3 (r-e), with a capacity for 5.000 m^3

- Peak Reservoir, Nº 4 (R-4), with a capacity for 5.000 m^3

.7.5 DISTRIBUTION.

In this stage, the following distribution mains were considered:

- Working distribution ring, interconnecting reservoir R-2 with reservoirs R-3 and R-4, and supplying the industries(minus the refinery) and the collective harbour.

- Distribution metwork, supplying the camp and th administrative zone.

- Distribution network for the plannned expansion of Nossa Senhora do Ó.

Distribution network for the Boasica residential zone.

Distribution network for the Gaibú residential zone.

7.6 QUANTITATIVES AND ESTIMATED COSTS OF THE 1st STAGE WORKS

7.6.1 BITA RESERVOIR

WORK	VOLUME OF EARTH M^3	VOLUME OF STONE M^3	COST CR$
DAM I	72.315	3.360	520.858,00
DAM II	84.087	3.360	555.845,00
DAM III	7.440	480	55.994,00
DAM IV	9.915	450	71.760,00
SPILLWAY	20.250	47.250	464.530,00
DISPOSSESSION	172 ha		250.000,00
T O T A L			1.966.987,00

7.6.2 UTINGA DE BAIXO RESERVOIR

WORK	VOLUME OF EATRH M^3	VOLUME OF STONE M^3	COST CR$
DAM I-A	128.573	2.987	872.537,00
DAM 2-A	35.325	1.995	260.770,00
DAM 2	11.188	252	75.783,00
CANAL C-1A	23.125		72.844,00
CANAL C-2A	4.910		15.467,00
AUXILIARY DAM 3	1.144		7.287,00
AUXILIARY DAM 4	1.160		7.390,00
AUXILIARY DAM 5	1.467		9.345,00
DISPOSSESSION	232 ha		348.000,00
T O T A L			1.669.423,00

7.6.3 FEEDER CANAL UTINGA DE BAIXO-BITA

WORK	VOLUME OF EARTH M^3	VOLUME OF STONE M^3	COST CR$
CANAL	38.351	525	225.805,00

7.6.4 IPOJUCA PUMPING STATION

WORK	QUANTITATIVE	COST
Pump, Motor, Auxiliaries		80.000,00
PIPING	600 m x 400,00	240.000,00
CIVIL WORKS	80 m^2 x 2.000,00	160.000,00
T O T A L		480.000,00

7.6.5 FEEDER CANAL IPOJUCA-BITA.

WORK	QUANTITY	UNIT COST	TOTAL COST
CANAL	6.000 m	150,00	900.000,00

7.6.6 IMPOUNDMENT WELLS, PUMPING STATION, ELEVATION MAINS AND BOASICA RESERVOIR

WORK	QUANTITATIVE	COST
Wells (80 m)	2	637.064,00
Pumping Station	2 x 50 HP	611.400,00
	2 x 3000 m - ø 200mm	1.381.764,00
Reservoir (r-7)	2 x 500 m^3	474.600,00
		3.104.828,00

7.6.7 SUB-TOTAL IMPOUDMENT ITEM

BITA RESERVOIR	1.966.987,00
UTINGA DE BAIXO RESERVOIR	1.669.423,00
FEEDER CANAL UTINGA DE BAIXO-BITA	225.805,00
IPOJUCA PUMPING STATION	480.000,00
DELIVERY CANAL IPOJUCA-BITA	900.000,00
IMPOUNDMENT WELLS	3.104.828,00
SUB-TOTAL	8.347.043,00

7.6.8 TREATMENT STATION (ETA), INCLUDING BITA-ETA FEEDER CANAL

WORK	QUANTITATIVE	COST
Treatment Station	Capacity 75.000 m^3/day	6.125.811,00

7.6.6 IMPOUNDMENT WELLS, PUMPING STATION, ELEVATION MAINS AND BOASICA RESERVOIR

WORK	QUANTITATIVE	COST
Wells (80 m)	2	637.064,00
Pumping Station	2 x 50 HP	611.400,00
	2 x 3000 m - ø 200mm	1.381.764,00
Reservoir (r-7)	2 x 500 m^3	474.600,00
		3.104.828,00

7.6.7 SUB-TOTAL IMPOUNDMENT ITEM

BITA RESERVOIR	1.966.987,00
UTINGA DE BAIXO RESERVOIR	1.669.423,00
FEEDER CANAL UTINGA DE BAIXO-BITA	225.805,00
IPOJUCA PUMPING STATION	480.000,00
DELIVERY CANAL IPOJUCA-BITA	900.000,00
IMPOUNDMENT WELLS	3.104.828,00
SUB-TOTAL	8.347.043,00

7.6.8 TREATMENT STATION (ETA), INCLUDING BITA-ETA FEEDER CANAL

WORK	QUANTITATIVE	COST
Treatment Station	Capacity 75.000 m^3/day	6.125.811,00

7.6.9 MAINS ETA-REFINERY

WORK	QUANTITATIVE	COST
Mains	4.500 m ø 600 mm	4.489.205,00

7.6.10 MAINS ETA - RESERVOIR Nº 2 (R-2)

WORK	QUANTITATIVE	COST
Mains	4.500 m ø 550 mm	3.961.890,00

7.6.11 RESERVOIR Nº 2 (R-2)

WORK	QUANTITATIVE	COST
Reservoir	cap. 2 x 5.000 m^3	4.647.404,00

7.6.12 PEAK RESERVOIR (r-3 and R-4)

WORK	QUANTITATIVE	COST
	cap. 5.000 m^3 each	4.647.404,00

7.6.13 SUB-TOTAL MAINS AND RESERVOIR

MAINS ETA-REFINERY.	4.489.205,00
MAINS ETA-RESERVOIR Nº 2 (R-2)	3.961.890,00
RESERVOIR Nº 2 (R-2)	4.647.404,00
PEAK RESERVOIR (R-3 and R-4)	4.647.404,00
SUB-TOTAL	17.745.903,00

7.6.14 DISTRIBUTION RING

WORK	QUANTITATIVE	COST
Distribution Line	11.600 m - ø 450	7.611.572,00
Distribution Line	800 m - ø 600	798.000,00
		8.409.572,00

7.6.15 DISTRIBUTION NETWORK - CAMP AND ADMINISTRATIVE ZONE

WORK	QUANTITATIVE	COST
Distribution network	7.500 m x 162	1.215.000,00

7.6.16 DISTRIBUTION NETWORK - NOSSA SENHORA DO Ó

WORK	QUANTITATIVE	COST
Distribution network	12.000 x 162,00	1.944.000,00

7.6.17 BOASICA DISTRIBUTION NETWORK

WORK	QUANTITATIVE	COST
Distribution Network	2.000 x 17 x 130,00	4.420.000,00

7.6.18 GAIBÚ DISTRIBUTIÖN NETWORK

WORK	QUANTITATIVE	COST
Trunk Line Branches	6.500 m x 270,00 1.000 m x 162,00	1.657.000,00

7.6.19 SUB-TOTAL - DISTRIBUTION

DISTRIBUTION RING	8.409.572,00
CAMP AND ADMINISTRATION ZONE	1.215.000,00
NOSSA SENHORA DO Ó	1.944.000,00
BOASICA	4.420.000,00
GAIBÚ	1.657.000,00
SUB-TOTAL	17.645.572,00

7.6.20 GRAND TOTAL

IMPOUNDMENT	8.347.043,00
TREATMENT	6.125.811,00
MAINS AND RESERVOIRS	17.745.903,00
DISTRIBUTION OF THE SYSTEM	17.645.572,00
GRAND TOTAL	49.864.329,00

7.7 PHYSICAL AND FINANCIAL SCHEDULE

WORK	YEARS 1975	1976	1977	1978	1979
BITA RESERVOIR					
UTINGA DE BAIXO RESERVOIR					
UTINGA DE BAIXO-BITA FEEDER CANAL					
IPOJUCA PUMPING STATION					
IPOJUCA-BITA FEEDER CANAL					
IMPOUNDMENT WELLS					
TREATMENT STATION					
MAINS - ETA-REFINERY					
MAINS - ETA-RESERVOIR Nº 2 (R-2)					
RESERVOIR Nº 2					
PEAK RESERVOIR DISTRIBUTION RING					
[illegible]					
CAMPDISTRIBUTION NETWORK					
NOSSA SENHORA DO Ó					
BOÁSICA					
GAIBU					
ANNUAL EXPENSES	1.400.000	19.741.920	28.722.405		
ACCUMULATED EXPENSES	1.400.000	21.141.920	49.846.329		

REMARK - The Financial schedule refers to the execution of services. However, expenses may be made earlier, due to advance purchase of equipment, especially piping.