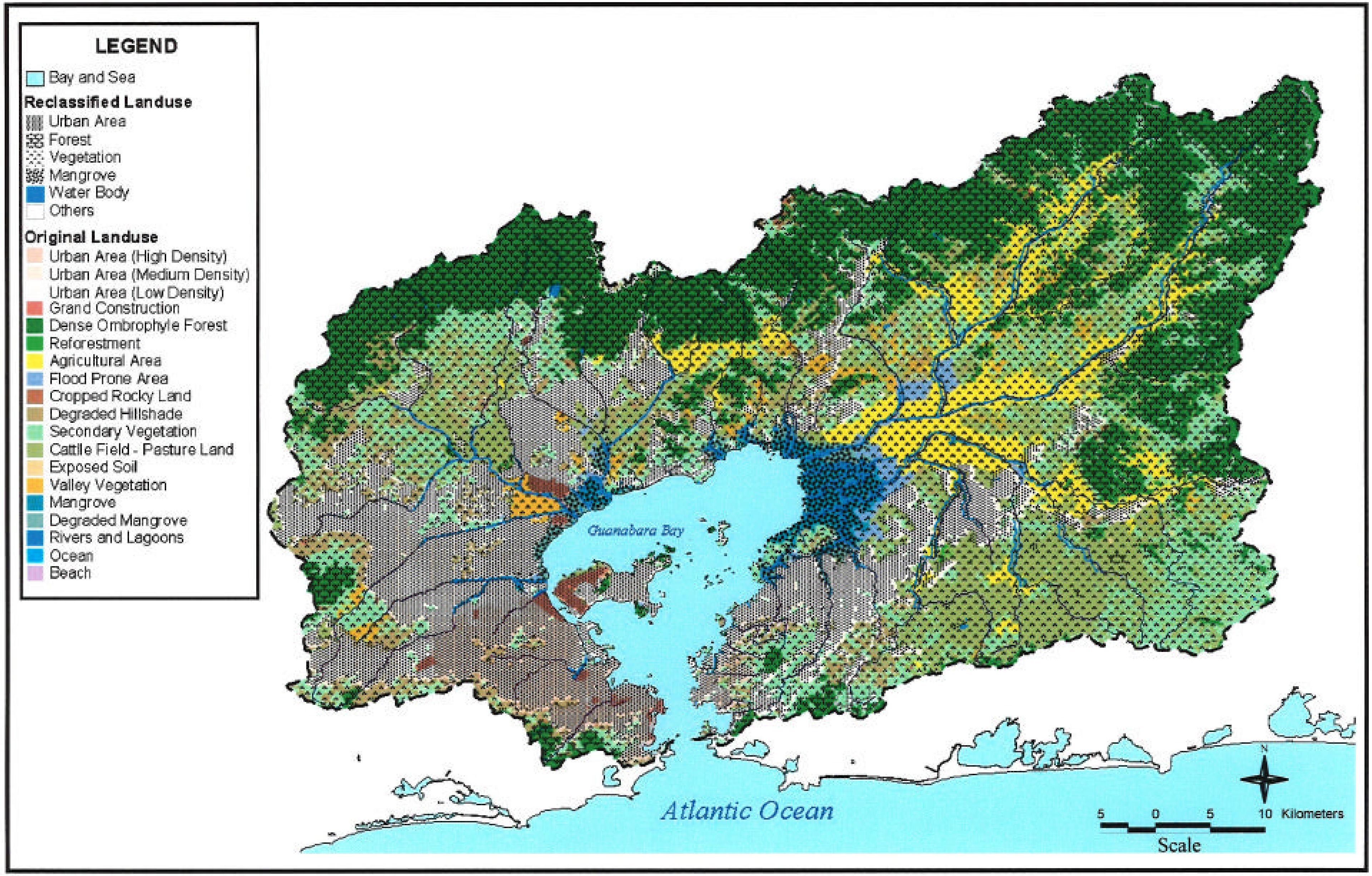


Figure 11 Original and Reclassified Landuse Map

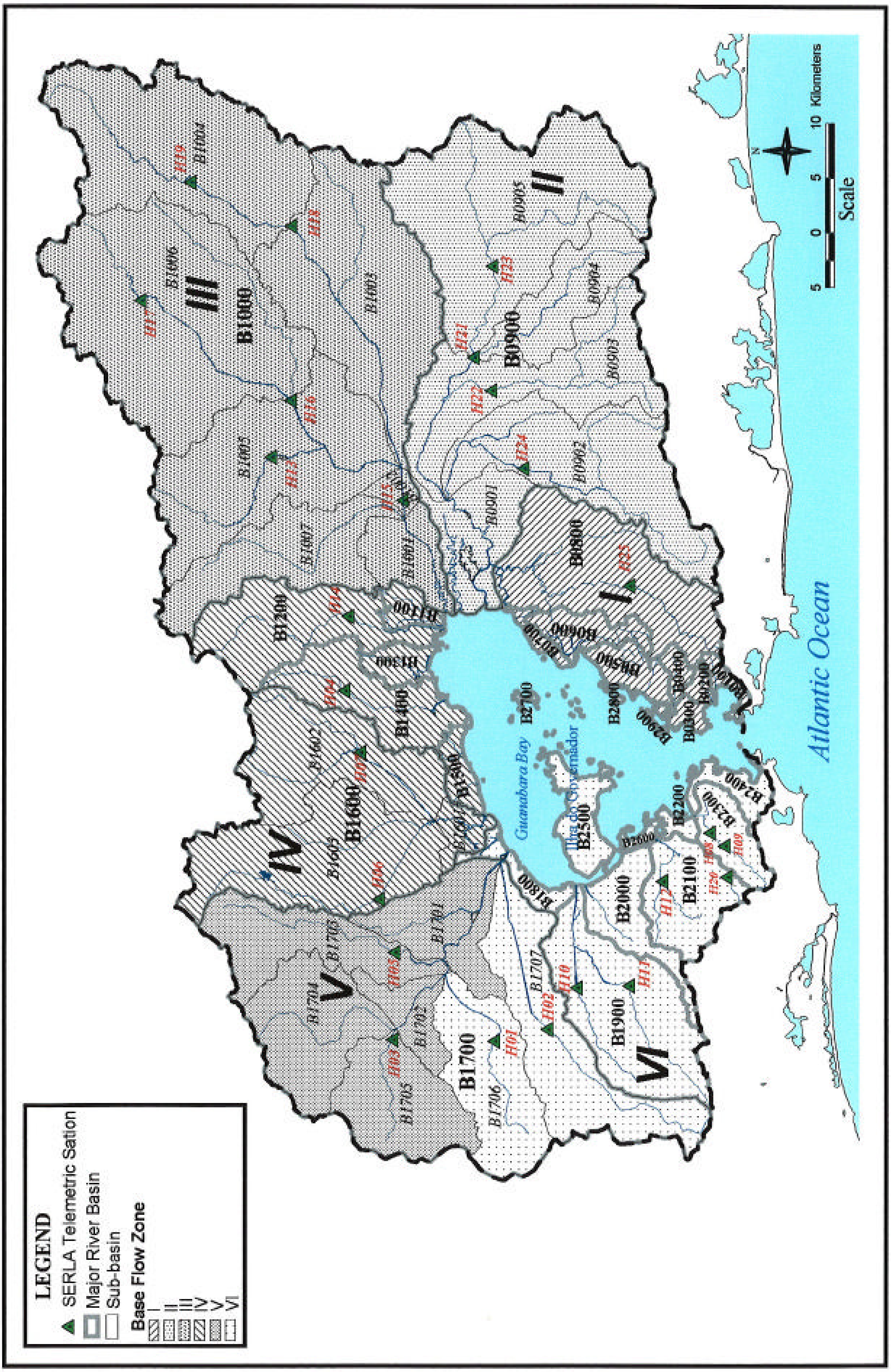


Figure 12 Base Flow Zones

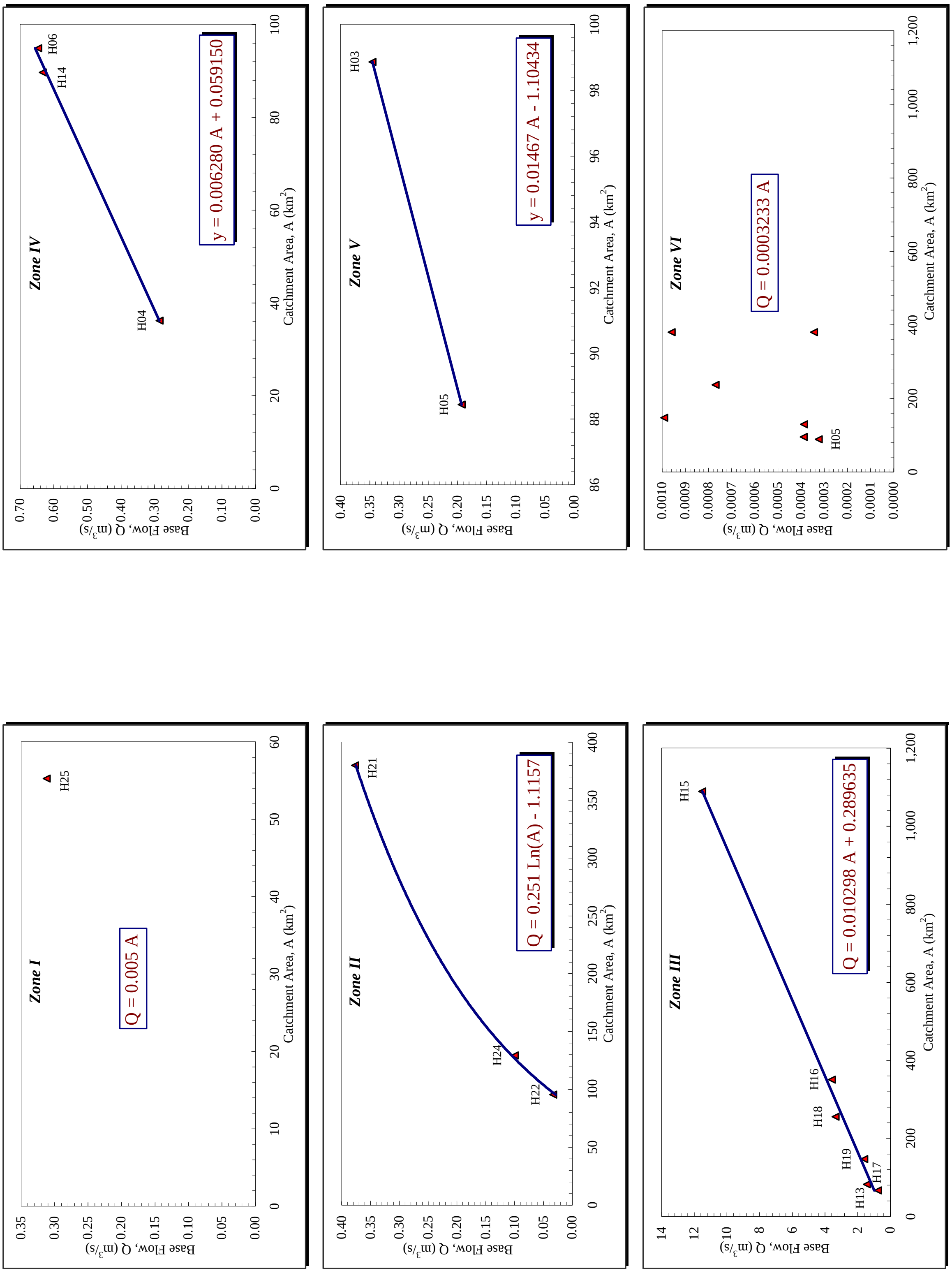
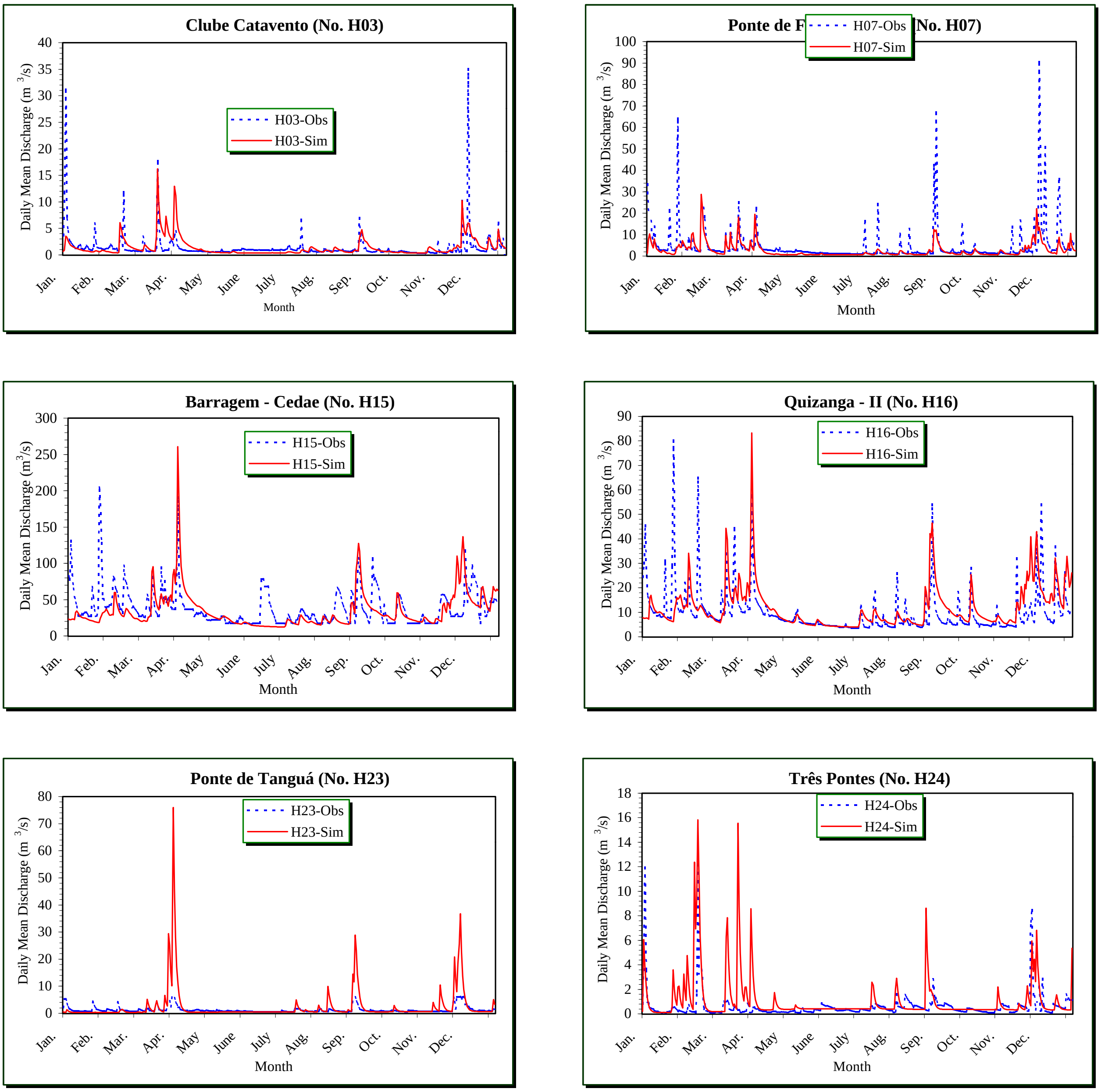


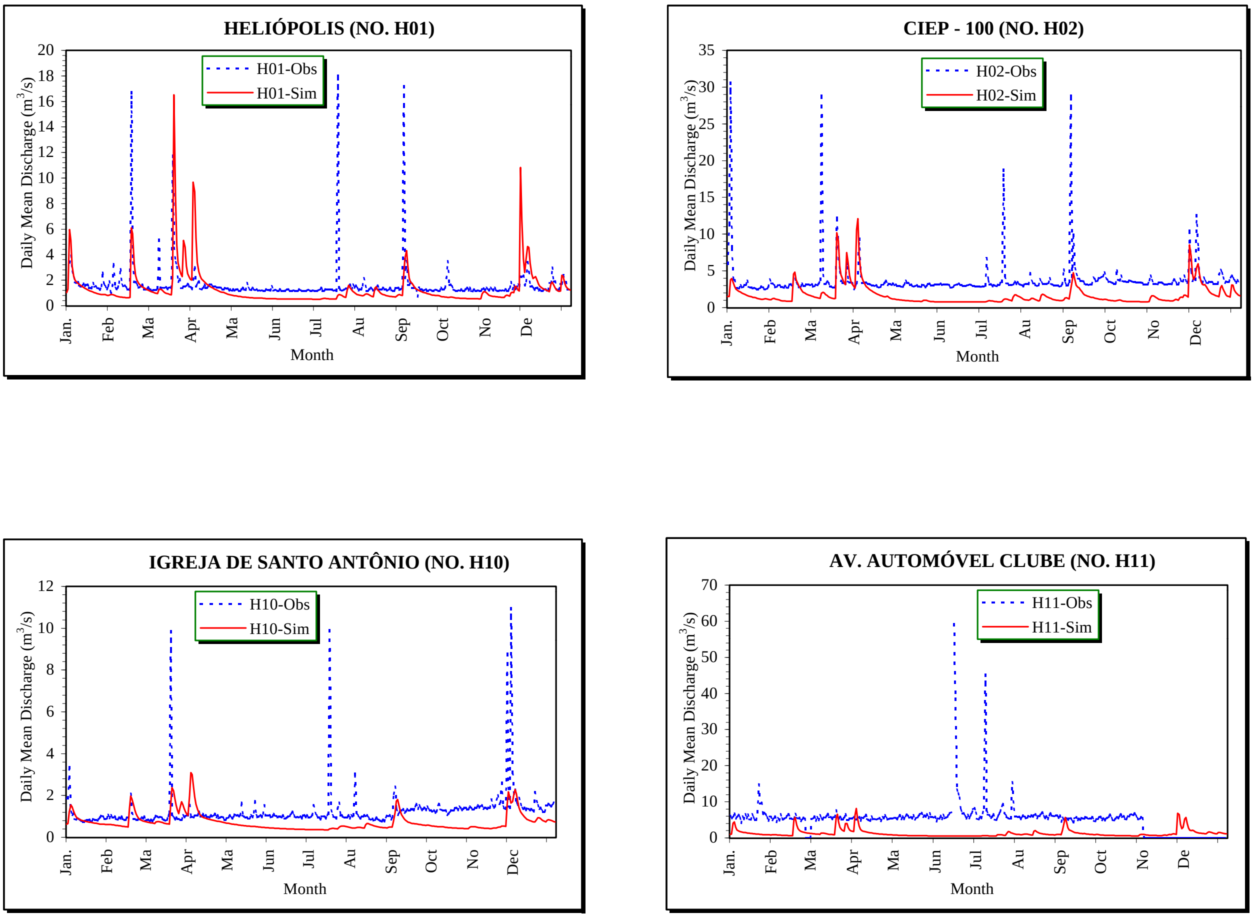
Figure 13 Base Flow Equations for Different Zones



Note : The observed discharges represent daily mean discharges for year 2000
as calculated from observed staff gauge readings and using rating curve for each station.

The simulated discharges represent surface runoffs as calculated from DHI's NAM model plus base flow.

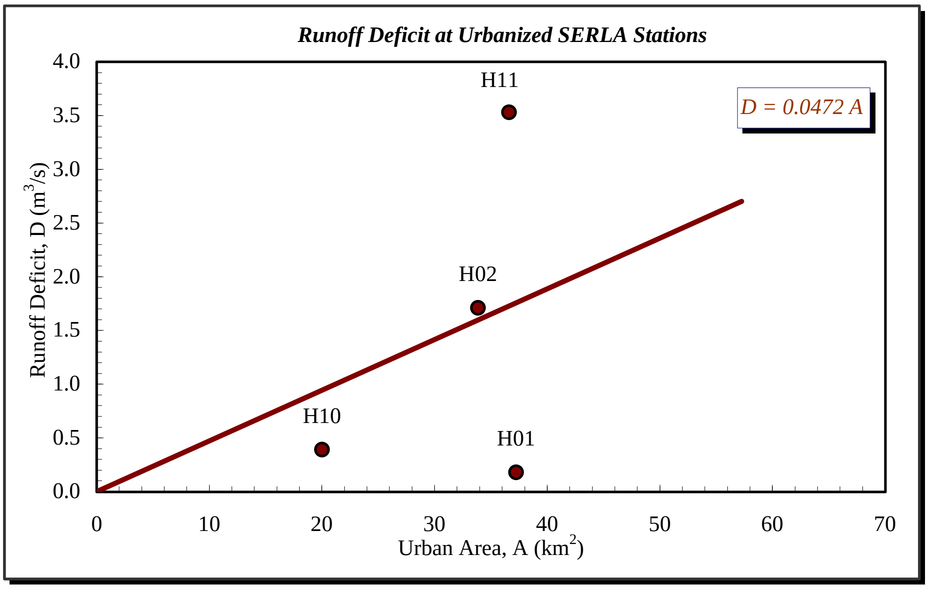
Figure 14 Runoff Model Calibration for Year 2000



Note : The observed discharges represent daily mean discharges for year 2000 as calculated from observed staff gauge readings and using rating curve for each station.

The simulated discharges represent surface runoffs as calculated from DHI's NAM model plus base flow.

Figure 15 Runoff Deficit at Urbanized Stations for Year 2000



Runoff Deficit at Urbanized SERLA Stations (Year 2000)

Station ID	Total Area (km^2)	Runoff Deficit (m^3/s)	Specific Q_{total} ($m^3/s/km^2$)	Urban Area (km^2)	Specific Q_{urban} ($m^3/s/km^2$)
H01	58.04	0.18	0.003	37.26	0.0048
H02	87.67	1.71	0.020	33.86	0.0505
H10	35.55	0.39	0.011	20.01	0.0195
H11	57.78	3.53	0.061	36.62	0.0964

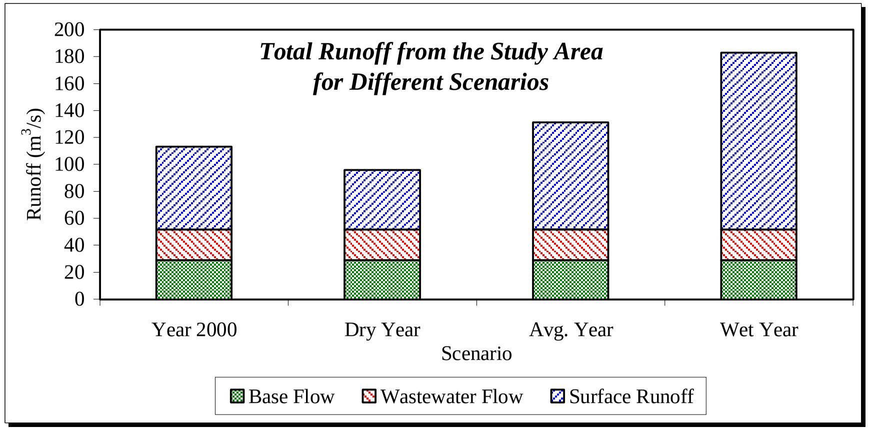
Note : Runoff Deficit = Obserevd Annual Minimum Discharge - Simulated Annual Minimum Discharge

Figure 16 Runoff Deficit at Urbanized SERLA Stream Gauge Stations

Total Runoff from the Study Area

Runoff	Runoff for Different Scenarios (m^3/s)			
	Year 2000	Dry Year	Avg. Year	Wet Year
Base Flow	28.93	28.93	28.93	28.93
Wastewater Flow	22.90	22.90	22.90	22.90
Surface Runoff	61.40	43.99	79.46	131.10
Total Runoff	113.23	95.82	131.29	182.93

Runoff	Runoff for Different Scenarios			
	Year 2000	Dry Year	Avg. Year	Wet Year
Base Flow	26%	30%	22%	16%
Wastewater Flow	20%	24%	17%	12%
Surface Runoff	54%	46%	61%	72%
Total Runoff	100%	100%	100%	100%



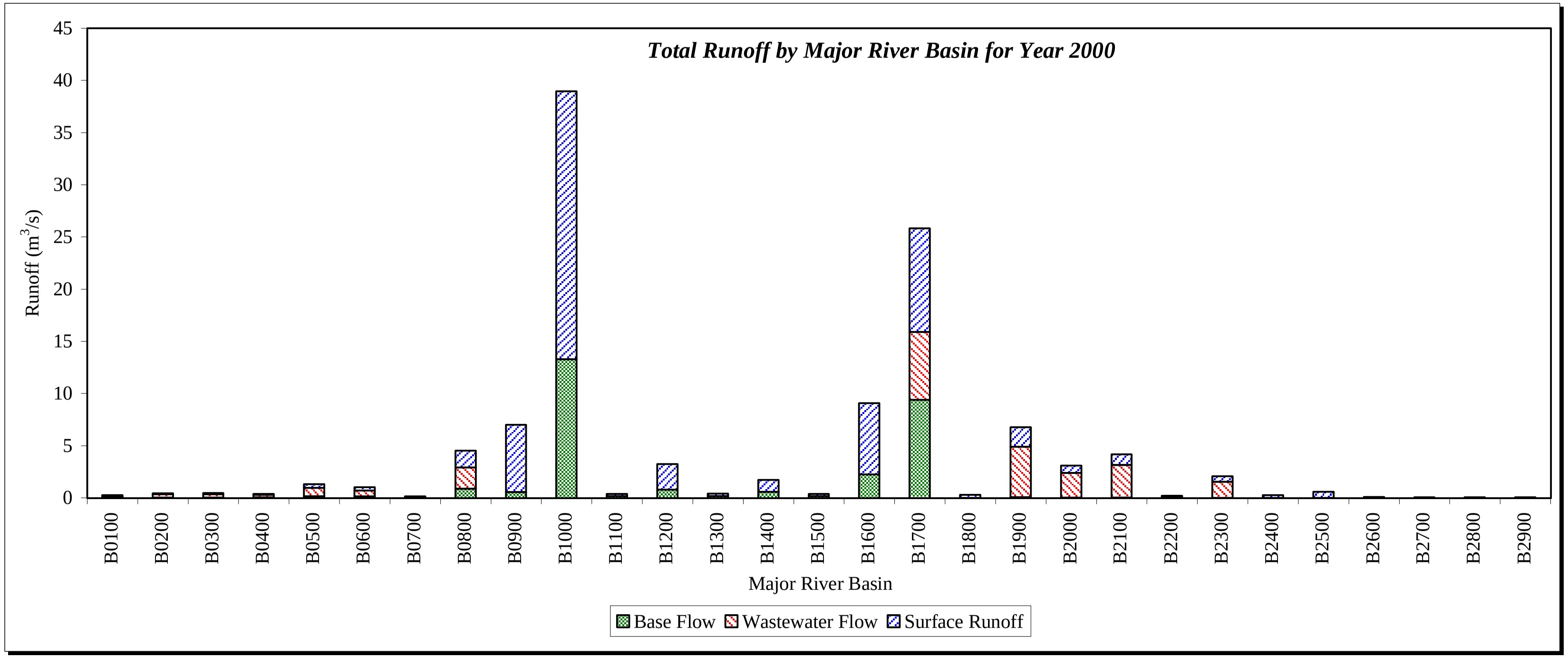
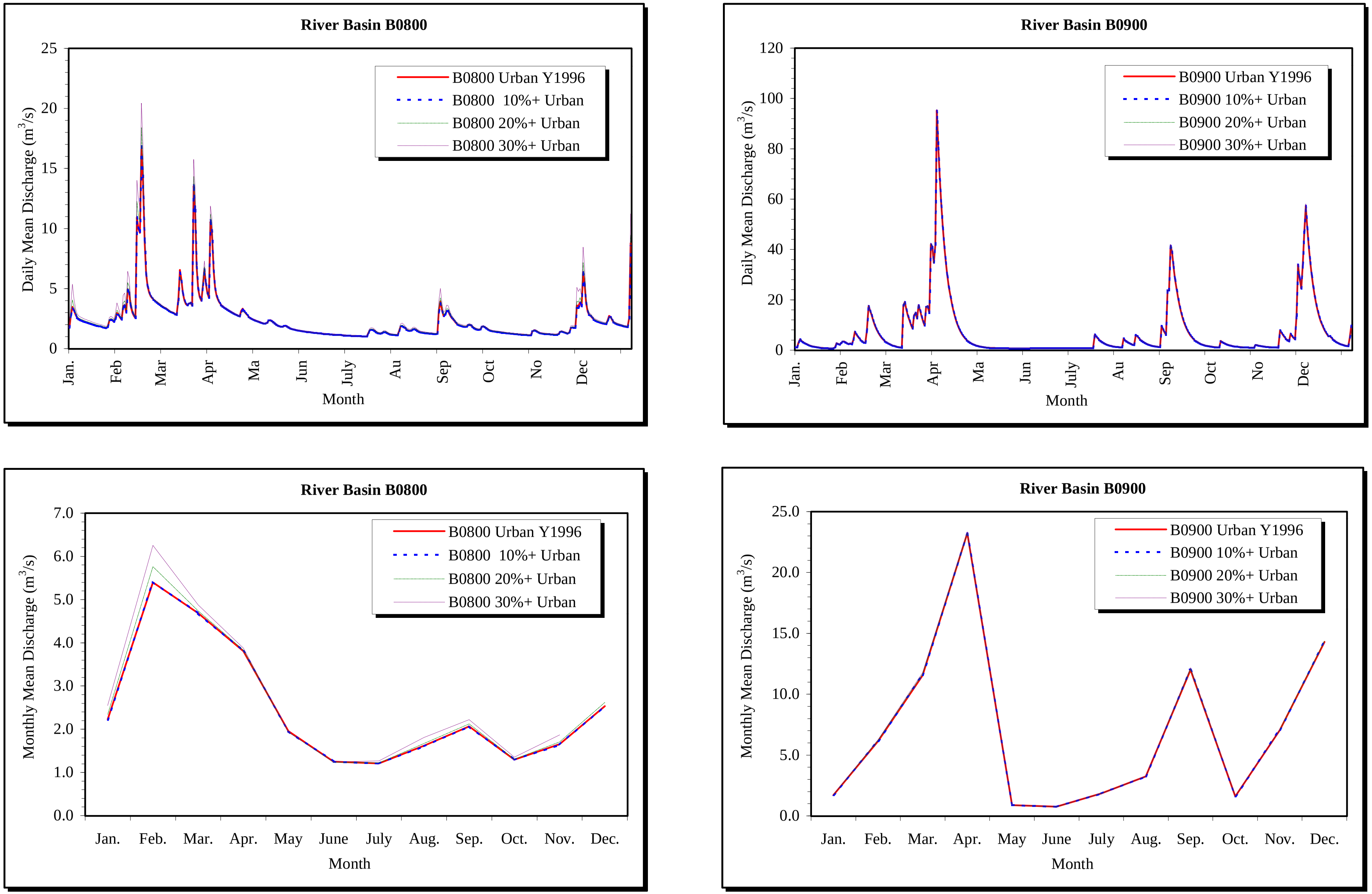


Figure 17 Summary of Result of Runoff Model



Note : For Caceribu river basin (B0900), increase in urban area is for Rio Porto das Caixas (B0902) sub-basin only.

Figure 18 Effect of Increase in Urbanization on Daily and Monthly Runoff

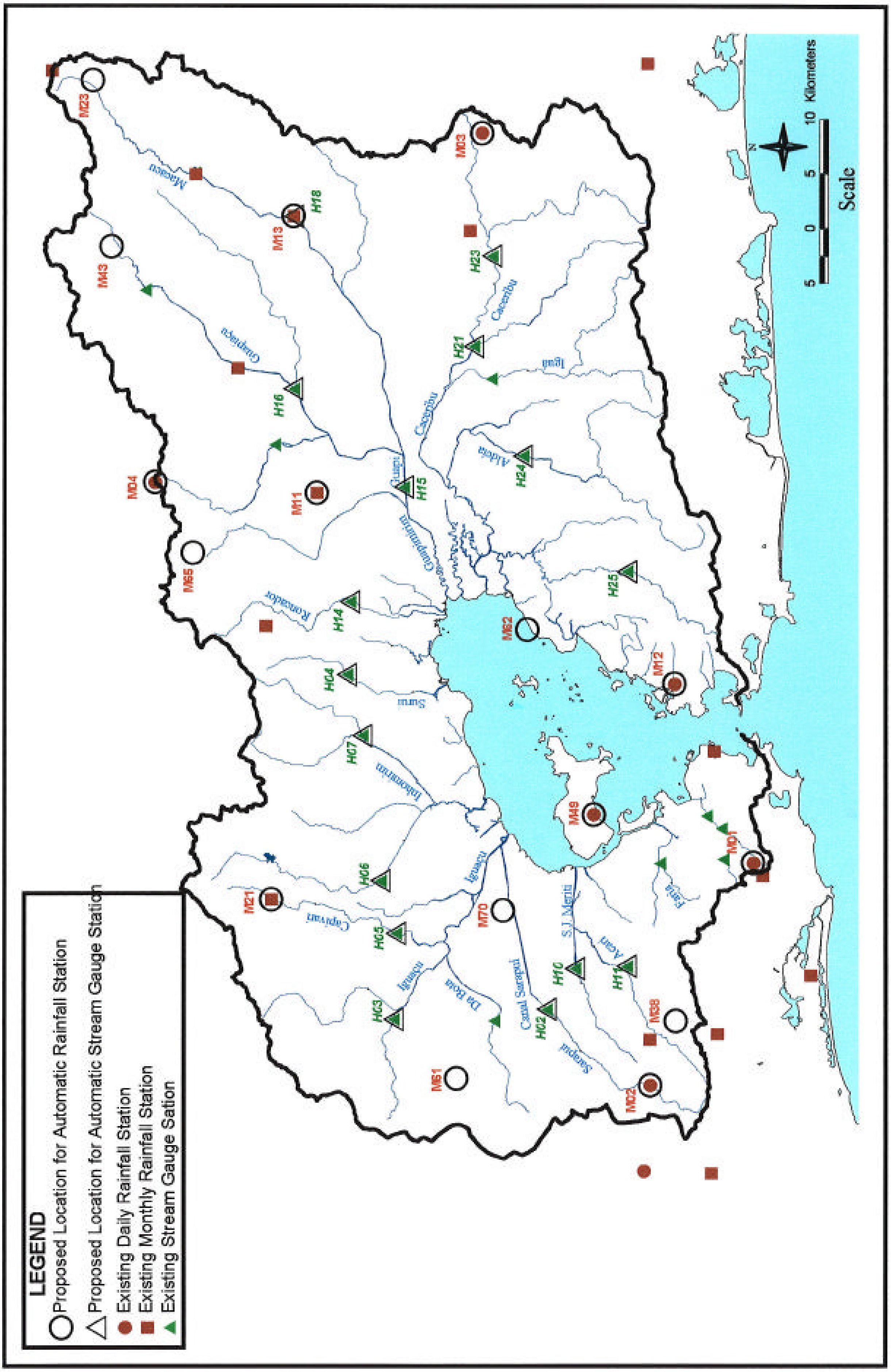


Figure 19 Proposed Monitoring Network on Meteo-Hydrology

SUPPORTING 5

POLLUTION LOAD ANALYSIS

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SUPPORTING 5 POLLUTION LOAD ANALYSIS

1. METHODOLOGY

Basic purpose of the pollution load analysis is to estimate pollution load reaching the bay through each river basin and to estimate the contribution of pollution sources. Pollution load estimate will be used as input data for the water quality simulation model as well as base information for the estimation of pollution loads in the future.

Estimate is made for the year 2000, 2010 and 2020 based on population estimates of the year in question. Further load estimates has been made assuming an increasing part of the population being served by at treatment plant. The load estimates has all been used for simulations of the water quality in the bay.

Figure 1 shows the schematic of pollution load estimate.

1.1 CATEGORY OF POLLUTION SOURCES

Pollution sources are categorized into point and non-point sources. Point sources can be defined as known loads for which the location of discharge is known. WWTP discharge and large industry discharge are point sources. All other sources are categorized as non-point sources which include the areal pollution load originating from urban, agricultural and natural processes.

1.2 ESTIMATION OF POLLUTION LOAD

Pollution loads are estimated for the following.

Point sources

- Generation of pollution load by population
- Pollution load discharge by WWTP and large Industries
- Pollution load discharged by small-scale treatment units for shopping centers, hospitals, schools etc.

Non-Point sources

- Areal pollutant load reaching the river due to natural, agricultural and urban origin

1.3 POLLUTION LOAD REACHING THE BAY THROUGH RIVERS

Based on the monitored river water quality and estimated river flow, monitored pollution load (L_{MON}) to the bay through each river basin is estimated to compare the pollution load generated and pollution load discharged to the bay utilizing water quality monitoring data and estimated basin discharge.

2. RIVER BASIN AND SEWER SYSTEM

Figure 2 shows boundaries of river basins and sewer systems. Sewer system boundary of CEDAE Sewer Master Plan is reviewed. Existing WWTP locations are also shown. Existing WWTP are as described in Section 2.3.2 and Section 2.3.3 of Main Report.

Table 1 shows the preliminary estimate of population by river basin based on the year 2000 census.

3. POLLUTION LOAD GENERATED BY HUMAN WASTE

Population connected to the WWTP (referred to as Sewage Treatment Population) is estimated based on the sewer service ratio and the incoming flow to WWTP. The below listed per capita pollution load generation for BOD, total N, total P and E. coli bacteria is used:

BOD: 54 g BOD/day, TN: 10 g N/day, TP: 2.5 g P/day E. coli: 10^9/day

Pollution load generated ($L_{POP\text{-}without\ sewer}$) is calculated based on the unit per capita generation and population which is not connected to the sewerage for each river basin.

In the following BOD is used an example showing how the load of TN, TP and E. coli.

Table 2 shows preliminary estimate of BOD load generation by total population classifying into population connected to WWTP and that population not connected to WWTP. Total BOD load generated is 445 ton/d out of which (75%) of the pollution load generated is not treated at WWTP.

4. POLLUTION LOAD AT WWTP

Pollution load discharged through WWTP ($L_{WWTP\text{-}Dis}$) is obtained considering efficiency of WWTP. As shown in *Table 3*, total BOD load to WWTP is 110 ton/d out of which 73 ton/d is removed resulting in 37 ton/d discharged to “waterbody” of rivers or directly to the Bay. Six of the listed WWTP discharge to the Bay. These are: Icarai, San Goncalo, Penha, Alegria, I. Do Governado, I. Do Paqueta.

5. POLLUTION LOAD DISCHARGED BY INDUSTRIES

FEEMA is carrying out an action program to control the pollution load from industries. established a database of industrial pollution load of major polluters and implementing a program to reduce pollution load of industries. Under these program, 455 industries are selected. Out of these 55 industries in classified as Priority 1 industries, which discharged 80% of the pollution load. A database of pollution load discharged by the major polluting industries which consists of 155 industries which included Priority 1 and Priority 2 industries is completed by FEEMA through self-reporting of industries and the data was obtained by the Study Team. Pollution load discharged by these industries (L_I) are distributed by river basin for the year 2000. *Table 4* shows their distribution by river basin. Total BOD pollution load of these industries are in year 2000 estimated to be 9.64 ton/d.

Number of industries not covered under the above are small and medium scale industries but are large in number. Pollution load of these industries is approximately 12 ton/d.

Data on nutrient load from industries have not been available, therefore ratios for TN/BOD and TP/BOD of 0.44 g N/g BOD and 0.079 g P/g BOD has been used to estimate the industrial total N and total P load, see ref. /4/.

6. OTHER POINT SOURCES (SMALL- SCALE TREATMENT UNITS)

Small-scale treatment units for developments such as condominium, hospitals, shopping centers, schools etc. has been registered with FEEMA under the “non-industry” category and data is obtained for 69 such units, on their location and pollution load. Pollution load discharged by such units are distributed by river basin.

7. AREAL POLLUTION LOAD

Areal pollution load due to natural, agricultural or urban sources can be estimated for a known section of basin if monitoring data is available at the inlet and outlet of the river through the basin and the point source pollution load is known. Only one such location is available in the Macacu River at FEEMA Monitoring location MC-967 which coincides with SERLA river gauging station 18. At this location, which is the uppermost sub-basin where point sources are negligible, pollution load is due to natural origin for which a reasonable number of flow and water quality measurements are available for the year 1994, year 1999 and year 2000. Relationship between specific BOD load (L_{BOD}) and specific discharge (Q_s) is obtained thorough regression *(Figure 3)* as follows:

$$L_{BOD}=0.268Q_s^{0.824}$$

Where, L_{BOD} is in kg/(km^{2}x d) and Q_s is in L/(km^{2}x s).

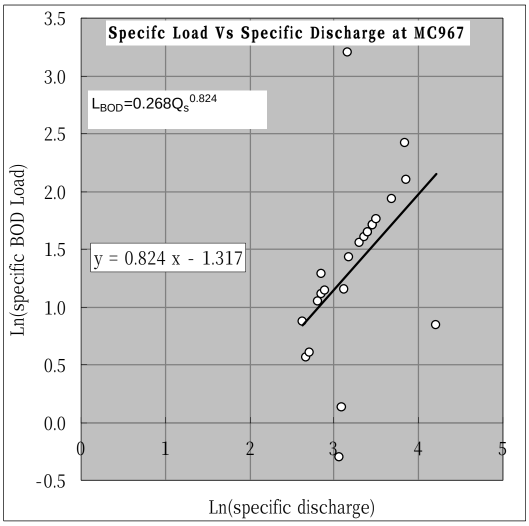

Figure 3 Relationship between Specific Load and Specific Discharge at MC967

Relationship between specific TN load (L_{TN}), TP load (L_{TP}), PO4-P load (L_{PO4}), DIN load (L_{DIN}) and specific discharge (Q_s) is obtained thorough regression as follows:

$$L_{TN}=0.072Q_s^{0.9142}$$

$$L_{TP}=0.0032Q_s^{1..3016}$$

$$L_{PO4}=0.00286Q_s^{0.9905}$$

$$L_{DIN}=0.0821Q_s^{0.6201}$$

Eighty eight percent of the specific discharge in year 2000 at this station is within the range of data used in the above derivation. In the absence of monitored data, the above relationship will be utilized to estimate the areal pollution load though it will not include the load during extreme rainfall events.

8. RUN OFF RATIO OF GENERATED POLLUTION LOAD

Monitored pollution load (L_{MON}) is calculated for river basins utilizing water quality monitoring locations where available and estimated basin discharge. There were six measurements of water quality in year 2000 and monitoring of water quality is generally not during storms. To include the load due to rain, it is assumed that the water quality of the river remains constant throughout the year and is obtained from the average of monitored quality. For those stations without water quality monitoring station, approximate estimation is made based on either population density or area depending on the type of basin. Estimated discharge load to the bay for year 2000 is 252 ton/d.

For each of the river basin, run-off ratio is calculated. Run-off ratio is calculated as total pollution load (L_{RIVER}) discharged to the rivers (Refer to *Table 5*) which is the sum of pollution load discharged through WWTP ($L_{WWTP\text{-}Dis}$), pollution load generated by large industries (L_I), small-scale treatment units (L_{NI}), and areal pollution load (L_{AREAL}) to the monitored pollution load (L_{MON}).

$$L_{RIVER} = L_{WWTP\text{-}Dis} + L_{POP\text{-}without\ sewer} + L_I + L_{NI} + L_{AREAL}$$

$$\text{Run-off Ratio} = L_{MON} / L_{RIVER}$$

Preliminary estimate of the run-off ratio is 0.67 for the whole of the basin of Guanabara Bay assuming that all of the pollution load generated by the population not treated by the WWTP reaches the bay.

When comparing the monitored load with the generated load basin by basin a great variation in the Run-off ratio can be observed. In some cases the monitored load is higher than the generated load, a great deal of this variation can be related to lack of frequent and consistent measurements of both concentrations and discharge on the same location in the river.

It has therefore decided to estimate the run-off ratio for each major basin based on assumed degradation rates for of BOD, TN, TP and E. coli and an estimated the average retention for the water each basin.

The mineralization of BOD, the death of E. coli, denitrification and other immobilization of TN and immobilization of TP is described by the below equation exemplified by BOD:

$$L = BOD * e^{K*t}$$

Where K is the daily mineralization rate (1/d) and t is the average time for pollutants in a specific basin to flow from the source to the Bay. The average retention time is estimated from the distance of the pollution centers in term of cities or industrial areas to the Bay and a velocity of the water in the river. The average velocity of the water is set to 0.05 m/sec. K values for different components are set to:

BOD: K=0.3 1/d, TN: K=0.2 1/d, TP: K=0.1 1/d E. coli: K=0.8 1/d

The resulting run-off ratios are presented in *Table 6.*

9. POLLUTION LOAD DISCHARGED TO BAY

The pollution load reaching the Bay through rivers and directly from WWTP discharging to the Bay is presented in the *Tables 7* to *Table 10.*

In year 2000 the load to the bay is estimated to be 275 ton BOD/day, 72 ton TN/day, 18.4 ton TP/day and $3.07*10^{15}$ E. coli bacteria pr. day.

10. POPULATION IN YEAR 2010 AND 2020

To be able to predict the load to the Bay in the future the population size has to be predicted for the future. In the present study year 2010 and year 2020 has been chosen as future reference years. The average annual growth ratio (AAGR) until year 2020 for the whole basin has been estimated to 0.67 %. The annual growth ratios however vary over time and with administrative areas and thereby also with basins. In *Table 11* the population in the administrative areas are broken down into river basins. For some of the administrative areas some of the population are located outside the Guanabara Bay catchment for example Niterói and Rio de Jenairo. The population in the administrative area will therefore be greater than the population in the river basin. The total population in the Bay catchment was 8,290,300 in year 2000.

The projections of the population size are presented in *Table 12* for year 2010 and *Table 13* for year 2020 respectively. The population size is expected to increases to 9,013,026 in year 2010 and 9,619,561 in year 2020.

11. FUTURE LOAD AND LOAD SCENARIOS

The load of BOD and nutrients has been estimated to be able to predict the future water quality in the Bay with the eutrophication model.

A series of simulations has been conducted with the purpose of estimating the load at which standards of 10 mg BOD/l and 5 mg BOD/l are achieved in the Bay. The series include simulations of year 2000, year 2010 and year 2020 populations and industrial development. In *Table 14* the scenarios are presented under "water quality in Bay relative to load". The table includes columns with data for generated load, load to Bay, population and population with sewage treatment. Three set of reduced domestic and industrial loads are included in this series, one with 80 % BOD, 30% TN and 50% TP reduction of domestic and industrial load after existing treatment but before self purification in rivers. One with 90 % BOD, 35% TN and 80% TP reduction and one with 90% BOD, 80% TN and 80% TP load reduction. The small natural background load is the same for all scenarios.

A second series of simulations has been conducted predicting the water quality in the Bay implementing treatment according to the PDBG1 plan for populations and industrial load of year 2000, year 2010 and year 2020. The population with sewage treatment is assumed to increase with the increase in population within existing areas connected to a treatment plant.

A third series of simulations has been conducted estimating the water quality in year 2010 using a Feasibility Plan with about 55% of the population connected to a treatment plant. One scenario for year 2010 labeled "Feasibility Study" assuming secondary treatment removing 90% BOD, 25% TN and 20 % TP for all plants except for 3 plants (Icarai, Sarapui & Puvuna) which all have primary treatment with chemical precipitation giving a reduction of 55% BOD, 35% TN and 80% TP. One scenario where all treatment plants has secondary treatment with chemical precipitation reducing the load with 90% for BOD, 30 % for TN and 50% for TP.

And forth series of load scenarios has been prepared according to the Strategy Plan for year 2020 and for year 2035 using population size of year 2020. Scenario for year 2020 assumes all treatment plants has secondary treatment except Icarai, Sarapui and Puvuna, which has primary treatment with precipitation. Scenario for year 2035 assumes all treatment plants having secondary treatment but the population size is from year 2020. The last scenario assume all treatment plants having 90% BOD, 30% TN and 50% TP removal.

Table 1 Population in the Basin Year 2000

Region	No.	Basin Name	Basin Area	Population	Sewage Treatment Population	Population without Sewage Treatment
			km^2			
E	B0100	B. Charitas	9.46	30,559	13,752	16,807
E	B0200	Canal Canto do Rio	6.21	90,467	40,710	49,757
E	B0300	B. Catedrar	7.57	91,390	41,126	50,264
E	B0400	B. Norte Centro	9.26	71,373	32,118	39,255
E	B0500	Rio Bomba	26.78	241,500	54,491	187,009
E	B0600	Rio Imboassu	29.43	157,098	19,987	137,111
NE	B0700	B. Itaoca	8.54	2,578	328	2,250
NE	B0800	Rio Alcântara	173.07	593,400	-	593,400
NE	B0900	Rio Cacerebú	811.34	256,254	-	256,254
NE	B1000	Rio Guapimirim	1,262.03	87,059	-	87,059
NE	B1100	Canal de Magé	17.08	33,734	-	33,734
NE	B1200	Rio Roncador	115.19	30,316	-	30,316
NE	B1300	Rio Iriri	19.63	4,659	-	4,659
NE	B1400	Rio Surui	84.44	22,169	-	22,169
NW	B1500	B. Maua	17.92	13,450	-	13,450
NW	B1600	Rio Estrela	348.88	385,215	-	385,215
NW	B1700	Rio Iguaçú	716.72	1,024,170	-	1,024,170
W	B1707	Rio Sarapui		1,172,773	476,450	696,323
W	B1800	B. Cabo do Brito	19.72	54,430	21,772	32,658
W	B1900	Rio S. J. Meriti	154.26	1,397,082	415,833	981,249
W	B2000	Rio Irajá	50.95	682,128	544,770	137,358
W	B2100	Canal do Cunha	70.23	899,762	147,500	752,262
W	B2200	B. São Cristóvão	6.41	30,459	5,269	25,190
W	B2300	Canal do Mangue	37.95	440,731	73,454	367,277
W	B2400	B. Botafogo	21.68	262,642	8,970	253,672
I	B2500	I. do Governador	36.28	209,426	159,164	50,262
I	B2600	I. do Fundão	5.35	1,826		1,826
I	B2700	I. de Paquetá	2.21	3,586	3,227	359
I	B2800	I. do Engenho	0.98	-		-
I	B2900	I.de S. Cruz	1.10	-		-
Total			4,070.7	8,290,200	2,058,900	6,231,300

Table 2 BOD Load Generation in the Basin Year 2000

Region	No.	Basin Name	Basin Area	Total BOD Load Generated	BOD Load to WWTP within Sewer System Area	BOD Load Generated by Population without Sewage Treatment
			km^2	ton/d	ton/d	
E	B0100	B. Charitas	9.46	1.7	0.7	0.9
E	B0200	Canal Canto do Rio	6.21	4.9	2.2	2.7
E	B0300	B. Catedrar	7.57	4.9	2.2	2.7
E	B0400	B. Norte Centro	9.26	3.9	1.7	2.1
E	B0500	Rio Bomba	26.78	13.0	2.9	10.1
E	B0600	Rio Imboassu	29.43	8.5	1.1	7.4
NE	B0700	B. Itaoca	8.54	0.1	0.0	0.1
NE	B0800	Rio Alcântara	173.07	32.0	-	32.0
NE	B0900	Rio Cacerebú	811.34	13.8	-	13.8
NE	B1000	Rio Guapimirim	1,262.03	4.7	-	4.7
NE	B1100	Canal de Magé	17.08	1.8	-	1.8
NE	B1200	Rio Roncador	115.19	1.6	-	1.6
NE	B1300	Rio Iriri	19.63	0.3	-	0.3
NE	B1400	Rio Surui	84.44	1.2	-	1.2
NW	B1500	B. Maua	17.92	0.7	-	0.7
NW	B1600	Rio Estrela	348.88	20.8	-	20.8
NW	B1700	Rio Iguaçú	716.72	55.3	-	55.3
W	B1707	Rio Sarapui		63.3	25.7	37.6
W	B1800	B. Cabo do Brito	19.72	2.9	1.2	1.8
W	B1900	Rio S. J. Meriti	154.26	75.4	22.5	53.0
W	B2000	Rio Irajá	50.95	36.8	29.4	7.4
W	B2100	Canal do Cunha	70.23	48.6	8.0	40.6
W	B2200	B. São Cristóvão	6.41	1.6	0.3	1.4
W	B2300	Canal do Mangue	37.95	23.8	4.0	19.8
W	B2400	B. Botafogo	21.68	14.2	0.5	13.7
I	B2500	I. do Governador	36.28	11.3	8.6	2.7
I	B2600	I. do Fundão	5.35	0.1	-	0.1
I	B2700	I. de Paquetá	2.21	0.2	0.2	0.0
I	B2800	I. do Engenho	0.98	-	-	-
I	B2900	I.de S. Cruz	1.10	-	-	-
Total			4,070.7	447.7	111.2	336.5

Per capita BOD generation 54 g/(capitax d)

Table 3 BOD Load at WWTP Year 2000

Region	No.	Basin Name	Basin Area	Name of WWTP	Load to WWTP	Load Removed at WWTP	WWTP Load Discharged to Water Body
			km^2		ton/d	ton/d	ton/d
E	B0100	B. Charitas	9.46				
E	B0200	Canal Canto do Rio	6.21	Icarai	8.913	4.902	4.011
E	B0300	B. Catedrar	7.57				
E	B0400	B. Norte Centro	9.26				
E	B0500	Rio Bomba	26.78	San Goncalo	2.018	1.816	0.202
E	B0600	Rio Imboassu	29.43				
NE	B0700	B. Itaoca	8.54				
NE	B0800	Rio Alcântara	173.07				
NE	B0900	Rio Cacerebú	811.34				
NE	B1000	Rio Guapimirim	1,262.03				
NE	B1100	Canal de Magé	17.08				
NE	B1200	Rio Roncador	115.19				
NE	B1300	Rio Iriri	19.63				
NE	B1400	Rio Surui	84.44				
NW	B1500	B. Maua	17.92				
NW	B1600	Rio Estrela	348.88				
NW	B1700	Rio Iguaçú	716.72	Sarapui Gramacho	25.728	14.311	11.427
NW	B1800	B. Cabo do Brito	19.72				
W	B1900	Rio S. J. Meriti	154.26	Pavuna Acarai	22.455	13.806	8.649
W	B2000	Rio Irajá	50.95	Penha	29.418	26.476	2.942
W	B2100	Canal do Cunha	70.23	Alegria	12.700	3.810	8.890
W	B2200	B. São Cristóvão	6.41				
W	B2300	Canal do Mangue	37.95				
W	B2400	B. Botafogo	21.68				
I	B2500	I. do Governador	36.28	I. do Governador	8.595	7.735	0.859
I	B2600	I. do Fundão	5.35				
I	B2700	I. de Paquetá	2.21	I. de Paquetá	0.174	0.141	0.017
I	B2800	I. do Engenho	0.98				
I	B2900	I. de S. Cruz	1.10				
Total			4,070.7		110.10	73.01	36.99

Table 4 Industrial Pollution Load Year 2000

Region	No.	Basin Name	Basin Area	Industrial Load
			km^2	ton/d
E	B0100	B. Charitas	9.46	0.368
E	B0200	Canal Canto do Rio	6.21	0.033
E	B0300	B. Catedrar	7.57	-
E	B0400	B. Norte Centro	9.26	-
E	B0500	Rio Bomba	26.78	1.198
E	B0600	Rio Imboassu	29.43	-
NE	B0700	B. Itaoca	8.54	-
NE	B0800	Rio Alcântara	173.07	0.820
NE	B0900	Rio Cacerebú	811.34	0.101
NE	B1000	Rio Guapimirim	1,262.03	0.900
NE	B1100	Canal de Magé	17.08	0.000
NE	B1200	Rio Roncador	115.19	-
NE	B1300	Rio Iriri	19.63	-
NE	B1400	Rio Surui	84.44	0.051
NW	B1500	B. Maua	17.92	-
NW	B1600	Rio Estrela	348.88	1.160
NW	B1700	Rio Iguaçú	716.72	3.514
W	B1800	B. Cabo do Brito	19.72	-
W	B1900	Rio S. J. Meriti	154.26	0.861
W	B2000	Rio Irajá	50.95	0.003
W	B2100	Canal do Cunha	70.23	0.587
W	B2200	B. São Cristóvão	6.41	-
W	B2300	Canal do Mangue	37.95	0.003
W	B2400	B. Botafogo	21.68	-
I	B2500	I. do Governador	36.28	0.043
I	B2600	I. do Fundão	5.35	-
I	B2700	I. de Paquetá	2.21	-
I	B2800	I. do Engenho	0.98	-
I	B2900	I. de S. Cruz	1.10	-
Total			4,070.68	9.64

Table 5 Summary of Total BOD Load Region Year 2000

	No.	Basin Name	Basin Area	WWTP Load	Untreated Domestic Load	Industrial/ Non-industrial Load	Surface Pollution Load
			km^2	ton/d	ton/d	ton/d	ton/d
E	B0100	B. Charitas	9.46	-	0.91	0.735	0.011
E	B0200	Canal Canto do Rio	6.21	4.01	2.69	0.033	0.007
E	B0300	B. Catedrar	7.57	-	2.71	-	0.009
E	B0400	B. Norte Centro	9.26	-	2.12	-	0.010
E	B0500	Rio Bomba	26.78	0.20	10.1	4.108	0.032
E	B0600	Rio Imboassu	29.43	-	7.40	-	0.033
NE	B0700	B. Itaoca	8.54	-	0.12	-	0.010
NE	B0800	Rio Alcântara	173.07	-	32.04	0.997	0.180
NE	B0900	Rio Cacerebú	811.34	-	13.84	0.183	0.722
NE	B1000	Rio Guapimirim	1,262.03	-	4.70	1.308	0.003
NE	B1100	Canal de Magé	17.08	-	1.82	0.000	0.022
NE	B1200	Rio Roncador	115.19	-	1.64	0.054	0.240
NE	B1300	Rio Iriri	19.63	-	0.25	-	0.022
NE	B1400	Rio Surui	84.44	-	1.20	0.051	0.118
NW	B1500	B. Maua	17.92	-	0.73	-	0.020
NW	B1600	Rio Estrela	348.88	-	20.80	2.398	0.674
NW	B1700	Rio Iguaçú	716.72	11.42	55.31	2.666	1.003
W	B1707	Rio Sarapui			37.60	3.051	
W	B1800	B. Cabo do Brito	19.72	-	1.76	0.218	0.029
W	B1900	Rio S. J. Meriti	154.26	8.65	52.99	1.826	0.217
W	B2000	Rio Irajá	50.95	2.94	7.42	0.900	0.075
W	B2100	Canal do Cunha	70.23	8.89	40.62	3.049	0.108
W	B2200	B. São Cristóvão	6.41	-	1.26	0.245	0.010
W	B2300	Canal do Mangue	37.95	-	19.83	0.425	0.054
W	B2400	B. Botafogo	21.68	-	13.7	0.898	0.027
I	B2500	I. do Governador	36.28	0.86	2.71	0.097	0.052
I	B2600	I. do Fundão	5.35	-	0.1	-	0.008
I	B2700	I. de Paquetá	2.21	0.02	0.02	-	
I	B2800	I. do Engenho	0.98	-	-	-	
I	B2900	I. de S. Cruz	1.10	-	-	-	
Total			4,070.7	36.99	336.5	23.2	3.8

Table 6 Estimated Run-off Ratios by Basin for BOD; TN, TP and E. coli

Region	No.	Basin Name	Basin Area	Distance from Bay	Run-off ratio BOD	Run-off ratio TN	Run-off ratio TP	Run-off ratio E. coli
			km^2	km	BOD	TN	TP	E. coli
E	B0100	B. Charitas	9.5	1.5	0.90	0.93	0.97	0.76
E	B0200	Canal Canto do Rio	6.2	1.5	0.90	0.93	0.97	0.76
E	B0300	B. Catedrar	7.6	1.0	0.93	0.95	0.98	0.83
E	B0400	B. Norte Centro	9.3	3.0	0.81	0.87	0.93	0.57
E	B0500	Rio Bomba	26.8	2.0	0.87	0.91	0.95	0.69
E	B0600	Rio Imboassu	29.4	3.5	0.78	0.85	0.92	0.52
NE	B0700	B. Itaoca	8.5	1.0	0.93	0.95	0.98	0.83
NE	B0800	Rio Alcântara	173.1	10.0	0.50	0.63	0.79	0.16
NE	B0900	Rio Cacerebú	811.3	15.0	0.35	0.50	0.71	0.06
NE	B1000	Rio Guapimirim	1262.0	30.0	0.12	0.25	0.50	0.004
NE	B1100	Canal de Magé	17.1	3.0	0.81	0.87	0.93	0.57
NE	B1200	Rio Roncador	115.2	7.5	0.59	0.71	0.84	0.25
NE	B1300	Rio Iriri	19.6	3.0	0.81	0.87	0.93	0.57
NE	B1400	Rio Surui	84.4	5.0	0.71	0.79	0.89	0.40
NW	B1500	B. Maua	17.9	1.0	0.93	0.95	0.98	0.83
NW	B1600	Rio Estrela	348.9	5.0	0.71	0.79	0.89	0.40
NW	B1700	Rio Iguaçú	716.7	7.0	0.62	0.72	0.85	0.27
W	B1707	Rio Sarapui		7.0	0.62	0.72	0.85	0.27
W	B1800	B. Cabo do Brito	19.7	7.0	0.62	0.72	0.85	0.27
W	B1900	Rio S. J. Meriti	154.3	1.0	0.93	0.95	0.98	0.83
W	B2000	Rio Irajá	51.0	5.0	0.71	0.79	0.89	0.40
W	B2100	Canal do Cunha	70.2	5.0	0.71	0.79	0.89	0.40
W	B2200	B. São Cristóvão	6.4	3.0	0.81	0.87	0.93	0.57
W	B2300	Canal do Mangue	38.0	1.0	0.93	0.95	0.98	0.83
W	B2400	B. Botafogo	21.7	2.0	0.87	0.91	0.95	0.69
I	B2500	I. do Governador	36.3	1.0	0.93	0.95	0.98	0.83
I	B2600	I. do Fundão	5.4	-	1.00	1.00	1.00	1.00
I	B2700	I. de Paquetá	2.2	-	1.00	1.00	1.00	1.00
I	B2800	I. do Engenho	1.0	-	1.00	1.00	1.00	1.00
I	B2900	I.de S. Cruz	1.1	-	1.00	1.00	1.00	1.00

Table 7 Total Load of BOD in ton/day Reaching Guanabara Bay after Selfpurification in the Basins, Year 2000

No.	Basin Name	BOD Produced	BOD to bay	WWTP direct	Back ground	Total
100	B. Charitas	1.6	1.5		0.011	1.5
200	Canal Canto do Rio	2.7	2.5	4.01	0.007	6.5
300	B. Catedrar	2.7	2.5		0.009	2.6
400	B. Norte Centro	2.1	1.7		0.010	1.8
500	Rio Bomba	14.2	12.4	0.20	0.032	12.7
600	Rio Imboassu	7.4	5.8		0.033	5.9
700	B. Itaoca	0.1	0.1		0.010	0.2
800	Rio Alcântara	33.0	16.5		0.180	17.2
900	Rio Cacerebú	14.0	4.9		0.722	5.8
1000	Rio Guapimirim	6.0	0.7		0.003	7.0
1100	Canal de Magé	1.8	1.5		0.022	1.6
1200	Rio Roncador	1.7	1.0		0.240	1.5
1300	Rio Iriri	0.3	0.2		0.022	0.3
1400	Rio Surui	1.2	0.9		0.118	1.3
1500	B. Maua	0.7	0.7		0.020	0.8
1600	Rio Estrela	23.2	16.4		0.674	18.6
1700	Rio Iguaçú	58.0	35.7		1.003	35.8
1707	Rio Sarapui	52.1	32.0			32.0
1800	B. Cabo do Brito	2.0	1.8		0.029	2.0
1900	Rio S. J. Meriti	57.8	40.8		0.217	42.3
2000	Rio Irajá	8.3	5.9	2.94	0.075	9.2
2100	Canal do Cunha	43.7	35.5	8.89	0.108	44.8
2200	B. São Cristóvão	1.6	1.5		0.010	1.5
2300	Canal do Mangue	20.3	17.6		0.054	17.9
2400	B. Botafogo	14.6	13.6		0.027	13.8
2500	I. do Governador	2.8	2.8	0.86	0.052	3.7
2600	I. do Fundão	0.1	0.1		0.008	0.1
2700	I. de Paquetá	0.0	0.0	0.02		0.0
2800	I. do Engenho	0.0	0.0			0.0
2900	I.de S. Cruz	0.0	0.0			0.0
Total		**374.1**	**256.7**	**16.9**	**3.8**	**275.2**

The “BOD produced” is the sum treated and untreated load form population and industry discharged to rivers in the basin.

Table 8 Total Load of Total N in ton/day Reaching Guanabara Bay after Selfpurification in the Basins, Year 2000

No.	Basin Name	TN Produced	TN Bay	WWTP direct	Back ground	Total
100	B. Charitas	0.49	0.46		0.006	0.46
200	Canal Canto do Rio	0.51	0.48	1.073	0.004	1.55
300	B. Catedrar	0.50	0.48		0.005	0.48
400	B. Norte Centro	0.39	0.34		0.005	0.35
500	Rio Bomba	3.67	3.34	0.280	0.017	3.64
600	Rio Imboassu	1.37	1.17		0.017	1.18
700	B. Itaoca	0.02	0.02		0.005	0.03
800	Rio Alcântara	6.37	4.01		0.089	4.10
900	Rio Cacerebú	2.64	1.32		0.357	1.68
1000	Rio Guapimirim	1.44	0.36		0.001	0.36
1100	Canal de Magé	0.34	0.29		0.011	0.30
1200	Rio Roncador	0.33	0.23		0.127	0.36
1300	Rio Iriri	0.05	0.04		0.012	0.05
1400	Rio Surui	0.24	0.19		0.061	0.25
1500	B. Maua	0.13	0.13		0.011	0.14
1600	Rio Estrela	4.90	3.89		0.356	4.24
1700	Rio Iguaçú	11.41	8.25		0.525	8.78
1707	Rio Sarapui	11.48	8.31		0.015	8.32
1800	B. Cabo do Brito	0.42	0.40		0.105	0.51
1900	Rio S. J. Meriti	13.39	10.62		0.038	10.66
2000	Rio Irajá	1.77	1.40	4.086	0.055	5.54
2100	Canal do Cunha	8.86	7.71	2.187	0.005	9.90
2200	B. São Cristóvão	0.36	0.34		0.028	0.37
2300	Canal do Mangue	3.86	3.52		0.014	3.53
2400	B. Botafogo	2.93	2.80		0.029	2.83
2500	I. do Governador	0.55	0.55	1.194	0.004	1.74
2600	I. do Fundão	0.02	0.02		0	0.02
2700	I. de Paquetá	0.00	0.00	0.024	0	0.03
2800	I. do Engenho	0.00	0.00		0	0.00
2900	I.de S. Cruz	0.00	0.00		0	0.00
Total		**78.4**	**60.7**	**8.8**	**1.9**	**72.0**

The “TN produced” is the sum treated and untreated load form population and industry discharged to rivers in the basin.

Table 9 Total Load of Total P in ton/day Reaching Guanabara Bay after Selfpurification in the Basins, Year 2000

No.	Basin Name	TP Produced	TP Bay	WWTP direct	Back ground	Total
100	B. Charitas	0.100	0.096		0.0013	0.098
200	Canal Canto do Rio	0.127	0.123	0.083	0.0008	0.206
300	B. Catedrar	0.126	0.123		0.0003	0.123
400	B. Norte Centro	0.098	0.092		0.001	0.093
500	Rio Bomba	0.791	0.755	0.075	0.0035	0.833
600	Rio Imboassu	0.343	0.316		0.0029	0.319
700	B. Itaoca	0.006	0.005		0.0021	0.008
800	Rio Alcântara	1.562	1.239		0.0132	1.252
900	Rio Cacerebú	0.655	0.463		0.0562	0.519
1000	Rio Guapimirim	0.321	0.160		0.0003	0.160
1100	Canal de Magé	0.084	0.079		0.0021	0.081
1200	Rio Roncador	0.080	0.067		0.0263	0.094
1300	Rio Iriri	0.012	0.011		0.0021	0.013
1400	Rio Surui	0.059	0.053		0.0109	0.064
1500	B. Maua	0.034	0.033		0.0023	0.035
1600	Rio Estrela	1.152	1.026		0.0727	1.099
1700	Rio Iguaçú	2.770	2.356		0.0999	2.456
1707	Rio Sarapui	2.323	1.976		0.0032	1.979
1800	B. Cabo do Brito	0.099	0.097		0.0155	0.112
1900	Rio S. J. Meriti	2.920	2.601		0.0073	2.608
2000	Rio Irajá	0.414	0.369	1.090	0.0113	1.470
2100	Canal do Cunha	2.121	1.978	0.517	0.00011	2.496
2200	B. São Cristóvão	0.082	0.080		0.0055	0.086
2300	Canal do Mangue	0.952	0.909		0.0026	0.911
2400	B. Botafogo	0.705	0.689		0.0081	0.697
2500	I. do Governador	0.133	0.133	0.318	0.0013	0.453
2600	I. do Fundão	0.005	0.005		0	0.005
2700	I. de Paquetá	0.001	0.001	0.006	0	0.007
2800	I. do Engenho	0.000	0.000		0	0.000
2900	I.de S. Cruz	0.000	0.000		0	0.000
Total		**18.1**	**15.8**	**2.1**	**0.4**	**18.4**

The “TP produced” is the sum treated and untreated load form population and industry discharged to rivers in the basin.

Table 10 Total Load of E. coli Bacteria in No/day Reaching Guanabara Bay after Selfpurification in the Basins, Year 2000

No.	Basin Name	E. coli Produced	E. coli Bay	WWTP direct	Total
100	B. Charitas	1.27E+13	1.27E+13		1.27E+13
200	Canal Canto do Rio	3.77E+13	3.77E+13	1.65E+13	5.42E+13
300	B. Catedrar	4.18E+13	4.18E+13		4.18E+13
400	B. Norte Centro	2.25E+13	2.25E+13		2.25E+13
500	Rio Bomba	1.29E+14	1.29E+14	3.74E+12	1.33E+14
600	Rio Imboassu	7.17E+13	7.17E+13		7.17E+13
700	B. Itaoca	1.87E+12	1.87E+12		1.87E+12
800	Rio Alcântara	9.31E+13	9.31E+13		9.31E+13
900	Rio Cacerebú	1.59E+13	1.59E+13		1.59E+13
1000	Rio Guapimirim	3.37E+11	3.37E+11		3.37E+11
1100	Canal de Magé	1.94E+13	1.94E+13		1.94E+13
1200	Rio Roncador	7.56E+12	7.56E+12		7.56E+12
1300	Rio Iriri	2.67E+12	2.67E+12		2.67E+12
1400	Rio Surui	8.78E+12	8.78E+12		8.78E+12
1500	B. Maua	1.12E+13	1.12E+13		1.12E+13
1600	Rio Estrela	1.53E+14	1.53E+14		1.53E+14
1700	Rio Iguaçú	2.80E+14	2.80E+14		2.80E+14
1707	Rio Sarapui	6.13E+14	6.13E+14		6.13E+14
1800	B. Cabo do Brito	8.93E+12	8.93E+12		8.93E+12
1900	Rio S. J. Meriti	4.05E+14	4.05E+14		4.05E+14
2000	Rio Irajá	5.44E+13	5.44E+13	5.45E+13	1.09E+14
2100	Canal do Cunha	4.32E+14	4.32E+14	2.35E+13	4.55E+14
2200	B. São Cristóvão	2.09E+13	2.09E+13		2.09E+13
2300	Canal do Mangue	2.54E+14	2.54E+14		2.54E+14
2400	B. Botafogo	2.11E+14	2.11E+14		2.11E+14
2500	I. do Governador	5.03E+13	5.03E+13	1.59E+13	6.62E+13
2600	I. do Fundão	1.83E+12	1.83E+12		1.83E+12
2700	I. de Paquetá	3.59E+11	3.59E+11	3.23E+11	6.82E+11
2800	I. do Engenho	0	0		0.00E+00
2900	I.de S. Cruz	0	0		0.00E+00
Total		**2.96E+15**	**2.96E+15**	**1.14E+14**	**3.07E+15**

The “E. coli produced” is the sum treated and untreated load form population and industry discharged to rivers in the basin.

Table 11 Population in Guanabara Bay Catchment Organised According to Municipality and River Basin Year 2000

Major River Basin			Population by Municipality for Year 2000														
ID	Name	Area (km^2)	Belford Roxo	Cachoeiras de Macacu	Duque de Caxias	Guapimirim	Itaboraí	Magé	Nilópolis	Niterói	Nova Iguaçu*	Petrópolis	Rio Bonito	Rio de Janeiro	São Gonçalo	São João de Meriti	Tanguá	Sub-Total
B0100	Bay - Charitas	9.46								30,559								30,559
B0200	Canal Canto do Rio	6.21								90,467								90,467
B0300	Bay - Catedrar	7.57								91,390								91,390
B0400	Bay - Norte Centro	9.26								71,363								71,363
B0500	Rio Bomba	26.78								62,498					179,038			241,536
B0600	Rio Imboaçu	29.43													157,098			157,098
B0700	Bay - Itaoca	8.54													2,578			2,578
B0800	Rio Alcantara	173.07					33,252			50,708					509,480			593,440
B0900	Rio Caceribu	811.34					150,916			3,943			33,758		41,634		26,001	256,252
B1000	Rio Guapimirim	1,262.03		46,989		36,488	2,959	617				6						87,059
B1100	Canal de Magé	17.08				1,053		32,681										33,734
B1200	Rio Roncador	115.19				399		29,910				7						30,316
B1300	Rio Iriri	19.63						4,659										4,659
B1400	Rio Suruí	84.44						22,169										22,169
B1500	Bay - Maua	17.92						13,450										13,450
B1600	Rio Saracuruna	348.88			240,685			102,213				42,317						385,215
B1700	Rio Iguaçu	716.72	433,120		368,943				106,250		740,528			263,088		285,014		2,196,943
B1800	Bay - Cabo do Brito	19.72			54,425									5				54,430
B1900	Rio Sâo Jão Meriti	154.26			106,752				47,322					1,078,793		164,215		1,397,082
B2000	Rio Irajá	50.95			60									682,068				682,128
B2100	Canal do Cunha	70.23												899,762				899,762
B2200	Bay - São Cristóvão	6.41												30,459				30,459
B2300	Canal do Mangue	37.95												440,731				440,731
B2400	Bay - Botafogo	21.68												262,642				262,642
B2500	Ilha do Governador	36.28												209,426				209,426
B2600	Ilha do Fundão	5.35												1,826				1,826
B2700	Ilha de Paquetá	2.21												3,586				3,586
B2800	Ilha do Engenho	0.98																0
B2900	Ilha de S. Cruz	1.10																0
Total of River Basins		4,024.78	433,120	46,989	770,865	37,940	187,127	205,699	153,572	400,928	740,528	42,330	33,758	3,872,386	889,828	449,229	26,001	8,290,300

Table 12 Population in Guanabara Bay Catchment Organised According to Municipality and River Basin Year 2010

ID	Name	Belford Roxo	Cachoeiras de Macacu	Duque de Caxias	Guapimirim	Itaboraí	Magé	Nilópolis	Niterói	Nova Iguaçu*	Petrópolis	Rio Bonito	Rio de Janeiro	São Gonçalo	São João de Meriti	Tanguá	Sum	Increase %
B0100	Bay - Charitas								31,989								31,989	4.68
B0200	Canal Canto do Rio								94,702								94,702	4.68
B0300	Bay - Catedrar								95,668								95,668	4.68
B0400	Bay - Norte Centro								74,704								74,704	4.68
B0500	Rio Bomba								65,424					203,816			269,240	11.47
B0600	Rio Imboaçu													178,840			178,840	13.84
B0700	Bay - Itaoca													2,935			2,935	13.84
B0800	Rio Alcantara					43,028			53,082					579,990			676,100	13.93
B0900	Rio Caceribu					195,287			4,128			37,152		47,396		28,007	311,969	21.74
B1000	Rio Guapimirim		52,863		47,109	3,829	786				6						104,593	20.14
B1100	Canal de Magé				1,359		41,650										43,009	27.50
B1200	Rio Roncador				515		38,118				7						38,641	27.46
B1300	Rio Iriri						5,938										5,938	27.44
B1400	Rio Suruí						28,253										28,253	27.44
B1500	Bay - Maua						17,141										17,141	27.44
B1600	Rio Saracuruna			276,631			130,263				44,897						451,791	17.28
B1700	Rio Iguaçu	510,595		424,045				108,031		849,146			272,337		287,880		2,452,033	11.61
B1800	Bay - Cabo do Brito			62,553									5				62,559	14.93
B1900	Rio Sâo Jão Meriti			122,695				48,115					1,116,718		165,866		1,453,394	4.03
B2000	Rio Irajá			69									706,046				706,115	3.52
B2100	Canal do Cunha												931,393				931,393	3.52
B2200	Bay - São Cristóvão												31,530				31,530	3.52
B2300	Canal do Mangue												456,225				456,225	3.52
B2400	Bay - Botafogo												271,875				271,875	3.52
B2500	Ilha do Governador												216,788				216,788	3.52
B2600	Ilha do Fundão												1,890				1,890	3.52
B2700	Ilha de Paquetá												3,712				3,712	3.52
B2800	Ilha do Engenho																0	0.00
B2900	Ilha de S. Cruz																0	0.00
SUM		510,595	52,863	885,994	48,983	242,144	262,149	156,146	419,696	849,146	44,910	37,152	4,008,519	1,012,976	453,746	28,007	9,013,026	
AAGR		1.659243	1.184855	1.4017	2.587615	2.610962	2.454639	0.166	0.458526	1.378081	0.593507	0.962544	0.3461069	1.304636	0.100091	0.74602		

Table 13 Population in Guanabara Bay Catchment Organised According to Municipality and River Basin Year 2020

ID	Name	Belford Roxo	Cachoeiras de Macacu	Duque de Caxias	Guapimirim	Itaboraí	Magé	Nilópolis	Niterói	Nova Iguaçu*	Petrópolis	Rio Bonito	Rio de Janeiro	São Gonçalo	São João de Meriti	Tanguá	Sum	Increase %
B0100	Bay - Charitas								33,686								33,686	10.23
B0200	Canal Canto do Rio								99,725								99,725	10.23
B0300	Bay - Catedrar								100,742								100,742	10.23
B0400	Bay - Norte Centro								78,666								78,666	10.23
B0500	Rio Bomba								68,894					225,843			294,737	22.03
B0600	Rio Imboaçu													198,168			198,168	26.14
B0700	Bay - Itaoca													3,252			3,252	26.14
B0800	Rio Alcantara					49,575			55,897					642,672			748,144	26.07
B0900	Rio Caceribu					224,999			4,346			40,245		52,518		30,938	353,046	37.77
B1000	Rio Guapimirim		60,843		55,883	4,412	900				7						122,045	40.19
B1100	Canal de Magé				1,613		47,696										49,309	46.17
B1200	Rio Roncador				611		43,652				8						44,271	46.03
B1300	Rio Iriri						6,800										6,800	45.94
B1400	Rio Suruí						32,354										32,354	45.94
B1500	Bay - Maua						19,629										19,629	45.94
B1600	Rio Saracuruna			312,629			149,174				46,896						508,699	32.06
B1700	Rio Iguaçu	563,739		479,225				110,337		923,768			280,858		289,756		2,647,683	20.52
B1800	Bay - Cabo do Brito			70,693									5				70,699	29.89
B1900	Rio Sâo Jão Meriti			138,662				49,142					1,151,659		166,947		1,506,410	7.83
B2000	Rio Irajá			78									728,137				728,215	6.76
B2100	Canal do Cunha												960,535				960,535	6.75
B2200	Bay - São Cristóvão												32,516				32,516	6.75
B2300	Canal do Mangue												470,500				470,500	6.75
B2400	Bay - Botafogo												280,382				280,382	6.75
B2500	Ilha do Governador												223,571				223,571	6.75
B2600	Ilha do Fundão												1,949				1,949	6.75
B2700	Ilha de Paquetá												3,828				3,828	6.75
B2800	Ilha do Engenho																0	
B2900	Ilha de S. Cruz																0	
SUM		563,739	60,843	1,001,288	58,107	278,985	300,205	159,479	441,956	923,768	46,911	40,245	4,133,941	1,122,453	456,704	30,938	9,619,561	
AAGR		1.326602	1.3003	1.316231	2.154256	2.016929	1.908238	0.188895	0.488329	1.111618	0.515055	0.882703	0.3273365	1.167988	0.082547	0.872998		

Table 14 Load Senarios Used for Simulation of Present and Future Water Quality

Scenario	BOD generated Ton/day	TN generated Ton/day	TP generated Ton/day	BOD to Bay Ton/day	TN to Bay Ton/day	TP to Bay ton/day	Population No.	Population No. with sewage treatment
Water quality in Bay relative to load								
Year 2000	474.7	93.9	22.9	275.3	72.0	18.4	8,290,200	2,058,900
Year 2000 80% BOD, 30 % TN, 50 % TP	474.7	93.9	22.9	64.9	53.8	9.8	8,290,200	-
Year 2000 90% BOD, 35 % TN, 80 % TP	474.7	93.9	22.9	36.7	50.2	4.2	8,290,200	-
Year 2000 90% BOD, 80 % TN, 80 % TP	474.7	93.9	22.9	36.7	16.8	4.2	8,290,200	-
Year 2010	520.3	103.9	25.2	300.6	78.7	20.2	9,013,000	2,165,300
Year 2010 80% BOD, 30 % TN, 50 % TP	520.3	103.9	25.2	70.0	58.5	10.7	9,013,000	-
Year 2010 90% BOD, 35 % TN, 80 % TP	520.3	103.9	25.2	52.5	67.6	5.0	9,013,000	-
Year 2020	557.8	112.0	27.1	321.1	84.0	21.6	9,619,500	2,262,100
Year 2020 90% BOD, 35 % TN, 80 % TP	557.8	112.0	27.1	41.4	58.0	4.8	9,619,500	-
PDBG1								
Year 2000 PDBG1	474.7	93.9	22.9	214.3	69.9	17.8	8,290,200	3,488,600
Year 2010 PDBG1	520.3	103.9	25.2	238.3	76.3	19.5	9,013,000	3,627,700
Year 2020 PDBG1	557.8	112.0	27.1	257.8	81.4	20.9	9,619,500	3,752,400
Feasibility study								
Year 2010 Feasibility Study	520.3	103.9	25.2	194.2	73.8	18.3	9,013,000	5,003,900
Year 2010 Feasibility Study, 90% BOD, 30% TN, 50% TP	520.3	103.9	25.2	181.3	72.9	17.2	9,013,000	5,003,900
Strategy Plan								
Year 2020 Strategy Plan	557.8	112.0	27.1	182.7	76.9	20.3	9,619,500	6,700,200
Year 2035 Strategy Plan, population year 2020	557.9	112.0	27.1	125.3	79.2	20.7	9,619,500	7,914,000
Year 2035 Strategy Plan, 90% BOD, 30% TN, 80% TP	557.9	112.0	27.1	125.3	76.0	10.8	9,619,500	7,914,000

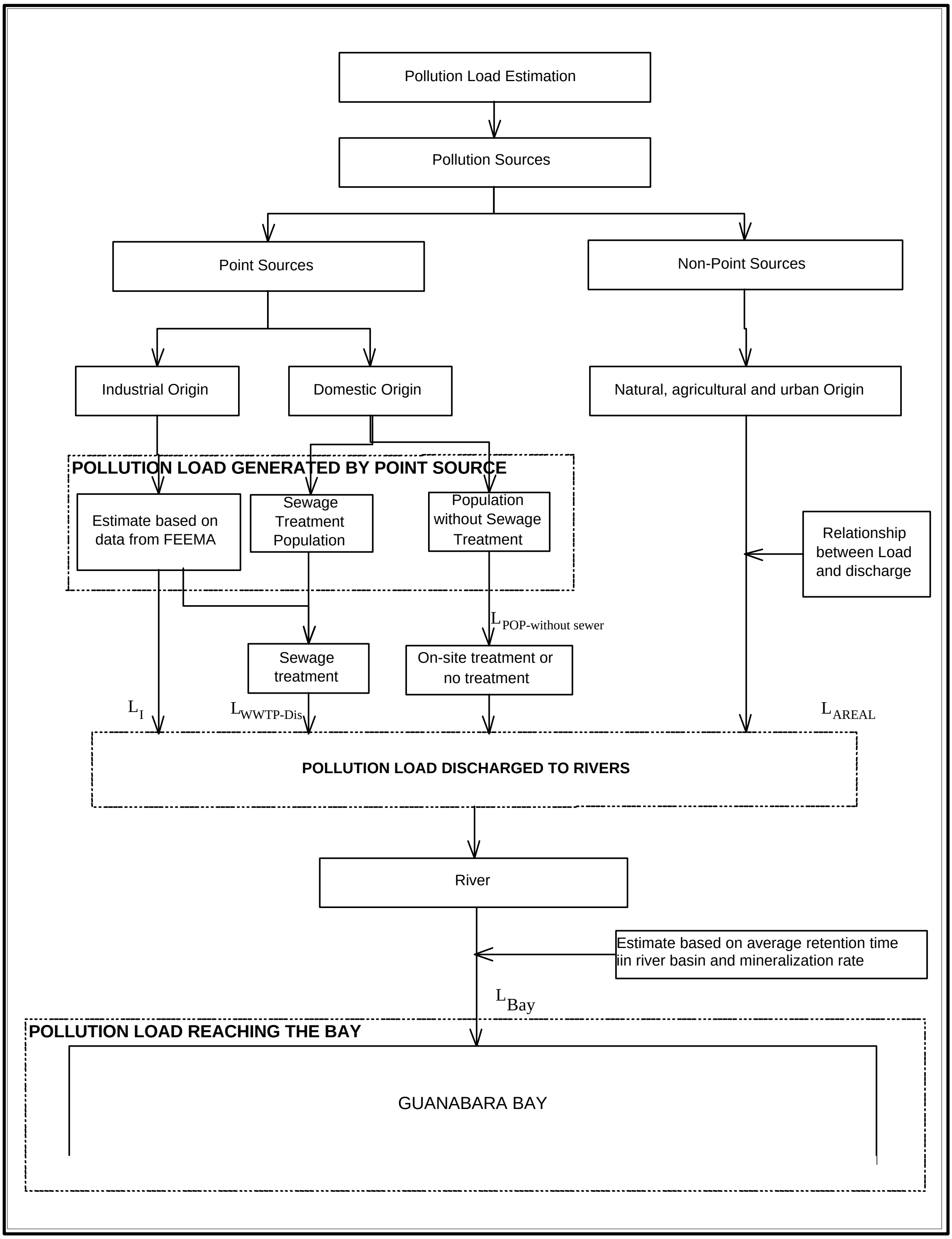

Figure 1 Pollution Load Estimate

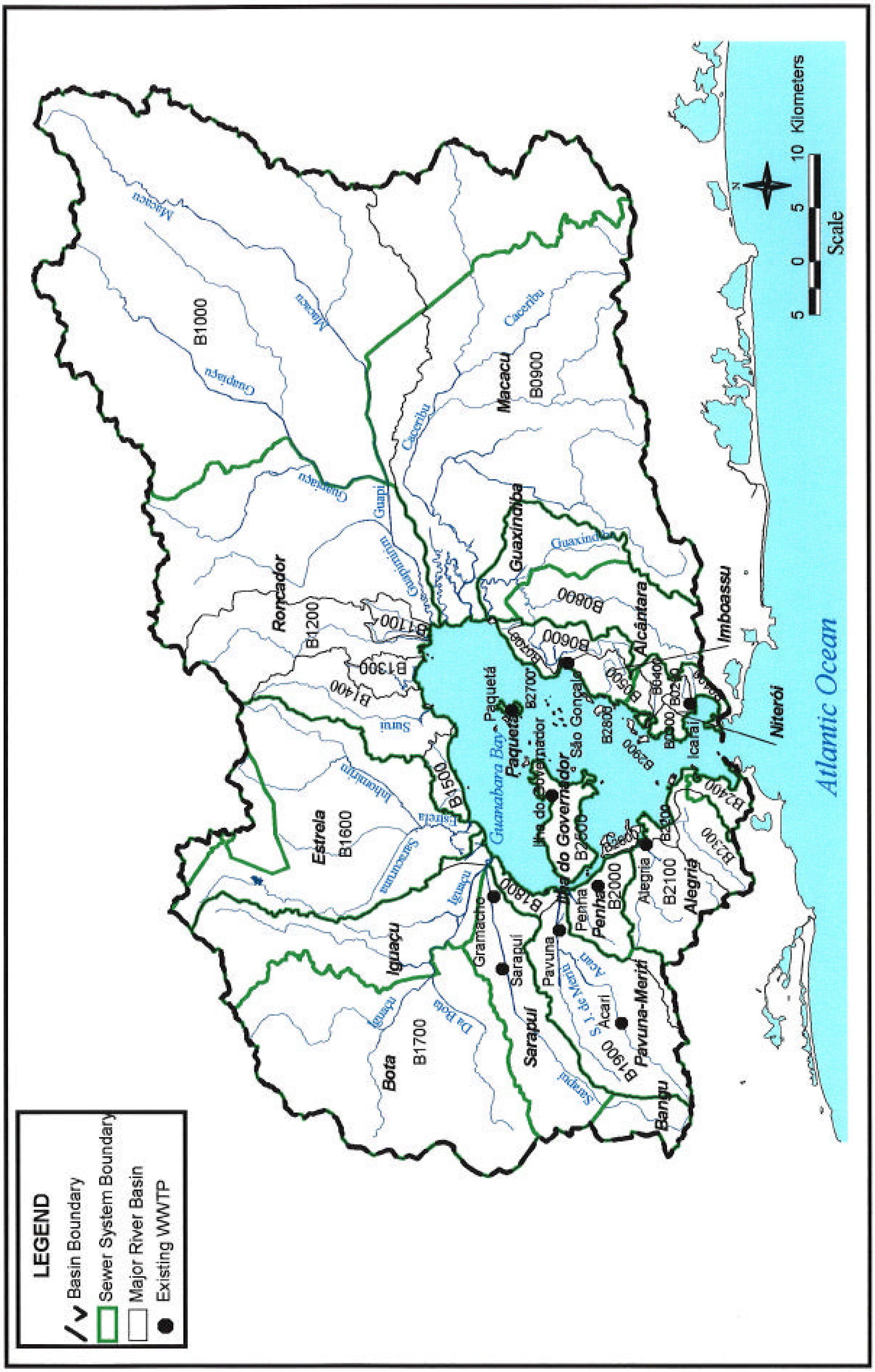

Figure 2 Boundaries of River Basin and Sewer System

References

Maria Louredes San Diego-Mclone, Stephen V. Smith, Vivian F. Nicolas. Stoichiometric Interpretations of C:N:P ratios in organic waste materials. Marine Pollution Bulletin Vol. No. 4 pp 325-330, 2000.