4.3 Objectives, Components and Executing Agency of the Master Plan

The objectives, components and executing agency of this Master Plan are as follows.

(1) Objectives

This Master Plan shows the strategies (action plan) for the restoration and conservation of the water quality and wetland ecosystem in the Mar de Dentro area.

(2) Components

This Master Plan consists of: ① water quality control plan, ② river and basin management plan, ③ wetland ecosystem conservation plan, ④ water quality and hydrological monitoring plan, ⑤ organizational structure reinforcement and information system improvement plan, and ⑥ environmental education and personnel capacity building plan. These plans were prepared based on the existing materials obtained through the study, the results of the field survey carried out thrice during the study period, and the interviews done in cooperation with the Brazilian counterparts.

(3) Executing Agency

This Master Plan is prepared assuming that the RS government will independently (technically and financially) carry out the implementation.

4.4 Target Area of the Master Plan

The plan to restore and conserve the environment of the Patos and Mirim lake areas was primarily intended to cover the entire water and basin areas. Due to the following reasons, however, the plan covers the Patos Lake and the Mar de Dentro area (L20, L30 and L40 basins established by RS State).

(1) Water quality and hydrological monitoring were not carried out for Mirim Lake since a considerable area of the lake belongs to Uruguay. Surveys did not include

the Mirim Lake basin, too. Consequently, the level of contamination in Mirim Lake and the actual conditions of pollution sources in this lake basin were hardly understood.

(2) The southern water section of the Patos Lake is mostly used for fishing and recreation (e.g. swimming). The Sao Goncalo channel connected to this lake section is being used as the Rio Grande water supply source, and is also scheduled to be developed as the water supply source of Pelotas. A very precious wetland ecosystem that should be preserved also exists in Camaqua River downstream section, the vicinity of Sao Goncalo channel, and Pequena Lagoon.

(3) As mentioned in section **4.1**, the water quality in the southern lake section borders on being mesotrophic to eutrophic, with the coastal area remarkably contaminated with human excreta. Bottom sediments from a part of this section are also contaminated with heavy metals and organic matter.

(4) As mentioned in **2.8**, contamination in the southern lake section is mostly due to non-point source pollutants that flow in through the Camaqua River and the Sao Goncalo channel, and point source pollutants discharged from municipalities along the coast. The effect of pollutants supplied from the Guaiba River basin is not significant.

(5) In addition to reasons underscored in the previous paragraph, another program called PRO-GUAIBA, which entails restoration and conservation measures, is already being implemented in the Guaiba River basin. Because of this program, Guaiba River basin was excluded from the Master Plan. However, if the load reduction measures for the Guaiba River basin are not fully implemented, eutrophic water areas will expand, possibly affecting even the central and southern water areas. This possibility accentuates the need to reconsider or review PRO-GUAIBA's sewage treatment plan and basin conservation plan, which does not take eutrophication countermeasures into account.

4.5 Target Year and Target Level of the Master Plan

4.5.1 Target Year

The extensiveness of the water and basin areas covered by this Master Plan and the current administration of the Mar de Dentro area environment suggest that the project may take at least a period of 10 years to complete (including the period allocated for planning). This span also takes into consideration the amount of time it would take to gain the mutual consensus of relevant agencies and the residents, and the establishment of a project implementation system. In addition, a longer period is considered necessary for the implementation of prevention measures for eutrophication because the pollution sources are distributed in a wide area. The results of the water quality improvement and ecosystem conservation measures will not also become immediately apparent, even after the completion of the project. It is appropriate, therefore, to establish the target year of this Master Plan at a period of about 20 years.

On the other hand, of the environmental conservation plans that are closely related to this Master Plan, the Programa Mar de Dentro, which covers the southern Patos Lake basin, consists of 4 modules and is expected to reach completion within a period of 10 to 15 years. Although the first module (assessment) commenced in 1998, the project was partly commenced in 2000. Programa Guaiba, which covers the northern Patos Lake basin, aims to have its 4 modules (phases) fully completed within a period of 20 years. Although the first module started in 1995, the project is scheduled to commence this year.

The aforementioned were taken into consideration and the target year was set at 2010 for the medium term and 2020 for the long term.

4.5.2 Target Level

(1) Desirable Water Quality Level

1) Beneficial Use of Patos Lake Waters

The following beneficial uses of water resources, i.e. rivers and lakes, will be considered:

1. Public Water Supply with Treatment System
2. Recreation
    1) Primary Contact
    2) Secondary Contact
3. Aesthetic
4. Aquatic Life Protection
    1) Natural Aquatic Life
    2) Aquatic species for Human Consumption
5. Farming Activities
    1) Irrigation of Green Vegetables
    2) Irrigation of Other Crops
    3) Animal Breeding
6. Industrial Supply
7. Navigation
8. Waste Dilution

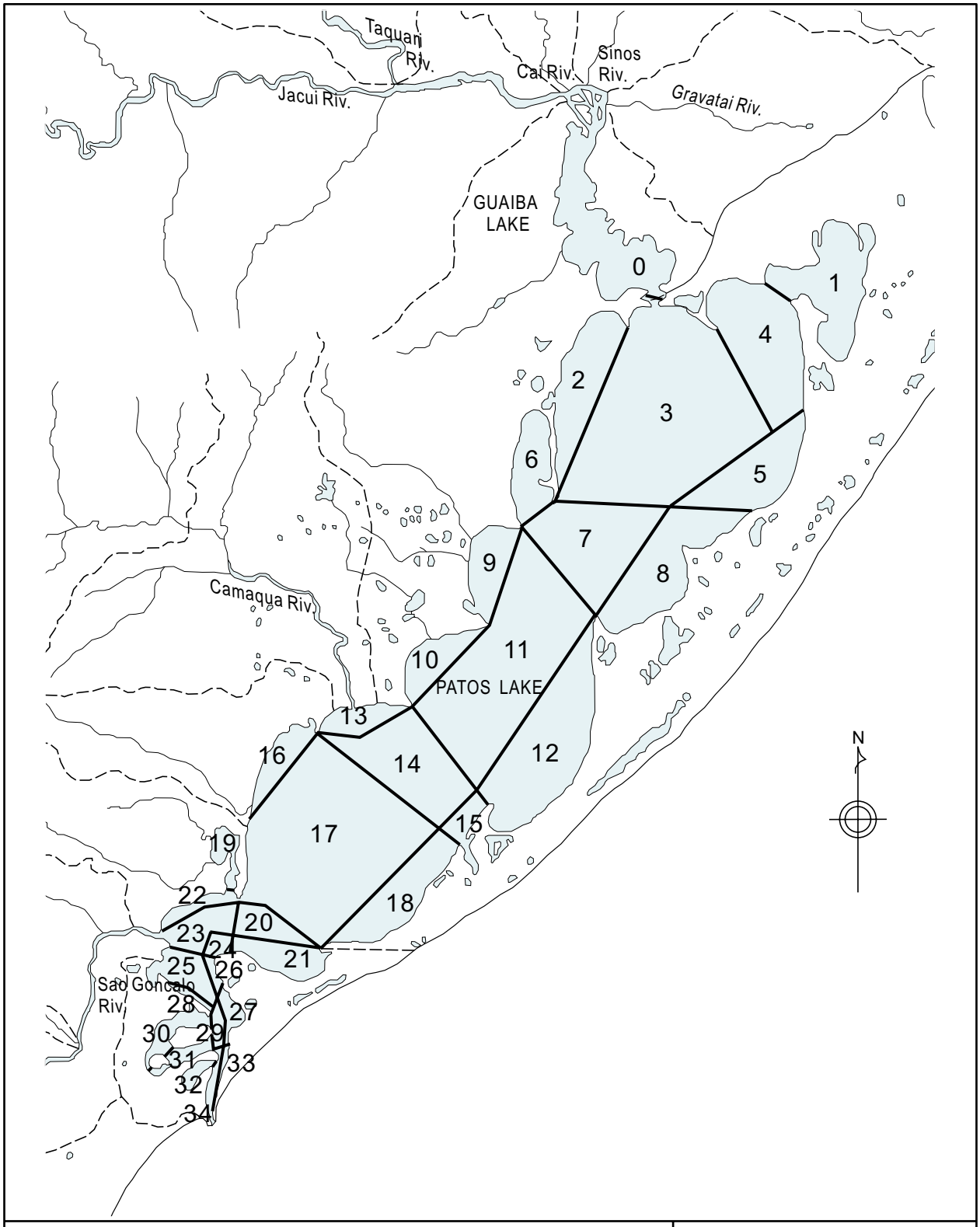
In accordance with the above, the Patos Lake area was divided into 34 water areas (**Fig. 4.5-1**)、and the present use of these areas is enumerated in **Table 4.5-1**. Except for the estuary in the southern section, there were no data available on the division and use of these water areas. These data were collected mainly through interviews.

Table 4.5-1 Classification of Patos Lake

Area No. of Patos Lake	Beneficial Uses											
	Public Water Supply	Recreation		Aesthetic	Aquatic Life Protection		Farming Activities			Industrial Supply	Navigation	Waste Dilution
		Primary Contact	Secondary Contact		Natural Aquatic Life	Species for Human Consumption	Irrigation of Green	Irrigation of Other Crops	Animal Breeding			
Area No. 0			○	○	△		△	△	△	○	○	○
Area No. 1				○	△		△	○		○		○
2				○	○							○
3				○	○	○					○	○
4				○	○		△	○				○
5				○	○		△	○				○
6		△	○	○	△		△	○		○		○
7				○	○	○					○	○
8				○	○		△	○				○
Area No. 9		○	○	○	○			△		△		○
10				○	○			△				○
11				○	○	○					○	○
12				○	○	○		△				○
13				○	○			△				○
14				○	○	○					○	○
15				○	○	○		△				○
16		○	○	○	○			△		△		○
17				○	○	○					○	○
18				○	○	○		△				○
Area No. 19				○	○	○		△				○
20				○	○						○	○
21				○	○	○		△				○
22		△	○	○	○	○		△				○
23				○	○						○	○
24				○	○	○		△				○
25				○	○						○	○
26				○	○	○		△		△		○
27				○	○	○		△		△		○
28				○	○	○						○
29				○	○					△	○	○
30				○	○	○						○
31				○	○	○						○
32				○	○	○						○
33			○	○	○	○		△				○
34				○	○					△	○	○

(Note) ○ : in use

△ : used depending on the water quality



THE STUDY ON THE ENVIRONMENTAL MANAGEMENT OF THE HYDROGRAPHIC BASIN OF PATOS AND MIRIM LAKES IN THE FEDERATIVE REPUBLIC OF BRAZIL	**Fig. 4.5-1**
JAPAN INTERNATIONAL COOPERATION AGENCY KOKUSAI KOGYO CO., LTD. / PACIFIC CONSULTANTS INTERNATIONAL	**Division of the Patos Lake Water Area**

2) Target Water Quality for the Patos Lake

This section recommends water quality environmental standards for the entire Patos Lake water area, where none exists at present, based on the aforementioned water area division and the field study results. The water quality environmental standards will be established with due consideration of the present condition and future use of the water areas, which should be finalized prior to the establishment of the water quality parameters and standards. It is necessary, therefore, that relevant agencies expedite the classification of the entire Patos Lake water area.

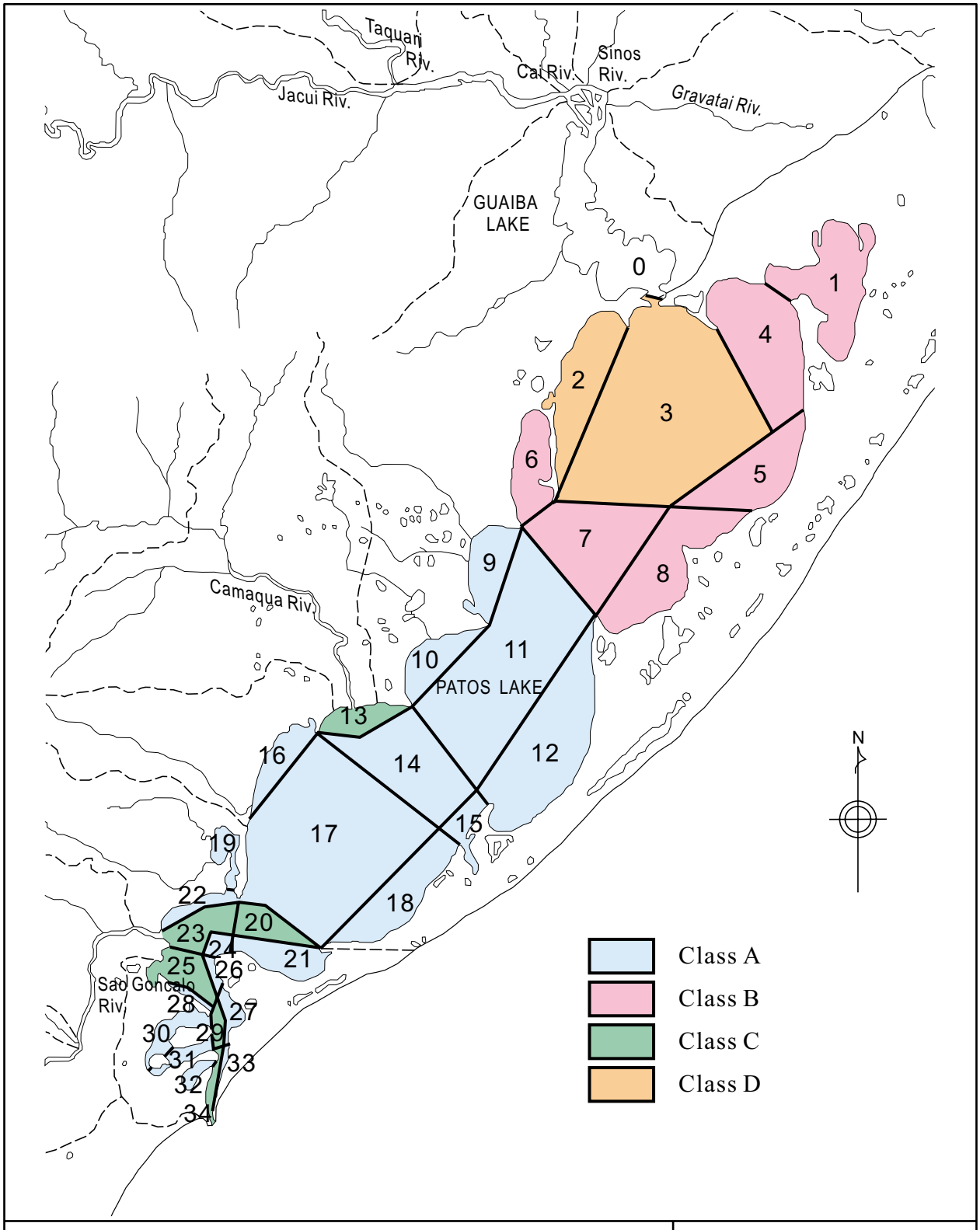
The SSMA NT No. 003/95 classified the water in the southern part of the lake estuary as brackish and categorized it into three (3) classes according to use, and the standards and conditions shown in **Table 3.2-3 and Fig. 3.2-1**. Since these standards are more stringent than those proposed herein for the same water area, their application will be given priority.

a) Proposed Water Area Classification

Based on **Table 4.5-1** and **Fig. 4.5-1**, and in consideration of the results of the water quality analysis carried out a year ago and the simulation results, the water areas were classified by use in **Table 4.5-2** in line with the CONAMA Resolution No. 30/86. On the other hand, **Fig. 4.5-2** shows the proposed classification of the water areas by use.

Table 4.5-2 Proposed Classifications and Beneficial Uses of Water Resources in Patos Lake

Class	Water Area Utilization	Remarks
A	1) Recreation (Primary contact) 2) Fishery (Natural and/or intensive breeding of species for human consumption) 3) Irrigation (Crops) 4) Aquatic Life Protection (Natural Aquatic Life) 5) Use listed in Class C	Brackish water
B	1) Recreation (Secondary contact) 2) Fishery (Natural breeding of species for human consumption) 3) Irrigation (Green vegetables) 4) Aquatic Life Protection (Natural Aquatic Life) 5) Use listed in Class D	Freshwater
C	1) Recreation (Secondary contact) 2) Fishery (Natural breeding of species for human consumption) 3) Aquatic Life Protection (Environmental conservation) 4) Navigation 5) Aesthetic 6) Industrial Water 7) Waste Dilution and Circulation	Brackish water
D	1) Aquatic Life Protection (Environmental conservation) 2) Navigation 3) Aesthetic 4) Waste Dilution and Circulation	Freshwater



THE STUDY ON THE ENVIRONMENTAL MANAGEMENT OF THE HYDROGRAPHIC BASIN OF PATOS AND MIRIM LAKES IN THE FEDERATIVE REPUBLIC OF BRAZIL	**Fig. 4.5-2**
JAPAN INTERNATIONAL COOPERATION AGENCY KOKUSAI KOGYO CO., LTD. / PACIFIC CONSULTANTS INTERNATIONAL	**Proposed Water Area Classification in Patos Lake**

b) Water Quality Indices

There are various water quality indices, but the CONAMA Resolution No. 20/86 designates the adoption of the following for water quality standards for living environment.

Freshwater: pH, BOD, TDS, DO, Number of Coliform Groups, Turbidity

Saltwater: pH, BOD, DO, Number of Coliform Groups

Brackish water: pH, BOD, DO, Number of Coliform Groups

The main indices to determine the Patos Lake water quality standard for living environment are 7 in total as proposed in the water quality parameter (principal index) of **Table 4.5-3**, in addition to COD(Cr) for organic pollutants and T-N & T-P for eutrophication, and basically those stipulated in the CONAMA Resolution No.20.

The following are also proposed as supplementary indices as they are easy to measure and observe: transparency, turbidity, oil film, floatage, color, odor, and biotic community. For biotic community, suitable indices that are sensitive to changes in water quality should be determined later on.

Table 4.5-3 Proposed Monitoring Indices for Water Quality (related to the Living Environment)

Item	Monitoring Indices
Water Quality Parameter (Principal Index)	pH, BOD, COD(Cr), DO, T-N, T-P, No. of Coliform Groups (fecal)
Environmental Management Index (Supplementary Index)	Transparency, Turbidity Oil film, Floatage Color, Odor Biotic community

c) Target Water Quality

A lot of studies are required before the target water quality for each beneficial use is scientifically established. Regarding the principal indices of water quality, the following information on water levels corresponding to the use of the water area concerned were obtained.

1. Biochemical Oxygen Demand (BOD)

2.5 mg/l or less:	Oligotrophic water area
2.5 mg/l – 5.0 mg/l:	Eutrophic water area
5.0 mg/l – 10 mg/l:	Polyeutrophic water area
10 mg/l or more:	Saprobic water area

2. Chemical Oxygen Demand (COD)

4 mg/l or less ($COD_{(Mn)}$), 18 mg/l or less ($COD_{(Cr)}$):

for natural breeding ground of aquatic animals

5 mg/l or less ($COD_{(Mn)}$), 23 mg/l or less ($COD_{(Cr)}$):

for the growth of aquatic animals

* The values in $COD_{(Cr)}$ were estimated by survey results as follows:

$$COD_{(Cr)} = 4.5 \times COD_{(Mn)}$$

3. Dissolved Oxygen (DO)

4.3 mg/l or more:	Most desirable environment for aquatic lives including benthic fish and shellfish.
4.3 mg/l – 3.6 mg/l:	Environment where shellfish can live.
3.6 mg/l – 2.1 mg/l:	Environment where benthic fish can live.
2.1 mg/l – 1.4 mg/l:	Environment where Polychaeta, etc. can live.

4. Total Nitrogen (T-N), Total Phosphorus (T-P)

0.2 mg/l or less (T-N), 0.02 mg/l or less (T-P):

Desirable level for the preservation of the natural environment.

0.3 mg/l or less (T-N), 0.03 mg/l or less (T-P):

Most desirable environment for aquatic life including benthic fish and shellfish.

0.3 mg/l – 0.6 mg/l (T-N), 0.03 mg/l – 0.05 mg/l (T-P):

Undesirable environment for some benthic fish and shellfish.

0.6 mg/l – 1.0 mg/l (T-N), 0.05 mg/l– 0.09 mg/l (T-P):

Undesirable environment for most benthic fish and shellfish.

1.0 mg/l or more (T-N), 0.09 mg/l or more (T-P):

Undesirable environment for aquatic life.

5. Number of Coliform Groups (Fecal Coliform)

250 MPN/100ml or less : Water quality standard for recreation (primary contact) of CONAMA 20

500 MPN/100ml or less : Water quality standard for recreation (secondary contact) of CONAMA 20

1000 MPN/100ml or more : Undesirable environment for aquatic life

The target water quality for Patos Lake is proposed as shown in **Table 4.5-4**, and based on the scientifically established data and the observed water quality conditions. The table shows the target water quality in terms of principle indices and supplementary indices.

It should be noted that the target water quality in this master plan represent the values at the surface—where conditions are generally far worse than the bottom layer—for all indices except Dissolved Oxygen (DO). But with respect to Dissolved Oxygen (DO), the value will represent conditions in the bottom layer where this property strongly

affects benthic fish and shellfish.

When 75% of values observed at a certain period at a monitoring point meet the target water quality, this point will be considered to have met the target water quality at the time of observation.

Although the water quality standards proposed in **Table 4.5-4** represent the water quality targeted for living environment, the aforecited CONAMA Resolution 20 (**Table 3.2-2**) and the SSMA NT No. 003 (**Table 3.2-4**) will be referred to for the standards for harmful substances.

As opposed to **Table 4.5-2** and **Fig. 4.5-2**, a *Special Class* was established and shown in **Table 4.5-4** along with the proposed target water quality. Together with the water quality division in **Fig. 4.5-2** and the designation by type, the target proposed is only for the medium term. For the long term, the target value should be more stringent than this, to wit, *Special Class* and Class A are respectively proposed, for the long term, to substitute Class A and Class C water quality targets for the medium term for brackish water areas.

Table 4.5-4 Targets for Patos Lake Water Quality (related to the Living Environment)

Principal Index

Class	pH	Biochemical Oxygen Demand (BOD)	Chemical Oxygen Demand (COD(Cr))	Dissolved Oxygen (DO)	Total Nitrogen (T-N)	Total Phosphorus (T-P)	No. of Coliform Groups (Fecal)
Special	6.5 | 8.5	3 mg/l or less	10 mg/l or less	6.0 mg/l or more	0.2 mg/l or less	0.02mg/l or less	250 MPN /100ml or less
A	6.5 | 8.5	5 mg/l or less	20 mg/l or less	5.0 mg/l or more	0.3 mg/l or less	0.03mg/l or less	1000 MPN /100ml or less
B	6.0 | 9.0	10 mg/l or less	30 mg/l or less	4.0 mg/l or more	0.6 mg/l or less	0.05mg/l or less	1000 MPN /100ml or less
C	5.0 | 9.0	10 mg/l or less	30 mg/l or less	3.0 mg/l or more	0.6 mg/l or less	0.05mg/l or less	1000 MPN /100ml or less
D	6.0 | 9.0	—	—	2.0 mg/l or more	1.0 mg/l or less	0.09mg/l or less	4000 MPN /100ml or less

[Note] 1. Values given in DO are target values in bottom layers.

2. With regard to the Number of Coliform Groups for Recreation (primary contact),Fecal Coliforms shall be less than 250 MPN/100ml.

3. With regard to the Number of Coliform Groups for Recreation (secondary contact),Fecal Coliforms shall be less than 500 MPN/100ml.

Supplementary Index

Class	Trans-parency	Turbidity	Oil Film	Floatage	Color	Odor	Biotic Community
Special	4 m or more	10 NTU	Not observed	Not observed	Greenish (not Brownish)	Not smelt	Diverse species
A	3 m or more	25 NTU	Not observed	Not observed	Greenish (not Brownish)	Not smelt	Diverse species
B	2 m or more	50 NTU	Not observed	Not observed	—	Not smelt	Existence of benthonic organisms
C	2 m or more	50 NTU	Not commonly observed	Not commonly observed	—	Not smelt	Existence of benthonic organisms
D	1 m or more	100 NTU	—	—	—	—	—

(2) Target Level of the Master Plan

1) Contamination by Human Excreta

The safety standard for the level of contamination by human excreta is set according to the fecal coliform standard provided in the CONAMA Resolution No.20. Residents and administrative agencies strongly desire the solution of this contamination problem since it makes urban rivers and channels unclean and directly harms public health through contact with water (e.g. recreation) and the consumption of fish and shellfish. The treatment of contamination by human excreta only requires a short period if the domestic wastewater from the urban area near the lake shore is adequately treated – this would prevent organic contamination and eutrophication. Accordingly, the year targeted to attain the acceptable level of human excreta in the water is set at 2010, considering that this is the most urgent among the various water environmental problems and the countermeasures will not take long to take effect.

2) Eutrophication

The safety standard for the level of eutrophication has not yet been established except for the upper limit of TP in fresh water areas categorized as Class 1, 2, 3 in CONAMA No.20. Therefore, in order to establish an appropriate target level, consideration should be paid to the water quality level that would hamper water use, present and future use of water areas, feasible countermeasures, etc.

Vollenweider (1984) says that the probability of water bloom outbreak becomes high when eutrophic level (TP and Chl-a in annual average are >0.035mg/l and >8mg/l respectively) is attained. In Patos Lake, TP concentration is over 0.035mg/l (annual average) in a wide area, while Chl-a was over 8mg/l in a limited area. TP concentration is expected to reach an annual average of around 0.05mg/l the same year water blooms often hinder water use.

Based on the above mentioned consideration, the target water quality level is set at TP<0.05mg/l for the southern lake area where conservation of shrimp fishery is an important theme, TP<0.03mg/l for the eastern part of the central area where the present water quality level should be maintained in view of ecosystem conservation, and TP<0.1mg for other areas.

Though the prevention of eutrophication is important in view of the multi-purpose and sustainable use of the lake water, it takes a while to attain since countermeasures have to cover extensive areas to reduce non-point source pollutants which make up more than 70% of the total runoff load. Thus the target year to solve eutrophication is set at 2020.

3) Soil Erosion

As of now, it is difficult to define the target level and target year for soil runoff due to the absence of adequate index for soil runoff and the ambiguity in the quantitative relation between soil runoff into the Patos Lake and the factors that hinder the use of the lake. However, any progress in the implementation of the countermeasures for non-point sources will not only prevent eutrophication but also soil runoff to a certain extent.

4) Organic Contamination

The standard level of organic contamination is set according to the BOD and DO standards stipulated in CONAMA Resolution No.20. The present contamination level of some small inlets is not known since these areas were not monitored in this study. Therefore, it is difficult to discuss the scale of the countermeasures at present. However, because the areas requiring countermeasures for organic pollution almost coincide with the areas requiring countermeasures for human excreta, and since both areas share to a certain extent common causal factors, the target year for the latter set of countermeasures was adopted as well (i.e. 2010).

5) Contamination of Agricultural Chemicals

The safety standard for the concentration of agricultural chemicals in water is stipulated in CONAMA Resolution No.20. The rule, however, is not in keeping with actual conditions, especially since many new agricultural chemicals have been used after the rule was passed. A new standard should be defined, therefore, using the guidelines of international agencies (e.g. WHO, EPA of USA) as reference. Further, the level of contamination by agricultural chemicals was not fully determined because only a few samples were analyzed in this study. Therefore, the safety standard for the level of

agricultural chemicals defined in CONAMA Resolution No.20 should be reexamined and further monitoring should be carried out prior to establishing the target level permissible for contamination by agricultural chemicals and the target year to attain this level.

6) Heavy Metals and Harmful Substances

Though the safety standard for the level of heavy metals and harmful substances in the water are defined in CONAMA Resolution No.20, careful monitoring and an inventory survey of generation sources should be carried out to confirm the contamination level and the generation sources before setting the target year. Further, the safety standard for the level of heavy metals and harmful substances in bottom sediments – which Brazil lacks – should be defined, too, using international guidelines as reference.

7) Wetland ecosystems

The conservation of the wetland ecosystem in the Patos and Mirim lake areas requires that the state residents understand the value of wetlands. Activities that promote wetland ecosystem conservation will be used as parameters to attain the target level for wetland ecosystem conservation. To be specific, the completion of a training program for the staff of government institutions, schools, environmental NGOs, which will be in charge of making the residents understand the value of wetlands, will be the medium term goal. For a long term goal, the study aims to have at least one member/household in the study area visit the wetlands.

In the absence of legally established parameters for the direct evaluation of the wetland ecosystem conservation level, biodiversity (no. of species), wetland area, and water level will be used. Wetlands were categorized into “important wetlands” and “other wetlands”. For the former, maintaining the parameters would be the medium term goal, while their recovery and maintenance are the long term goal for the latter.

Important wetlands herein refer to those with a highly bio-diversified ecosystem that is also in the danger of being easily destroyed by manmade activities. Examples of such wetlands are: Del Rey Wetland, Rio Camaqua Riverine Forest & Parque Estadual do Camaqua, Lagoa Pequena, Barra Falsa Wetland, Canal de Sao Goncalo, Lagoa Formosa,

Rio Piratini.

The results of the above-mentioned surveys are summarized in **Table 4.5-5**.

Table 4.5-5 Master Plan Target Year and Target Level

Target Level / Target Year	Water Quality	Wetland Ecosystem
Targets for the Medium Term (2010)	**Solving contamination by human excreta** To attain the no. of fecal coliform groups (annual average) designated by water section A Class: less than 1,000MPN/100ml B Class: less than 1,000MPN/100ml C Class: less than 1,000MPN/100ml D Class: less than 4,000MPN/100ml For water areas used for recreation, however, the following should be attained during the peak season Less than 250MPN/100ml (primary) Less than 500MPN/100ml (secondary)	**1. Promote understanding of the value of wetlands** ・ Training of the staff of government agencies, schools, environmental NGOs. ・ Attain the target number of users of the visitor center **2. Conservation of significant wetlands** (Del Rey wetland, Camaqua riverine forest, Pequena Lake, S. Goncalo canal) ・ Maintain bio-diversity (number of species) ・ Maintain wetland area and water level
Targets for the Long Term (2020)	**Solving problems concerning eutrophication and soil runoff** To attain the TP level (annual average) established for every water section. A Class: less than 0.03mg/l B Class: less than 0.05mg/l C Class: less than 0.05mg/l For the majority of the northern water section, B class will be applied, while A class will be applied for the majority of the central and eastern water sections, and C class will be designated for the most part of the southern water section.	**1. Promote understanding of the value of wetlands** Have at least 1 member of every household in the study area visit the wetlands. **2. Preservation and recuperation of other wetlands** Restoration and preservation of essential vegetation.