(3) Outline of the measures

The areas where the ocean outfall system, as is being proposed as on alternative measure, is being applied to are Sub-basins 1 - 7, 19 - 24, which are comparatively close to the mouth of the Bay. However, some specialists say that Sub-basin 6, 7, 19 should not be included since these sub-basins are too far from the bay mouth.

According to the CEDAE project, three sewage treatment plants will be constructed in addition to the three sewage treatment plants already in operation carrying out secondary treatment and the majority of the wastewater collected is proposed to undergo secondary treatment.

With the ocean outfall system, the three sewage treatment plants proposed are only needed to perform primary treatment and the treated water is then to be discharged offshore via sewage pipes.

The sewer pipes to extend out to sea shall be laid underground (or in a tunnel method) rather than the current structure of having been laid over the seabed; and the diffusers should be located at a place sufficiently far from the coast where the depth of water is deep enough to avoid pollution along the coast. **Fig. 16.7-1** shows one of the ideas for the route of the sewage pipeline and the location of the diffuser.

Since seven cities in Brazil already operate ocean outfall systems, the technical level should be high enough to cope with this proposed measure.

What is most important is to limit the drainable pollutants to biologically decomposable organic substances, nutrient salts and pathogenic bacteria, and to have other suspended solids, heavy metals and organic substances that are difficult to biologically decompose removed at the point of pollution or at the primary treatment site thus preserving the environment of the open sea.

(4) Issues of the Feasibility Study

- Selection of districts

- Investigation of the social environment (population served and quantities of various loads)

- Investigation of the natural environment (rainfall intensity, flow rate of rivers during the rainy season, geology along the sewer route, ocean weather, wave and current characteristics, drift sand and life within it, simulation of movement and diffusion of pollutants, etc.)

- Evaluation of environmental influences (especially influences to the ecosystem in the sea area)

- Surveys of the related laws and regulations (elimination of industrial wastewater from the sewer pipes and laws concerning the sea)

- Study of the characteristics of sewer pipes and diffusers

- Stud of construction methods

- Estimation of construction costs

- Economic evaluation of the project

18.2 Planning of the Stabilization Pond System

(1) Grounds for the proposition

The ocean outfall system, described in Clause 18.1, is an effective way of reducing the load flowing into the Bay but for districts away from the mouth of the Bay, the system instead becomes disadvantageous owing to the much longer length of sewers required. Therefore, wastewater from these districts should be properly treated before being discharged into the Bay.

In these areas, we would in such a case suggest the application of a multicellular stabilization pond system because the reduction rate of organic matter and nutrient salts is higher than that of ordinary secondary treatment systems plus construction and maintenance costs are lower.

(2) Outline of the measures

The Iguacu River basin and Sarapui River basin (Sub-basin No. 17) have a high runoff load from domestic and industrial sources and are designated as influential areas but since they are located beyond the north-eastern innermost shore of the Bay, it becomes disadvantageous to apply the ocean outfall system here.

Under the CEDAE program, wastewater from the basins of these two rivers is planned to be treated by the Sarapui Sewage Treatment Plant, expected to be constructed by the year 2000 (secondary treatment from 2007) and by the additional three sewage treatment plants scheduled to be constructed by 2007, but the beneficial population of Sarapui Sewage Treatment Plant will be about 35 % of the total population of Sub-basin No. 17-6 in 2007. The sewage from the Rio Ignacu basin will not be treated until 2007.

We therefore would like to propose the construction of large-scaled stabilization treatment ponds in the undeveloped low and swamp area widely remaining in the basins of the two rivers.

Since treated water coming out from these stabilization ponds usually exhibits a lower coliform bacteria content, it can be used for irrigation. If farmland is available or can be developed in the peripheral areas of these ponds, treated water is usable for irrigation and the productivity of the land will increase. Species of crops for farming should include, as a promising one,

sugar cane which is much in demand in Brazil as a material for making alcohol. Also, since the last pond among the ponds of 6-stages usually tends to have a high zooplankton content, it could be used for farming fish. The stabilization pond system not only works as an effective measure for wastewater treatment, it also provides employment and income from the availability of irrigation water and the fish farming, thus the advantages of this system are many.

(3) Issues of the Feasibility Study

- Selection of the districts
- Selection of construction sites
- Investigation of the natural environment (characteristics of rainfall, flow rate of rivers, properties of soil, etc.)
- Selection of irrigation method and associated facilities
- Evaluation of environmental influences (especially possibilities of the generation of offensive odors and noxious insects)
- Maintenance and supervisory organization (feasibility of commercializing the work)
- Studies of harvesting the sugar cane crops and establishing a sales system.
- Study of construction methods
- Estimation of construction costs (including land price investigations)
- Economic evaluation of the project

18.3 Collection System of Wastewater and Solid Waste in Favela

(1) Grounds for the proposition

Among the influential Sub-basin Nos. 20, 21 and 23, in particular have a large favela population. Most of the favelas are located on steep slopes or along riversides, and owing to lack of lavatories and sewers, domestic wastewater drains out directly into the rivers without treatment. Also, due to the narrow alleyways and streets, the solid waste collection rate is low and portions of accumulated solid wastes flow out with the rain and cause pollution of the water bodies.

It therefore is very important to develop and implement a system to collect wastewater and solid wastes from the favela districts where the waste collection program is poor, not only for the improvement of water quality but also for the improvement of hygiene in the favelas.

COMLURB is currently working actively to improve the waste collection rate in the favelas but the collection rate still remains at around 40%. CEDAE is aiming to collect 70% of the wastewater from favelas by the year 2000 and 90% by 2007 under "Projeto Ambinete Rio", but specific plans have not yet been disclosed.

Although we are as yet unable to suggest particular programs for effective measures, we thought that technical and financial aid is needed to advance the projects having been prepared by COMLURB and CEDAE and this is the reason why we have made this proposition.

(2) Outline of the measure

It is difficult to establish individual treatment systems or sewage works in the favelas, where the inhabitants' incomes are very low and space is limited. However, measures deemed suitable and necessary to improve the sanitary conditions include the collection and disposal of human waste from public lavatories, and the gathering of non-point source pollutants such as domestic sewage and uncollected solid wastes at designated points via open stormwater channels and to eliminate these pollutants by facilities that are relatively simple in their structure and require low operating energy e.g. the swirl separation tank.

Presently, household solid waste being generated in inadequate accessed favelas located on steep slopes are being brought down to the foot by means devised by COLURB such as open ducts, cable ways, agricultural tractors and donkeys. Also, in some areas favela inhabitants are participating in the waste collection work thus helping to increase employment. Since this kind of a system suits the geographical and social conditions of the favelas, it is recommended to develop a more convenient collecting means and to promote the more systematic participation of inhabitants.

Together with the aforementioned measures, education and public relations activities are required to improve resident attitudes, such as, promoting the fact that a sanitary environment brings significant benefits to the residents themselves and that the residents themselves must share a portion of expenses in order to improve the sanitary conditions.

18.4 Joint Treatment System for Industrial Wastewater

(1) Grounds for the proposition

Many sources of industrial wastes and pollution are located around the basin of Guanabara Bay and the majority of these factories are not equipped with wastewater disposal facilities, or even when they are most of the facilities do not function properly draining a lot of the pollutants into the rivers and the Bay. Moreover, most of such factories are of small to medium size lacking the financial capabilities for building or improving wastewater disposal facilities by themselves.

But the Rio de Janeiro State Government established a target that 70 % of the current effluent organic substances (BOD) derived from industrial pollution sources should be reduced under the act DZ205-R5 in 1991.

Moreover, IDB is also demanding a reduction by 90% of the current industrial effluent load by the year 2000 as the condition for financing the second phase of "Projeto Ambiente Rio". The Rio de Janeiro state Government therefore has to reduce the industrial effluent load for legal and political reasons.

Basic methods for lessening industrial effluent loads include <1> closing down plants with excessive effluent loads, <2> reduc-

ing effluent loads by improvements in production processes and <3> installation or improvement of wastewater treatment facilities. In certain areas of the Guanabara Bay basin, plants of the same industry are located in close proximity to each other. The common treatment requirements of these plants should also be examined as a possible method to save resources and to improve results.

(2) Outline of the measures

In the Guanabara Bay basin, food processing plants are gathered in Sub-basin No. 5, chemical plants in No. 17-1 and food processing and chemical plants in No. 24. In case of chemical plants, however, since wastewater quality differs greatly depending on the types of products and processes, joint treatment is not always advantageous. While the food processing plants gathered in Sub-basin No. 5 are marine product processing plants, wastewater quality is very much alike so joint treatment would be effective.

The key points of this measure should be the separation of animal oil constituents and removal of the high organic constituents.

(3) Issues of the Feasibility Study

- Selection of the districts and industrial categories
- Investigation of wastewater discharge and water quality of the wastewater from subject factories
- Investigation of the production processes (studying the possibility of reducting wastewater generation)
- Designing treatment systems and the selection and evaluation of individual treatment systems
- Studying administration and financing methods of the treatment center
- Economic evaluation of the project

18.5 Planning of the Load Reduction System in Freshet Time by Retardation Ponds and Swirl Separation Tanks

(1) Grounds for the proposition

A lot of waste is flowing or is being dumped into the urban rivers in the Guanabara Bay basin causing the deterioration of the water quality.

These wastes flow out into the Bay when the rivers overflow or swell and are a main cause of the deterioration of the seawater quality in the Bay, and also ruin the natural beauty of the sea and the beaches. Eventually these wastes accumulate on the sea-bed, generating offensive odors and decreasing the depth of the Bay thus affecting the harbor's functions.

On the other hand, since medium and small scale rivers flowing through the City of Rio de Janeiro have steep grades and as they are all tidal rivers, they tend to flood after heavy rainfalls causing inundation and damage frequently.

The rising of the river beds and the decreasing flow capacity of the drainage canals due to accumulated wastes, and the destruction of forests upstream near the favelas are helping increase the flood damage.

Aiming at increasing the runoff speed as a protective measure against flood, SELRA and the City of Rio de Janeiro are currently working to straighten the river channels and dredging downstream. Nevertheless, a measure to temporarily retain the river water to reduce the peak flow rate for the purpose of preventing floods and reducing the loads due to first-flush is worth examining.

(2) Outline of the measures

It becomes necessary to construct a storage reservoir (water retention pond) of a certain capacity to reduce the peak flow rate during freshet time. Since the capacity of such a storage reservoir depends on the flow rate of a river during freshet time, a vast site is necessary if the flow rate is very high.

Out of the rivers flowing through the city of Rio de Janeiro and its vicinity, those which exhibit low water quality during

freshet time and which tend to frequently flood include: the Rio Iguacu and its branches, the Rio Sarapui, the Rio Meriti and its branches and the Rio Faria-Timbo. In the basins of the Rio Iguacu and Rio Sarapui, in particular, undeveloped land still exists in many areas and, in their lower reaches, the vast Fluminense low lands exist. Constructing water retention ponds in these undeveloped areas would work to decrease the peak flow rate during freshet time and remove pollutants. The excess flow volume during freshet time in the Rio Meriti can be retained in a facility which is to be constructed in the Fluminense low lands.

Unused land along rivers large enough to construct storage reservoirs is not available in the city of Rio de Janeiro but the flow rate of these rivers is not as large and storage facilities such as swirl separation tanks constructed at each branch would work effectively.

(3) Issues of the Feasibility Study

- Selection of suitable sites for the construction of retardation ponds and routing of drainage canals
- Observation of the weather and the rivers (rainfall intensity, flow rate, water quality, etc.)
- Studying the load reduction effects
- Studying the methods of removal and disposal of floating wastes and accumulated deposits.
- Evaluation of environmental influences
- Studying the construction methods
- Estimation of construction, maintenance and supervisory costs
- Economic evaluation of the project

18.6 Planning for the Water Quality Improvement of Jurujuba and Botafogo Bays

(1) Grounds for the proposal

Although the smaller bays including Botafogo Bay and Gloria Bay with the Flamengo Beach of Rio de Janeiro between them and the Jurujuba Bay of Niteroi are as yet unable to provide satisfactory social and economic benefits, owing to the contamination of their water and bottom sediments, although the demand for various uses is high.

To improve the environment of the small bays with the aim of gaining social and economic benefits from them and in turn help in the attainment of a portion of funds needed to improve the environs of other water areas, we would like to propose the following measures.

(2) Outline of the measures

The small bays inside Guanabara Bay are of closed configuration and the seawater exchange in these bays is very low. The situation is made worse by the domestic wastewater and industrial wastewater directly draining into these bays through storm water drains and small rivers thus seriously deteriorating the water and sediment quality.

However, since the area of basins adjacent to these small bays is relatively small and the number of outlets for wastewater and of industrial sources of pollution are limited, taking necessary measures to reduce the flow load is relatively easy. Also, since all these bays are located near the mouth of Guanabara Bay where the water quality is relatively good, the water quality of these bays themselves should be improved in a comparatively short period of time if the flow-in load is lightened and seawater exchange is activated. Also, the removal of deposits accumulating on the bottom of these small bays would greatly improve the water quality in them.

Under these circumstances, we consider it enough to just implement measures to deal with the generating sources of pollutants and wastes, measures to cope with problems in the rivers and channels flowing into these bays and the removal of deposits from the bottom of these bays.

(3) Issues of the Feasibility Study

- Investigation of social circumstances (population of target basins, status of land utilization etc.)
- Investigation of the natural environment (rainfall intensity, flow rate and water quality of rivers and stormwater drains, etc.)
- Finding out the current status of industrial pollution sources and investigation of their load
- Investigation of currents and water flow inside the bays
- Research into effective measures to activate seawater exchange in these bays
- Finding out the volume of accumulated deposits
- Studying dredging methods
- Estimation of costs
- Economic evaluation of the project

18.7 Planning for Widening and Dredging of the Channel West of Governador and Fundao Islands

(1) Grounds for the proposition

Water channels to the west of Governador and Fundao are currently the worst water areas in the Guanabara Bay from a hygienic viewpoint owing to resident sewage and the accumulation of waste. The first impressions of many visiting travelers heading for the urban areas from the international airport are affected by the offensive odors along the highway. This is because a large volume of pollutants coming out of the Rio Meriti and the Rio Iraja flows in through the north of these channels and stagnates after being conveyed into the narrow channels by the tidal current.

Currently, the width of the water channel is 1km at the widest and only 200m at the narrowest section, and the maximum water depth is about 3m. Consequently, water flow inside the channel is complex and water is apt to stagnate at many points and pollutants are easily deposited.

As explained in Clause 16.7, if this water channel is widened and deepened, not only will extremely polluted water and sediments in the water channel be improved, but the overall seawater exchange in the Bay can also be activated to improve the ecosystem. Also, it has already been proved that the release of pollutants from the bottom deposits is badly influencing the water quality of the Bay.

We therefore would like to propose measures to increase the width of the water channel and to dredge pollution deposits accumulating on its bed and on the bottom of neighboring sea areas.

However, since such a measure usually cannot maintain its effectiveness unless the inflow loads are suppressed by adoption of the necessary measures along the river, its execution timing should be carefully selected.

(2) Outline of the measures

In Clause 16.7, we discussed the extent of improvements in the flowing status and water quality expected from measures on the assumption of the width of the water channel was +500m at the minimum and the depth was 5m. However, when planning an actual project, it is necessary to carry out more detailed tidal current observations and sediment surveys, and pollution simulation based on results of these observations and surveys. Also, when changing the sectional shape of a water channel, the land utilization status along the channel and the opinions of channel supervisors must be thoroughly considered in the planning.

(3) Issues of the Feasibility Study

- Measuring the depth throughout the length of the channel
- Investigation of deposits throughout the length of the channel (thickness distribution, soil mechanics and degree of pollution)

- Investigation of land utilization and existing facilities along the water channel

- Design of the channel

- Expected influences to flow status, deposit quality and existing facilities of widening and deepening of the channel

- Studying dredging methods

- Estimating the quantity of deposits and mud to be dredged

- Studying the disposal of dredged deposits and mud

18.8 Planning for Land Use in the Potentially Critical Sub-Basins

(1) Grounds for the proposition

Although the runoff load from potentially critical sub-basins is not at present as large as from the influential sub-basins; increases in the population, expansion of urban areas and the lessening of forest acreage are serious concerns today and destructive influences on the environment of the downstream water areas are feared. In order to prevent the critical sub-basins from becoming influential sub-basins, it is essential to establish land utilization programs, location restrictions, designation of environmental preservation areas to effectively reduce the generation and discharge of pollutants as early as possible.

However, the municipalities in the Guanabara Bay basin have not yet drafted or planned clear-cut development projects or land utilization programs, with the only exception being the City of Rio de Janeiro. Therefore, we would like to propose drafting, at the very least, land utilization programs for these critical sub-basins.

(2) Outline of the measures

The land utilization projects of the potentially critical sub-basins from the viewpoint of prevention of water pollution should be based on <1> preservation of forests including mangrove forests and tree planting , <2> restriction of the enlargement of

urban areas and <3> restriction of setting up industrial establishments requiring large quantities of water or draining wastewater that is difficult to treat.

As referred to in Chapter 2, remaining forests in the Guanabara Bay basin are already limited to steep mountain areas and are still decreasing in area. Any decrease in the acreage of the forests intrinsically deteriorates water retention capabilities causing flood damage by sharply increasing peak flows during and after rainfall and impedes the self-purification capacity by excessively decreasing the flow volume in dry weather. It also accelerates soil erosion. Although substantial areas of forest have already been designated as reserved forests in the potentially critical sub-basins, it is desirable to expand areas designated such. Moreover, execution of tree planting on unused grasslands, still remaining in vast acreages, would effectively improve the water retention capability and prevent soil erosion. Although preservation of mangrove forests is important from the viewpoint of preserving the rich ecosystem in these forests and maintenaning marine resources, the increasing inflow of soil and sand and the deterioration of river water quality due to the development of the sub-basin would very much disturb the preservation of these mangrove forests.

In the potentially critical sub-basins, the population increase rate is quite high and if left as it is, household wastewater will become a major source of water contamination as is similarly anticipated by the pollution simulation. Consequently, it is suggested that zonal restrictions for housing development be legally implemented in these basins and if being developed at all, the obligation for construction of household wastewater treatment facilities and tree-planting in an area of equal size to the area developed be imposed on the relevant developers.

Although some of the municipalities in the potentially critical basins are planning to invite industries to set up plants in an attempt to increase their tax revenues, it is not desirable to invite establishments requiring large quantities of water or those draining difficult to treat wastewater, from the viewpoint of prevention of water pollution. Also, if inviting industrial establishments at all, their sites should be restricted to certain areas and existing effluent standards should be strictly applied.

The land utilization project for potentially critical sub-basins when considered from the viewpoint of water pollution control should be based on <1> preservation of forests including mangrove forests and tree planting, <2> restricting the expansion of urban areas and <3> restricting the establishment of factories requiring large quantities water or discharging wastewater difficult to treat.

As was referred to in Chapter 2, the remaining forests in the Guanabara Bay basin are limited to the steep mountain areas and are gradually decreasing. Removing trees reduces the water retentive capability of land, causing floods by increasing the peak flow during and after rainfall. It also deteriorates the self-purification capacity of the rivers by decreasing the flow rate during long spells of fine weather. It also stimulates soil erosion.

Although substantial portions of forests in potentially critical sub-basins have already been designated as reserved forests, it is desirable to expand the area of the reservations. Also, tree planting on undeveloped grassland would enhance water retentivity and be effective in the prevention of soil erosion.

The preservation of mangrove forests is also important from the viewpoint of the preservation of the rich ecosystem in these forests. When purification of Guanabara Bay progresses further, these mangrove forests will play an important role in the enrichment of marine resources.

The rate of population increase in potentially critical sub-basins is usually high and, if left as is, household wastewater will become an influential cause of water pollution in the Bay, as the pollution simulation models predict.

Consequently, areas available for housing developments should be legally controlled in these basins. If approval is given, it is desirable to impose regulations on the installation of facilities for household wastewater treatment and for tree planting in an area equal in size to the developed area.

Although some municipalities are planning to invite industries to set up plants in these potentially critical sub-basins, to improve municipal finance and promotion of employment, it is not desirable to invite establishments which require large quantities

of water or which discharge wastewater difficult to treat. Also, if inviting industrial establishments at all, their sites should be restricted to certain areas and existing effluent standards should be strictly applied.

As it is important to examine each land utilization project to determine what affects it has on other areas of a basin, it is suggested that a basin control committee be established, with a representative from by all the municipalities located in the basin.

(3) Issues of the Feasibility Study

- Collection of geographical information concerning the current status of land utilization

- Studying the natural environments (ground configurations, rivers, soils and natural resources)

- Finding out the social and economic situations (distribution of population, movement of population, traffic, industries, infrastructural facilities and revenue sources of these municipalities)

- Studying the local development projects (financial foundations, business trends and feelings of residents)

- Studying land use control and industrial location control from the legal point of view

- Studying the formation of a land utilization encouragement policy

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APPENDIX

<Appendix> Explanation of the Environmental Information Map on Guanabara Bay and its Basin

1. Reasons for making the Environmental Information Map

"Environmental Information Map on Guanabara Bay and its Basin" contains various information collected from "The Study on Recuperation of the Guanabara Bay Ecosystem" in which the State Government of Rio de Janeiro requested technical and financial cooperation from the Government of Japan. This map is intended as a basis for the state government to plan and promote the project to improve the environment of the bay and to help the residents to understand the current state of the bay.

The information contained on this map will not always be up to date. Therefore, the contents should be updated and improved regularly by such organizations as "The Guanabara Bay Basin Managing Committee" which is to be established in the future.

2. Climatic Conditions (front, upper left)

This figure shows the annual isothermal lines and annual isohyet lines; the data was prepared by SARSAN, the predecessor of CEDAE. Though the data is old, it represents the climatic conditions in the basin.

The graph on the right shows the monthly average temperature and precipitation in Rio de Janeiro City and the monthly precipitation during the study period (from April 1992 to March 1993) at PETROBRAS, Duque de Caxias.

It is possible that the discharge and water-quality of the rivers and the flow regime and water quality of the bay during the study period differ from those in a normal year since the precipitation pattern during the study period was considerably far from normal. Consequently, the monitoring on the rivers and the bay should be continued to accumulate data useful for design purposes.

3. Present Land Use (front, center)

In addition to the present land use, the map also outlines the topography, basin boundaries, administrative boundaries, special areas, main roads and other information.

Topographical information is taken from the topographical maps on a scale of 1:50,000 covering the basin (published between 1962 and 1986). The contour lines on this map are drawn at 100 m intervals, and with 50 m intervals on the flatter areas. The major rivers, the boundaries and numbered sub-basins are also shown.

Of the information on land use, the distribution of urban areas, grasslands or farmlands, mangrove areas, forests, swamps and barelands is based on the results of the image analysis of LAND-SAT-TM data taken on Nov. 26, 1991. There are many areas where the land use categories on this map differ from its actual state, as a comprehensive ground survey had not yet been carried out.

The distribution of the slums (favelas) is based on data obtained from IPLANRIO (Planning Institute of Rio de Janeiro Municipality) and shows the situation in 1991. The industrial zones were taken from topographical maps of scale 1:50,000. The distribution of the industrial zones on this map may be different from the actual state since the topographical maps are old.

The limits of the special areas (national parks, biological preservation areas and environmental protection areas) were drawn by referring to a map scale of 1:400,000 published by IEF (State Institute of Forest) in 1991.

The contour lines in the sea were drawn referring to a chart (No.1501) published in 1992. Features along the coast and the distribution of tidelands were also shown based on this chart.

4. Area and Population of the Municipalities within the Guanabara Bay Basin (front, lower right)

The table on the right shows the area, population and population density of the twelve municipalities within the Guanabara Bay basin calculated from the 1991 Census by IBGE (Federal Bureau of Statistics).
In the 1991 Census, the population of each municipality is shown according to urban and rural areas. It is desirable to calculate the population in each sub-basin with high accuracy using the data by sector.

The figure on the left shows the limits of the twelve municipalities with the sub-basin boundaries. Great differences in the

population density were found among three districts: Eastern district (pink), Western district (green) and Northeastern district (yellow).

5. Observation and Sampling Stations in the Study from 1992 to 1993 (back, upper left)

The information necessary for preparation of the Master Plan was collected during three field surveys: Phase 1 (from March to June, 1992), Phase 2 (from October to December, 1992), Phase 3 (from March to May, 1993).

This map shows the observation and sampling stations used to obtain data on discharge and water quality of the rivers, tides, tidal current, water quality and aquatic life in the bay. The environment of the rivers and the bay should be monitored continuously, and it is desirable to select the monitoring stations from the points indicated.

6. Main Point Pollution Sources and Water Quality Classification of the Rivers (back side, upper right)

This map shows the distribution of the main point pollution sources in the basin. The areas where the domestic pollution sources are densely gathered are represented by urban areas. The industrial pollution sources are factories with large effluent loads and have been monitored by FEEMA/DCON since 1993. They are classified into nine categories; food, beverage, paper, chemicals, plastics, pharmaceutical products, textile, machinery and others. The sewage treatment plants and the solid waste disposal sites are also shown as influential pollution sources.

The major rivers in the basin were classified into four groups according to average water quality (BOD) on clear days measured from 1992 to 1993. The distribution of the point pollution sources is concordant with the water quality class of the rivers.

7. Current Use of the Beaches and the Water Areas in Guanabara Bay (back, lower left)

This map is largely based on a chart (No.1501) published in 1992 and shows the current use of the beaches and the water areas of

Guanabara Bay. however, some of the fishing ports and sea-bathing beaches on this map are presently not utilized because of the deterioration of water quality in the bay.

The areas reclaimed since 1962 are also shown on this map. In particular, large scale reclamation has been carried out on the west side of Governador Island and around Fundao Island. The flow regime changed due to reclamation and water quality deterioration that ensued thereafter.

8. Water Quality in the Bay on Nov. 10, 1992 (back, lower center)

This map shows transparency, dissolved oxygen concentration in the bottom layer, COD (Mn) and T-P concentrations at the surface and the number of Fecal Coliform; this is part of the data obtained from the simultaneous observations conducted in the ebb tide period on Nov. 10, 1992 (spring tide period).

The runoff load from the rivers increases in the wet season, and water quality in the bay is worse in the ebb tide period than flood tide period because the pollutants from the rivers diffuse over the whole bay. Consequently, this map represents the period when water quality is worst. Transparency is less than 2 m even near the mouth of the bay due to a large quantity of phytoplankton and the almost zero Do concentration in the bottom layer in the inner bay area.

9. Bottom Material and Benthos in the Bay (back, lower right)

The distribution of the bottom material in the bay shown on this map was drawn in reference to a thesis by E.S. Amador (1986), a chart (No.1501) published in 1992 and the acoustic profiles obtained in this study. Species and numbers of benthos were classified according to samples collected in October, 1992. Attention should be paid to the fact that benthos were not found in the inner bay area.

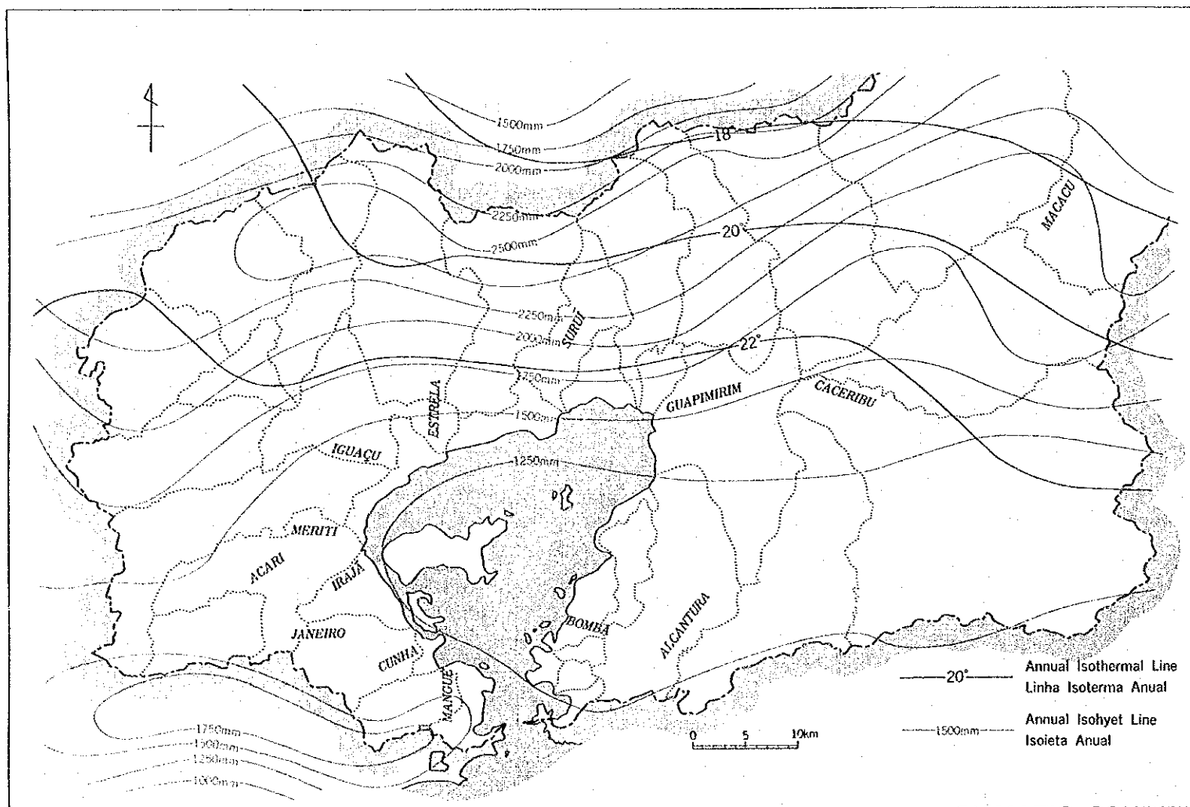
ENVIRONMENTAL INFORMATION MAP
ON
GUANABARA BAY AND ITS BASIN

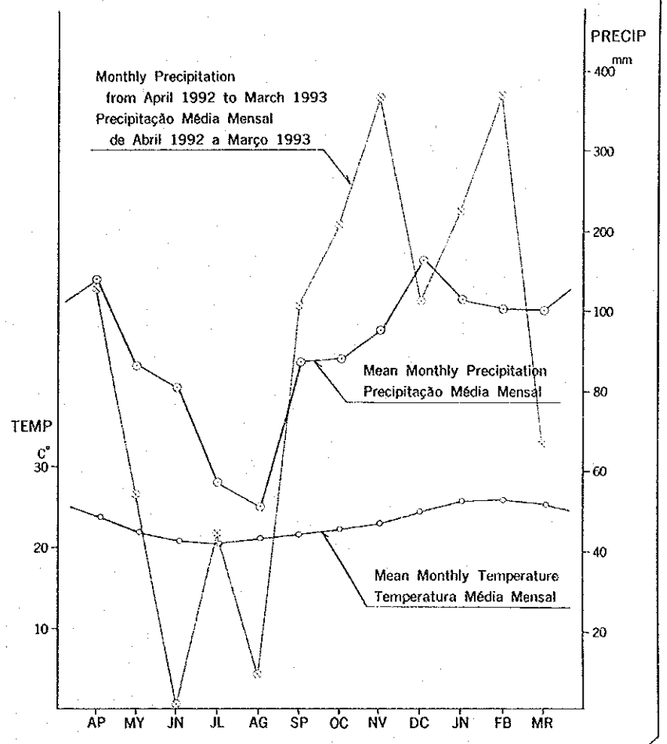
MAPA DE INFORMACAO AMBIENTAL
DA
BAIA DE GUANABARA E SUA BACIA FORMADORA

1994

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
KOKUSAI KOGYO CO., LTD. (Consulting Engineers & Surveyors)

ENVIRONMENTAL
MAPA DE INFORMAÇ





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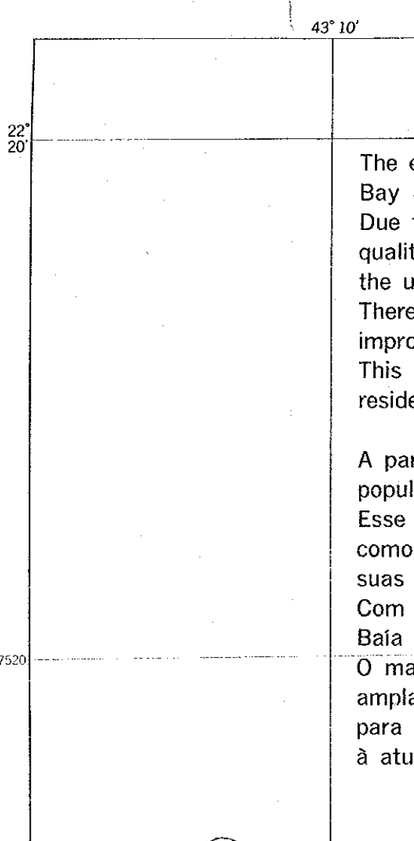

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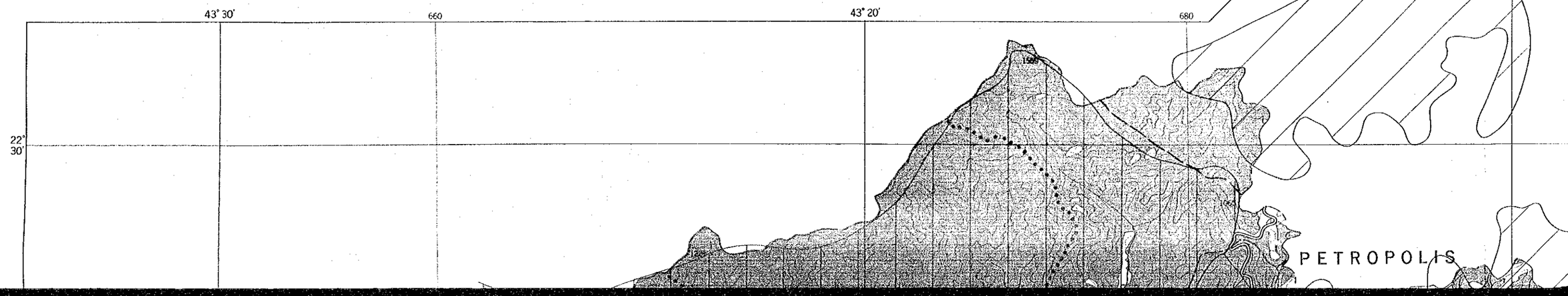
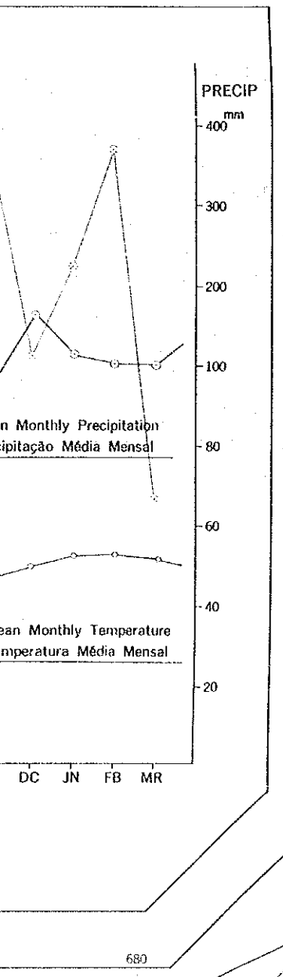
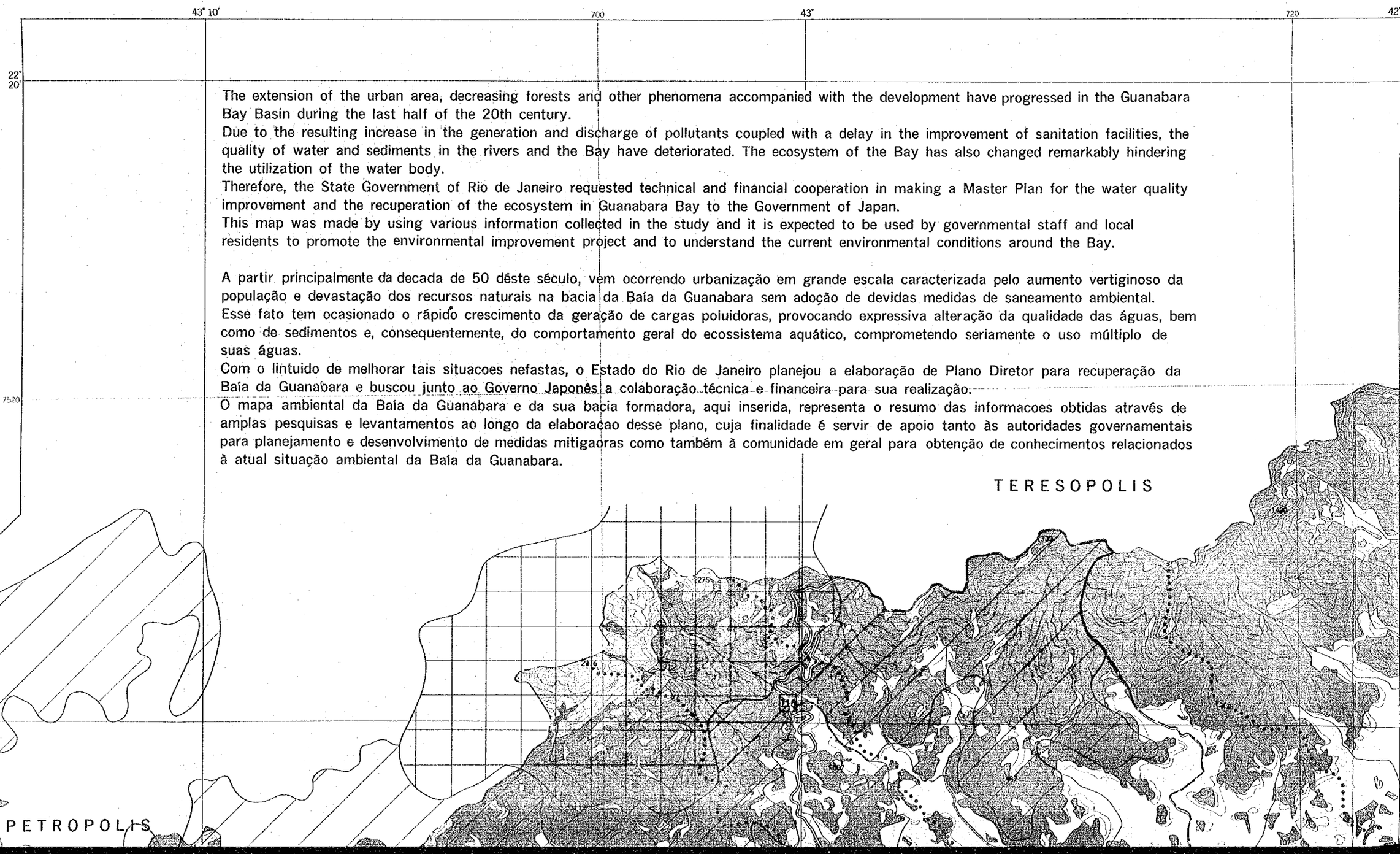


ENVIRONMENTAL INFORMATION MAP ON GUANABARA BAY AND ITS BA

MAPA DE INFORMAÇÃO AMBIENTAL DA BAIA DE GUANABARA E SUA BACIA FORM





The extension of the urban area, decreasing forests and other phenomena accompanied with the development have progressed in the Guanabara Bay Basin during the last half of the 20th century.
Due to the resulting increase in the generation and discharge of pollutants coupled with a delay in the improvement of sanitation facilities, the quality of water and sediments in the rivers and the Bay have deteriorated. The ecosystem of the Bay has also changed remarkably hindering the utilization of the water body.
Therefore, the State Government of Rio de Janeiro requested technical and financial cooperation in making a Master Plan for the water quality improvement and the recuperation of the ecosystem in Guanabara Bay to the Government of Japan.
This map was made by using various information collected in the study and it is expected to be used by governmental staff and local residents to promote the environmental improvement project and to understand the current environmental conditions around the Bay.

A partir principalmente da decada de 50 déste século, vem ocorrendo urbanização em grande escala caracterizada pelo aumento vertiginoso da população e devastação dos recursos naturais na bacia da Baía da Guanabara sem adoção de devidas medidas de saneamento ambiental.
Esse fato tem ocasionado o rápido crescimento da geração de cargas poluidoras, provocando expressiva alteração da qualidade das águas, bem como de sedimentos e, consequentemente, do comportamento geral do ecossistema aquático, comprometendo seriamente o uso múltiplo de suas águas.
Com o lintuido de melhorar tais situacoes nefastas, o Estado do Rio de Janeiro planejou a elaboração de Plano Diretor para recuperação da Baía da Guanabara e buscou junto ao Governo Japonês a colaboração técnica e financeira para sua realização.
O mapa ambiental da Baía da Guanabara e da sua bacia formadora, aqui inserida, representa o resumo das informacoes obtidas através de amplas pesquisas e levantamentos ao longo da elaboracao desse plano, cuja finalidade é servir de apoio tanto às autoridades governamentais para planejamento e desenvolvimento de medidas mitigaoras como também à comunidade em geral para obtenção de conhecimentos relacionados à atual situação ambiental da Baía da Guanabara.

RA BAY AND ITS BASIN

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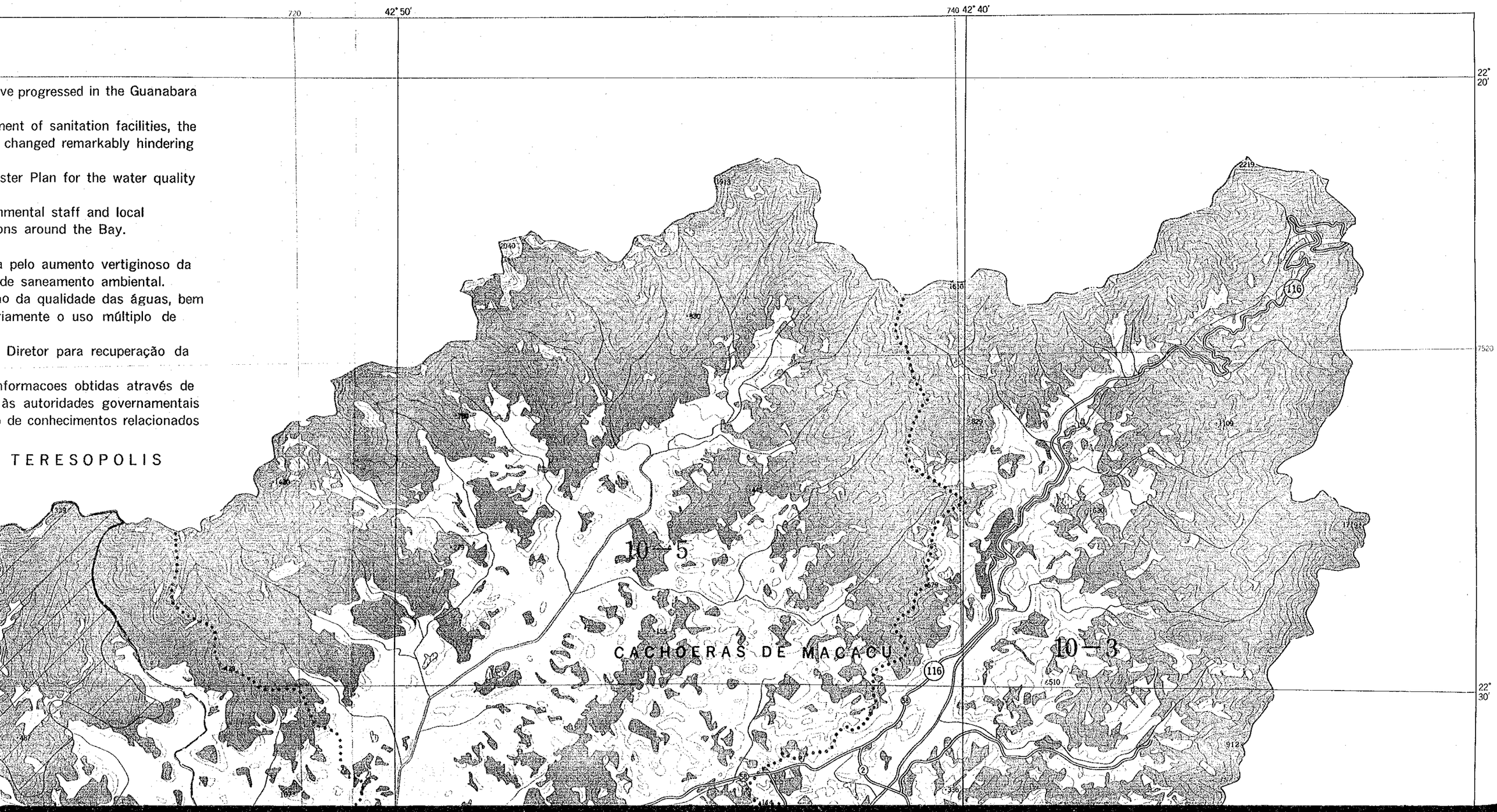

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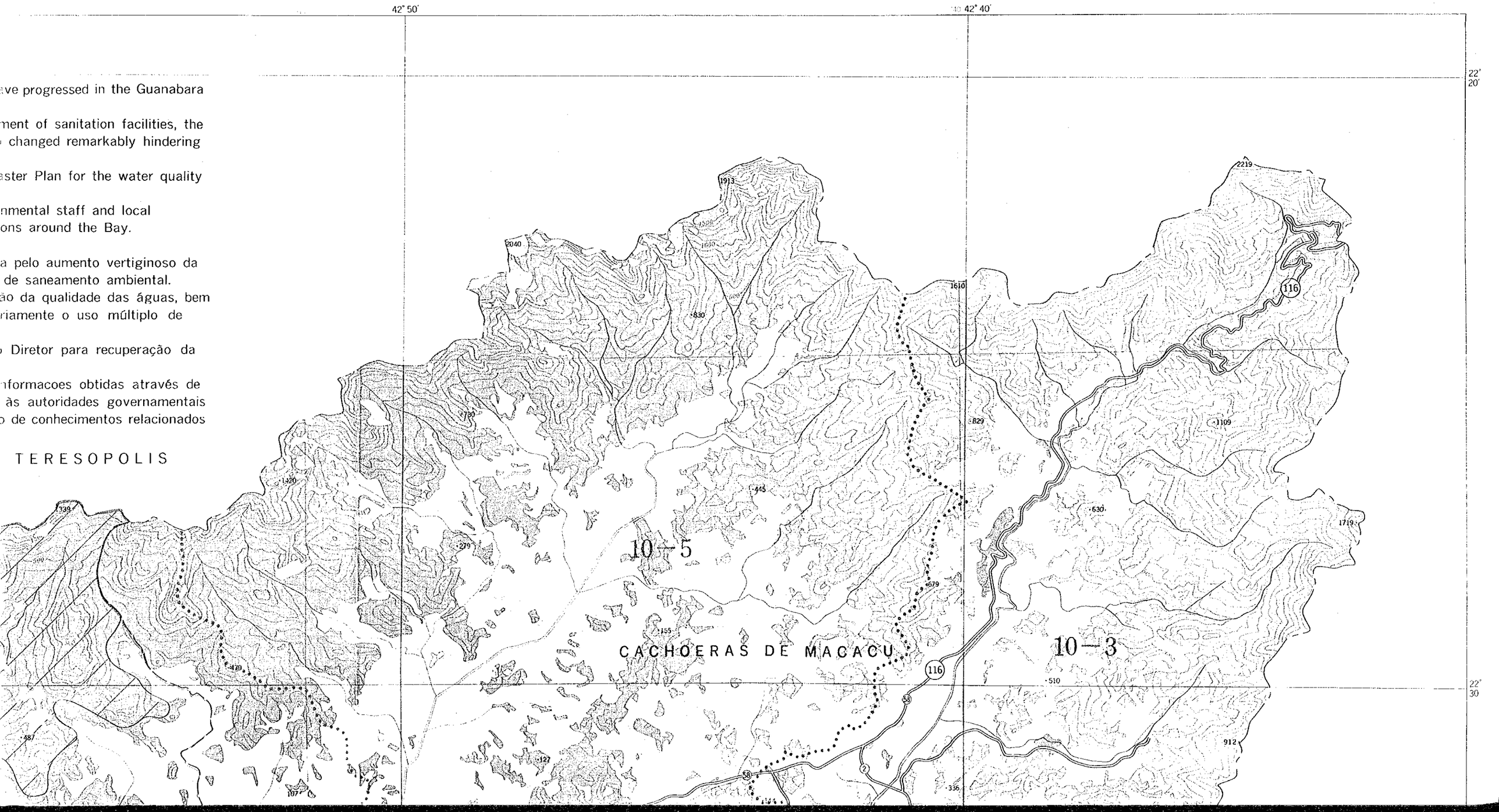

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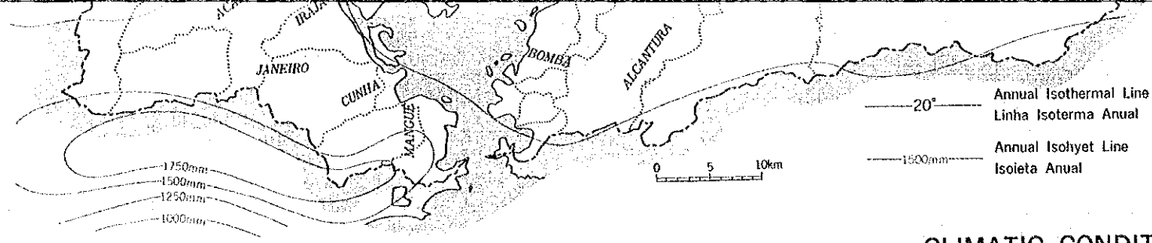
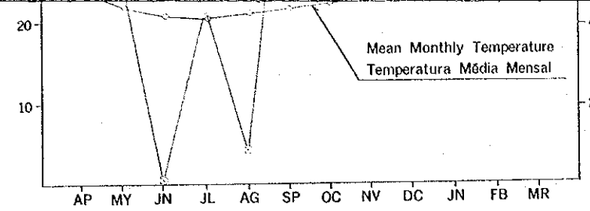
CACHOEIRAS DE MACACU

(Legends) (Legenda)

Ordinary Urban Area





CLIMATIC CONDITIONS
CONDICOES CLIMATICAS