

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

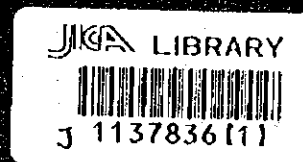
MINISTERIO DEL AMBIENTE Y DE LOS RECURSOS NATURALES
RENOVABLES
THE REPUBLIC OF VENEZUELA

THE STUDY ON
THE ENVIRONMENTAL IMPROVEMENT PROGRAM
OF THE UPPER AND MIDDLE STREAM OF THE
TUY RIVER BASIN

FINAL REPORT

VOLUME 1

EXECUTIVE SUMMARY



AUGUST 1997

CTI ENGINEERING CO., LTD.
KOKUSAI KOGYO CO., LTD.

SSS
JR
97-098

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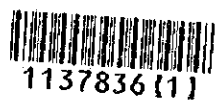
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**THE COST ESTIMATE IS BASED
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ACCORDING TO THE FOLLOWING EXCHANGE RATES:**

**US\$1.00 = Bs. 470 = ¥100.20
(AS OF JULY 16, 1996)**

PREFACE

In response to a request from the Government of the Republic of Venezuela, the Government of Japan decided to conduct the Study on the Environmental Improvement Program of the Upper and Middle Stream of the Tuy River Basin and entrusted the Study to the Japan International Cooperation Agency (JICA).

JICA sent to Venezuela a study team headed by Mr. Yoshiharu Matsumoto, CTI Engineering Co., Ltd., and composed of members from CTI Engineering Co., Ltd. and Kokusai Kogyo Co., Ltd., four times between January, 1996 and June, 1997.

The team held discussion with the officials concerned of the Government of the Republic of Venezuela, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Venezuela for the close cooperation extended to the team.

August 1997



KIMIO FUJITA
President

Japan International Cooperation Agency

August 1997

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Sir:

LETTER OF TRANSMITTAL

We are pleased to submit herewith the Final Report on the Study on the Environmental Improvement Program of the Upper and Middle Stream of the Tuy River Basin, Venezuela. The report contains the advice and suggestions of authorities concerned of the Government of Japan and the Japan International Cooperation Agency (JICA), as well as the formulation of the environmental improvement program for the study area. Also included are the comments made by the authorities concerned of the Government of the Republic of Venezuela during the technical discussions on the Draft Final Report.

The Final Report presents the Master Plan of the Environmental Improvement Program of the Upper and Middle Stream of the Tuy River Basin to secure a potable water supply with acceptable water quality and to establish a sustainable pollution control system. In view of the urgency and necessity to improve the environmental condition in the study area, the priority projects were selected and technical viability and financial feasibility were identified. It is recommended that the Government of the Republic of Venezuela should promote all priority projects to the next stage of project implementation at the earliest possible time.

Finally, we wish to take this opportunity to express our sincere gratitude to the Government of Japan, particularly, JICA, the Ministry of Foreign Affairs, the Ministry of Construction and other offices concerned. We also wish to express our deep appreciation to Ministerio del Ambiente y de los Recursos Naturales Renovables (MARNR), Tuy River Basin Agency, Oficina Central de Coordinacion y Planificacion de la Presidencia de la Republica (CORDIPLAN), HIDROCAPITAL and other authorities concerned of the Government of the Republic of Venezuela for the close cooperation and assistance extended to the JICA Study Team during the Study.

Very truly yours,


YOSHIIHARU MATSUMOTO
Team Leader
JICA Study Team

Encl. : a/s

COMPOSITION OF FINAL REPORT

- Volume 1: Executive Summary**
- Volume 2: Main Report (Master Plan Study)**
- Volume 3: Main Report (Feasibility and Pre-Feasibility Study)**
- Volume 4: Supporting Report (I) (Sector A to E)**
- Sector A: Water Quality Condition and Monitoring**
 - Sector B: Existing Water Supply System**
 - Sector C: Industrial and Piggery Wastewater Treatment**
 - Sector D: Sewage Treatment**
 - Sector E: Turbid Water Treatment**
- Volume 5: Supporting Report (II) (Sector F to J)**
- Sector F: Securement of Water Quantity**
 - Sector G: Institutional Aspect**
 - Sector H: Construction Plan and Cost Estimate**
 - Sector I: Socioeconomic Condition and Project Evaluation**
 - Sector J: Environmental Aspect**
- Volume 6: Data Book**
- Volume 7: Resumen (Summary in Spanish)**
- Volume 8: Informe Principal: Estudio del Plan Maestro
(Main Report for Master Plan Study in Spanish)**
- Volume 9: Informe Principal: Estudio de Factibilidad y de Pre-Factibilidad
(Main Report for Feasibility and Pre-Feasibility Study in Spanish)**

**The Study on
the Environmental Improvement Program
of the Upper and Middle Stream
of the Tuy River Basin**

OUTLINE OF THE STUDY

1. General

Objectives of the Study

The objectives of the study are:

- To formulate a master plan of environmental improvement for the upper and middle streams of Tuy River consisting of two stages, a short-term program and a mid-term program with the target year set at 2010, to secure a potable water supply with acceptable water quality and to establish a sustainable pollution control system;
- To conduct a feasibility study for the priority project(s) identified in the master plan; and
- To transfer technology on planning methods and skills to counterpart personnel.

Study Area

The Study Area covers the upper and middle streams of the Tuy River, namely the part of the watershed between El Consejo and the water intake site (Toma de Agua) near San Antonio, with an area of approximately 1,900 km².

2. Identification of Key Issues and Problems

2.1 Water Quality

There are three major groups of pollutants in the Study Area: organic materials, toxicants and turbid materials.

With regard to organic materials, the BOD level projection at Boca de Cagua in the upper Tuy River for the year 2010 is 2,440 mg/l, while that at Toma de Agua is lower at 14 mg/l. Such high BOD levels will cause destruction of aquatic life in the river and suspension of water intake for drinking water supply.

Toxicants in the Study Area are composed mainly of heavy metals. Through water quality analysis, heavy metal concentrations exceeding Type 1B standard were found at three out of ten sampling points along the Tuy River. This condition is expected to increase in the future due to increase in the number of factories.

High turbidity causes problems at the intake site such as the suspension of water intake and high maintenance cost for the removal of sediment at the pre-treatment plant. Further turbidity has created unfavorable environmental conditions in the Tuy river basin.

2.2 Water Quantity

The Tuy I, II, and III water supply systems are literally the lifelines to the 3.6 million inhabitants of the Caracas Metropolitan Area. A major source of the Tuy I and II systems is the Tuy River, in particular, the water taken at Toma de Agua.

The following water quantity problems have been identified:

- Suspension of water intake due to poor water quality resulting in the increase of use of water stored in the reservoirs.
- Insufficient water flow of the Tuy River during the dry season.
- Increased dependency on the fragile Tuy III system in the dry season as a result of the above two problems.

3. Selection of Targets

The following targets have been selected for the short and mid-term programs:

Short-Term Program

The target year of the Short-Term program is set at 2003. The target water quality of the Short-Term Program is set as the improvement of water quality at Toma de Agua (see table below). These are interim targets which are selected for the purpose of achieving the objectives of the Mid-Term Program.

Item	Description
Reference point	San Antonio (Toma de Agua)
Organic pollution	BOD of 3.5 mg/l (proposed in the Study)
Toxicant	Type IB in Decree No. 883
Turbidity	920mg/l of SS (proposed in the Study)

Target water quantity is set from two aspects: water demand aspect and stability of supply aspect.

Item	Value
Monthly average secured water from the upper and middle streams of the Tuy River basin	Approx. 4.0 m ³ /s
Intake at Toma de Agua	2.0 m ³ /s
Newly developed water	Approx. 2.0 m ³ /s
Reduction in suspension of intake at Toma de Agua:	
Due to color and odor	From 13 to 0 day/yr
Due to high turbidity	From 10 to 5 days/yr

Mid-Term Program

The target year for the Mid-Term Program is set at 2010. The target water quality for the Mid-Term Program is set for the upper and middle reaches to achieve a favorable river environment (see table below).

Basin	Upper basin	Middle basin
Reference point	Boca de Cagua	San Antonio (Toma de Agua)
Organic pollution	BOD of 60 mg/ℓ (Wastewater discharge criteria to the river in Decree No. 883)	BOD of 3 mg/ℓ *1 (proposed in the Study)
Toxicant	Type 1B in Decree No. 883	Type 1B in Decree No. 883
Turbidity	SS of 750 mg/ℓ Turbidity of 250 NTU (Type 1B in Decree No. 883)	SS of 750 mg/ℓ Turbidity of 250 NTU (Type 1B in Decree No. 883)

*1: BOD of 3 mg/ℓ is the limit for conventional treatment.

The target of water quantity for the Mid-Term Program is the securement of a stable water supply for the Tuy I and II systems amounting to approximately 4 m³/s, consisting of 2 m³/s of average intake at Toma de Agua and approximately 2 m³/s of newly developed water. This target is set because the intake of 2 m³/s at Toma de Agua will not be maintained if no measure to improve water quality is taken.

4. Formulation of the Master Plan

4.1 Project Components of the Master Plan

To achieve the target of the Master Plan consisting of two stages, the Short-Term and the Mid Term program, the following project components are selected:

Program	Category	Project Component
Short Term	Structural Measures	
	- Water Quality Improvement	Installation of Treatment Plant in Factories and Piggeries (For organic, toxicant and turbidity) - Existing and Newly constructed Construction of Sewerage System - Ocumare del Tuy and Las Tejerias Reforestation - Maitana Basin
	- Securement of Water Quantity	Installation of Treatment Plant for Factory (For color/odor) - Existing and newly constructed by 2003 Sand Settling Pond Ocumarito- Tuy III Pumping system and Guare Dam
	Institutional Measures	Laws and Regulation Organization Monitoring Public Education Environmental Fund Pollution Charge

Program	Category	Project Component
Mid Term	Structural Measures	Installation of Treatment Plant in Factories and Piggeries (For organic, toxicant and turbidity) <ul style="list-style-type: none"> - Newly constructed from 2003 to 2010 Construction of Sewerage Systems <ul style="list-style-type: none"> - San Francisco de Yare, El Consejo and Ocumare del Tuy Reforestation <ul style="list-style-type: none"> - Guayas and Cagua Basins Sand Settling Pond for Tributaries <ul style="list-style-type: none"> - Upper Tuy River, Qda. Guayas, Qda. Maitana and Guare River
	Institutional Measures	Laws and Regulations Organization Monitoring Public Education Environmental Fund Pollution Charge

4.2 Priority Projects for Feasibility Study and Pre-feasibility Study

Priority projects have been selected for the feasibility and pre-feasibility studies. These priority projects are included in the Short-Term Program (1998-2003). The Mid-Term Program (2004-2010) will follow.

The feasibility study covered all physical measures for water quality improvement in the Short-Term Program, as well as the sand settling pond at the water intake for securement of water quantity and all institutional measures. On the other hand, the pre-feasibility included the water resource development projects: the Ocumarito-Tuy III pumping system and the Guare Dam.

5. Feasibility Study of Priority Projects and Pre-feasibility Study for Water Resources Development

5.1 Cost and Benefit

Financial Cost

The financial costs are summarized in the following table:

Study	Project	(US\$ thousand)	
		Initial Cost	O&M Cost
F/S Study	Installation of Treatment Plants in Factories	(23,817)*	(1,903)
	Construction of Sand Settling Pond for Intake	6,245	17
	Construction of Sewerage System in Ocumare del Tuy	26,763	341
	Construction of Sewerage System in Las Tejerías	11,368	194
	Reforestation in Priority Areas	3,347	-
	Environmental Fund	24,017	177
	Monitoring and Education System	658	116
	Total	72,398	845
Pre-F/S Study	Ocumarito-Tuy III Pumping Plan	9,880	1,453
	Construction of Guare Dam	76,100	5,240
	Total	85,980	6,693

* The cost is included in the Environmental Fund.

Benefit

In general, some essential benefits from the implementation of environmental improvement projects are hard to evaluate in monetary terms. Hence, the benefits are herein presented in a descriptive manner.

(1) Direct Benefits

As the direct benefits, the following are considered:

- Water quality improvement brings about better environmental quality of the Tuy River. The present dirty colored and bad smelling river water will change to less dirty colored and less smelling water.
- The removal of BOD and turbidity substances brings about a reduction of the times of water intake suspension due to color, odor and turbidity. This also brings about a reduction of operation and maintenance costs for treatment of water.
- The Tuy River water can be used as a safe water resource for water supply to the Caracas Metropolitan Area with less coliform and heavy metals.
- The Tuy river water flow which is wastefully spilling at the water intake can be utilized resulting in the increase of water supply capacity.
- By maximizing the use of water of the Tuy River, dependency on the Tuy III system which has higher potential of water supply failures can be reduced.

(2) Indirect Benefits

As the indirect benefits, the following effectiveness are expected:

- As the result of water quality improvement, estate value along the river course will appreciate.
- Waterborne diseases will be reduced.
- The tourism resource value of the Tuy River basin will appreciate.
- The existence value of the Tuy River basin will appreciate.

5.2 Financial Evaluation

Financial evaluation is made only for the project components of the feasibility study.

The total cost for the six F/S projects amounts to US\$72 million. The foreign component is US\$46 million accounting for 63% of the total cost and the local component is US\$26 million accounting for 37%.

The repayment, O&M and replacement cost for construction of structural measures will be borne by the agencies concerned or the beneficiaries. The amount to be borne by them appears to be reasonable.

MARNR will shoulder the cost for institutional measures other than the Environmental Fund. The ratio of payment to budget will be 0.070%, the annual payment coming to US\$147 thousand. This seems to be not a heavy obligation.

As a conclusion, it can be said that all the six projects under study as the Short-Term program are financially feasible.

6. Conclusion and Recommendation

Conclusion

In this Study, the Master Plan to secure a potable water supply with acceptable water quality and to establish a sustainable pollution control system is formulated of two stages: the Short-Term Program and the Mid-Term Program targeting the year 2010.

To facilitate the realization of the Master Plan, priority projects in the Short-Term Program with the target year of 2003 are selected and the feasibility of these projects excluding the project components for water resources development is examined.

It is identified that as a whole the projects of the feasibility study are technically feasible and financially viable.

Recommendation

(1) Justification of Master Plan

Since the environmental improvement of the Tuy River is crucial, the Master Plan formulated for the purpose should be considered as a part of the Venezuelan National Development Plan.

(2) Implementation of Priority Projects

Since it is concluded that as a whole the projects components for feasibility study are technically feasible and financially viable, it is recommended that they be promoted to the next stage of implementation at the earliest possible time.

(3) Arrangement of Loan from Available Financing Source

For the implementation of the projects, it is necessary to obtain a loan from an international financing agency. In this connection, it is recommended that appropriate action be taken to arrange a loan from the financing source available.

**THE STUDY ON
THE ENVIRONMENTAL IMPROVEMENT PROGRAM OF
THE UPPER AND MIDDLE STREAM OF THE TUY RIVER BASIN**

DRAFT FINAL REPORT

EXECUTIVE SUMMARY

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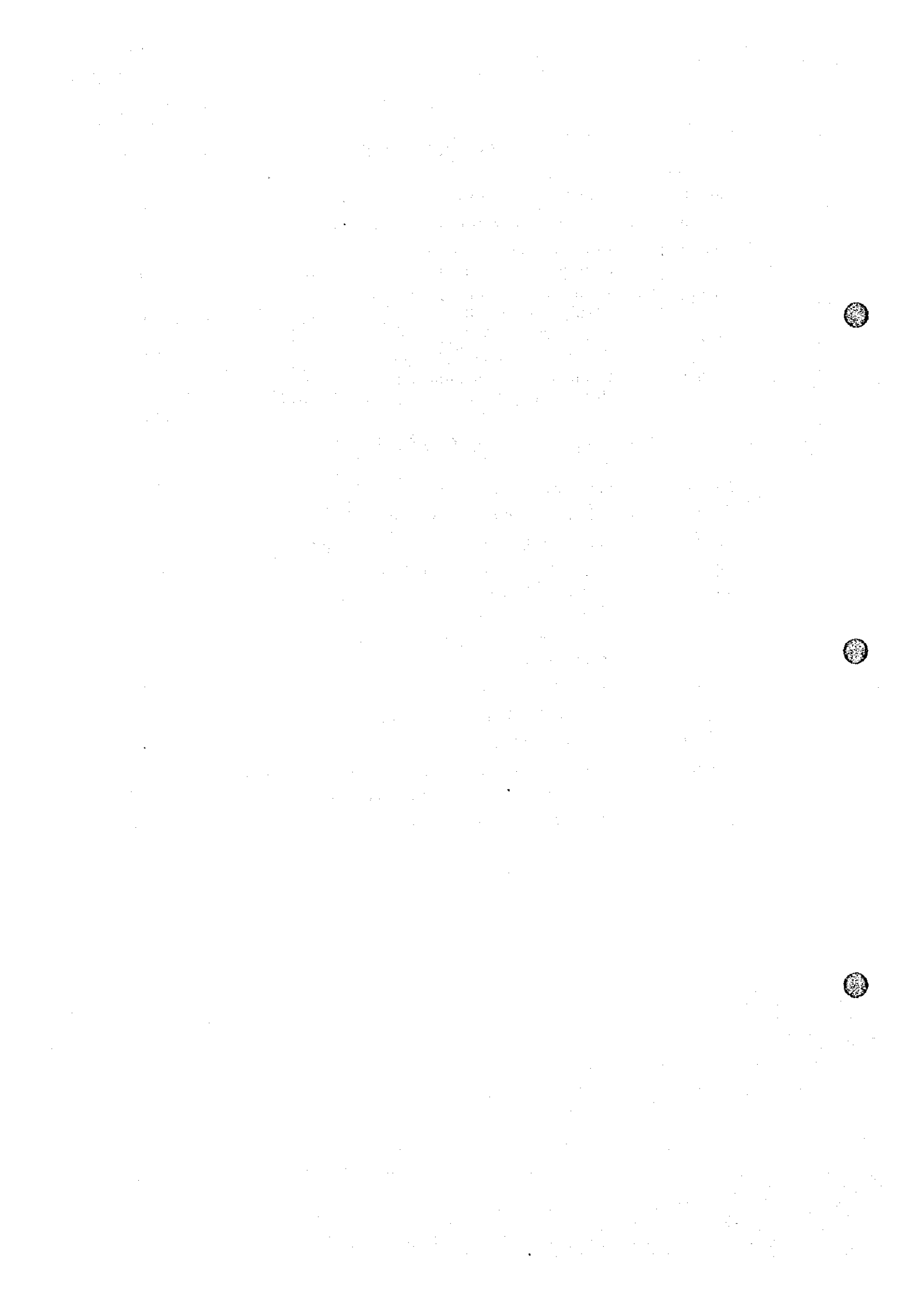
FEATURES OF STRUCTURAL MEASURES OF THE PRIORITY PROJECTS

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1. General

Background of the Study

The water quality of Tuy River, an important water supply source to Metropolitan Caracas, has deteriorated due to wastewater from factories, piggeries and urban areas, while turbidity is caused mainly by basin erosion. The water supply system which started operations in the 1950's is antiquated and water supply is seriously affected by the polluted water. To cope with the situation, the Government of Venezuela has considered improving the water supply condition to Metropolitan Caracas by: (1) rehabilitation of the current water supply system and (2) improvement of the water quality of Tuy River.

The Government of Venezuela has requested the Government of Japan to provide technical assistance for the improvement of water quality of the Tuy River, while the Venezuela Government is to undertake the first project. In response to the request, the Government of Japan has decided to conduct the Study on the Environmental Improvement Program of the Upper and Middle Stream of the Tuy River Basin.

Objectives of the Study

The objectives of the study are:

- To formulate a master plan of environmental improvement for the upper and middle streams of the Tuy River consisting of two stages, a short-term program and a mid-term program with the target year set at 2010, to secure a potable water supply with acceptable water quality and to establish a sustainable pollution control system;
- To conduct a feasibility study for the priority project(s) identified in the master plan; and
- To transfer technology on planning methods and skills to counterpart personnel.

Study Area

The Study Area covers the upper and middle streams of the Tuy River, namely the part of the watershed between El Consejo and the water intake site (Toma de Agua), near San Antonio, with an area of approximately 1,900 km².

Study Schedule

The study was conducted through field studies in Venezuela and home office studies in Japan in accordance with the schedule shown in Fig. S-1.

2. Baseline Projection of Water Quality

The results of the BOD and SS baseline projections for the year 2010 are as follows:

Summary

Pattern	Location	BOD (mg/l)	SS (mg/l)
Pattern 1 (standard growth)	Boca de Cagua	2,440	-
	Toma de Agua	14	1,080
Pattern 2 (high growth)	Boca de Cagua	2,776	-
	Toma de Agua	16	1,170
Pattern 3 (low growth)	Boca de Cagua	1,794	-
	Toma de Agua	11	1,020

3. Identification of Key Issues and Problems

3.1 Water Quality

Major Groups of Pollutants

There are three major groups of pollutants in the Study Area: organic materials, toxicants and turbid materials in the river water.

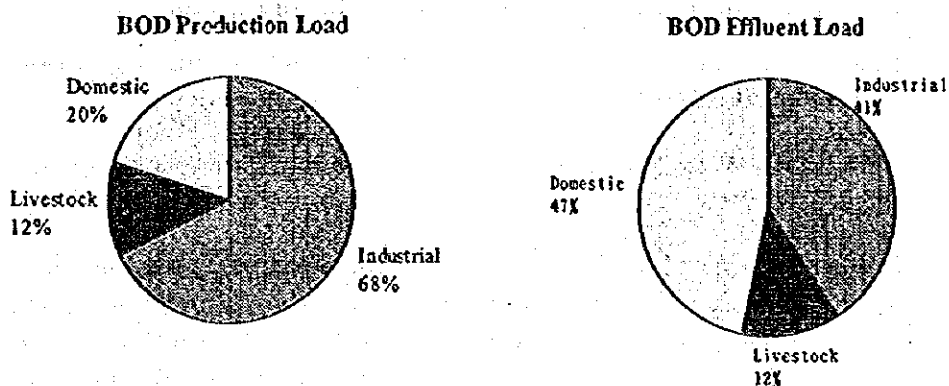
With regard to organic materials, the BOD at Boca de Cagua in the upper Tuy River is projected at 2,440 mg/l for the year 2010 while that at the intake site, Toma de Agua, is relatively low at 14 mg/l. Such high levels of BOD will cause the destruction of aquatic life in the river and the suspension of water intake for drinking water supply.

Toxicants in the Study Area are composed mainly of heavy metals. Through water quality analysis, heavy metal concentrations exceeding the Type 1B standard were found at three out of ten sampling points along the Tuy River. Based on such findings, the occurrence probability of toxicant pollution is preliminarily estimated at 30%, which is expected to increase in the future due to increase in the number of factories.

High turbidity causes problems at the intake site such as suspension of water intake and high maintenance cost for the removal of sediment at the pre-treatment plant. Turbidity has already created unfavorable environmental conditions in the Tuy river basin.

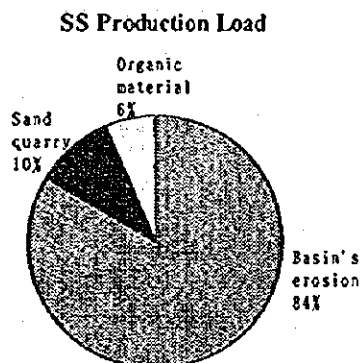
Pollution Sources

Pollution production load and pollution effluent load from the whole basin are presented below. As shown in the figure, effluent load due to industrial and domestic wastes are at higher levels, while the production load from factories is much higher than that from domestic wastewater. This means that the removal efficiency of domestic wastewater is very low resulting in high effluent loads in spite of the moderate pollution production load.



The sources of toxicants in the Study Area are the factories, particularly, the non-food factories. Heavy metals are found in the discharge of factories such as car parts, tannery, faucet factory and textiles.

Turbidity is discussed in terms of suspended solids. The sources of production of suspended solids (SS) are broadly divided into soil erosion, sand quarries, and organic pollutants from factories. The projected composition in the year 2010 is graphically shown below.



Ongoing Pollution Control Efforts and Present Problems

The ongoing pollution control efforts and present problems are summarized by pollution source in Table S-1, Summary of Key Issues for Water Quality.

3.2 Water Quantity

The Tuy I, II, and III water supply systems are literally the lifelines to the 3.6 million inhabitants of the Caracas Metropolitan Area. A major source of the Tuy I and II systems is the Tuy River, in particular, the water taken at Toma de Agua.

The following water quantity problems have been identified:

- Suspension of water intake at Toma de Agua due to poor water quality, resulting in the increased use of water stored in the reservoirs.

Summary

- Insufficient discharge of the Tuy River during the dry season.
- Increased dependency on the fragile Tuy III system in the dry season as a result of the above two problems.

At present the annual average intake for water supply to the Caracas metropolitan and neighboring areas is 19 m³/s, out of which 2.0 m³/s is from the Tuy River.

The total intake volume of 19.0 m³/s is enough for the current demand; however, periodical shortages occur due to low river and reservoir levels in the dry season, in addition to electrical and mechanical failures of the water supply system, the deterioration of water quality, and other causes. It was reported that the intake volume decreased to 11.1 m³/s in 1992.

The average annual number of water intake suspensions in the 1993-95 period was 36 times/year, with an average daily suspension duration of 8 hours. The causes of suspension are turbidity, odor, color, etc.

3.3 Institutional Aspect

Institutional measures already undertaken and the present problems are summarized in Table S-1, Summary of Key Issues for Water Quality.

4. Selection of Targets

Targets have been selected for the short and mid-term programs, as follows:

Short-Term Program

(1) Water Quality

The target year for the Short-Term Program is set at 2003, aiming at water quality improvement. Target water quality in the Short-Term Program is set as the improvement of water quality at Toma de Agua (see table below). These are interim targets which are selected for the purpose of achieving the objectives of the Mid-Term Program.

Item	Description
Reference point	San Antonio (Toma de Agua)
Organic pollution	BOD of 3.5 mg/l (proposed in the Study)
Toxicant	Type IB in Decree No. 883
Turbidity	920 mg/l of SS (proposed in the Study)

(2) Water Quantity

For the securement of a stable water supply at the intake for the Tuy I and Tuy II systems, two aspects should be considered in order to define the target water quantity, namely the stability of supply aspect and the demand aspect.

From these aspects to secure water supply, the development of a new water source for an additional increase of approximately 2.0 m³/s is proposed as the target to contend with short term water shortages.

With the additionally developed water of approximately 2.0 m³/s, suspension of water intake of 13 days/year due to color and odor is eliminated, and suspension due to turbidity is reduced from 10 days/year to 5 days/year as presented in the table below.

Item	Value
Monthly average secured water from the upper and middle streams of Tuy River basin	Approx. 4.0 m ³ /s
Intake at Toma de Agua	2.0 m ³ /s
Newly developed water	Approx. 2.0 m ³ /s
Reduction in suspension of intake at Toma de Agua:	
Due to color and odor	From 13 to 0 day/yr
Due to high turbidity	From 10 to 5 days/yr

Mid-Term Program

The target year for the Mid-Term Program is set at 2010. The target water quality for the Mid-Term Program is set for the upper and middle reaches to achieve a favorable river environment (see table below).

Basin	Upper basin	Middle basin
Reference point	Boca de Cagua	San Antonio (Toma de Agua)
Organic pollution	BOD of 60 mg/l (Wastewater discharge criteria to the river in Decree No. 883)	BOD of 3 mg/l *1 (proposed in the Study)
Toxicant	Type 1B in Decree No. 883	Type 1B in Decree No. 883
Turbidity	SS of 750 mg/l Turbidity of 250 NTU (Type 1B in Decree No. 883)	SS of 750 mg/l Turbidity of 250 NTU (Type 1B in Decree No. 883)

*1: BOD of 3 mg/l is the limit for conventional treatment.

The target of water quantity for the Mid-Term Program is the securement of a stable water supply for the Tuy I and II systems amounting to approximately 4 m³/s, consisting of 2 m³/s, average intake at Toma de Agua, and approximately 2 m³/s of newly developed water. This target is set because the intake of 2 m³/s at Toma de Agua would not be maintained if no measures for the improvement of water quality are taken.

Expected Effect by Achievement of Target

The following effects are expected by achievement of the target: reduction of BOD up to 3 mg/l at Toma de Agua, toxicant up to the limit of water quality standard and SS up to 750 mg/l, and development of new water resources of 2 m³/s.

Firstly, the water quality of the Tuy River is improved and the river water can be used as a safe water source with less coliform and heavy metals for water supply to

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Caracas Metropolitan Area. Furthermore, the present dirty brown gray colored and bad smelling water will change to that without smell and with natural water color, reviving aquatic life.

With the development of a new water resources of 2 m³/s as well as water quality improvement, the water supply quantity to Caracas Metropolitan Area until around 2003 can be secured, although new water resources development projects including the Tuy IV system have to be undertaken to fulfill further future demand due to population increase.

5. Formulation of the Master Plan

5.1 Selection of Optimum Measures

5.1.1 Pollution Reduction

Applicable Measure

To select the optimum measures for pollution reduction, the following physical measures have been examined.

Pollution	Pollution source	Measures at pollution source (private sector)	Measures at pollution source (public sector)	Measures at river (public sector)
Organic	Factory	Treatment plant	Public sewerage system*	Retarding basin
	Piggery	Treatment plant		
	Domestic	Septic tank	Public sewerage system	
Toxicant	Factory	Treatment plant	Public sewerage system*	
Turbidity	Factory	Treatment plant	Public sewerage system*	Sand settling pond
	Basin Erosion		Reforestation	

* For factories whose effluents enter the public sewerage network.

Selection of Optimum Measures

For the selection of optimum measures, several cases have been examined, as summarized below.

(1) Factory and Piggery Effluent

Water pollution by factory effluents is caused mainly by organic, toxic and turbid pollutants, while pollution by piggery effluents is by organic and turbid pollutants. To cope with this problem, it is necessary to install water treatment plants, a responsibility of factory and piggery owners.

(2) Domestic Wastewater

For domestic wastewater from urban centers, it is necessary to provide a sewage treatment system for urban centers.

The priority areas for the installation of sewage treatment plants are selected from the viewpoint of effectiveness to reduce pollution at the water intake. The highest priority is given to Ocumare del Tuy and Las Tejerías, followed by San Francisco de Yare and El Consejo.

The trickling filter method is selected for the sewage treatment plant since it is cheaper and easier to maintain than the other methods.

(3) Basin Erosion

For basin erosion that results in the high turbidity of river water, the optimum measures are selected from the following two aspects: (1) securement of water quantity and (2) improvement of water quality.

A sand settling pond at the intake point of Toma de Agua is selected from the securement aspect, and reforestation and sand settling pond on the tributaries are selected from the water quality aspect.

5.1.2 Securement of Water Quantity

To achieve the target for the securement of water quantity, a new water supply source is proposed. The following measures are evaluated: (1) torrent diversion, (2) Ocumarito-Lagartijo diversion, (3) Ocumarito-Lagartijo diversion with El Peñón Dam, (4) Ocumarito-Tuy III pumping system, and (5) Guare Dam.

Based on the economic comparison of these plans, the Ocumarito-Tuy III pumping system diversion and construction of Guare Dam are selected as the optimum measures. (Refer to Section 9.3, Results of the Pre-feasibility Study).

5.1.3 Study on Regulatory and Organizational Measures

Improvement Plan for Laws and Regulations

At present, there are about 35 laws and regulations concerning environmental aspects, and the current environmental problems are covered by an existing extensive legal framework. The following items are proposed to promote the environmental improvement, especially, through the installation of treatment plants for factories and piggeries: (1) enforcement of tax reduction or tax incentives; (2) enactment of new legislation to create an environmental fund, and to impose pollution charges on factories and piggeries which do not comply with the water quality standard; and (3) modification of the water quality standards.

Organization

For the realization of the project, several agencies including CORDIPLAN, MARNR, Tuy River Basin Agency (ACRT), Hidrocapital, state governments, etc., will be involved. Among these agencies, it is assumed that the ACRT and Hidrocapital will play a leading role in the execution of the project, in particular, the physical measures such as the construction of river diversion and domestic wastewater sewage treatment facilities.

Summary

Concerning the physical measures, Hidrocapital, which has a vast experience in similar projects, should have no difficulty in executing the projects. However, the ACRT has lesser experience in the planning, design, and supervision of construction. Therefore, strengthening of the organization of ACRT is proposed, setting up new sections including planning, design and supervision sections.

5.1.4 Monitoring System

In the monitoring system, the works mainly covered are monitoring of the pollution condition of river water and factory and piggery effluents. To strengthen the current monitoring system, 9 monitoring sites are proposed: 6 sites along the Tuy River and 3 sites on its tributaries. Since factory and piggery effluents have a large impact on the water quality of the Tuy River, they shall be monitored regularly to confirm compliance with the water quality standards.

The present organization for monitoring should be strengthened to cover all the works required. Provision of additional facilities and improvement of necessary equipment, including laboratory equipment, should be considered.

5.1.5 Study on Educational Program to Promote Public Awareness

For the effective implementation of the Master Plan, an educational program to promote public awareness of environmental issues shall include all public and private sectors involved in the basin. The program focuses on three levels: schools, the general public, and the manufacturers.

5.2 Formulation of the Project

5.2.1 Short-Term Program

To achieve the target of the Short-Term Program, the following measures are selected.

Structural Measures

Location of the measures are presented in Fig. S-2.

(1) Water Quality Improvement

(a) Organic Pollution

- Installation of treatment plants for existing factories and piggeries which do not meet the water quality standards.
- Installation of treatment plants for new factories.
- Installation of sewerage systems for the Las Tejerías and Ocumare del Tuy areas.

(b) Toxicants

- Installation of treatment plants for existing factories which do not meet the water quality standards.
- Installation of treatment plants for new factories.

(c) Turbidity

- Installation of treatment plants for existing factories and piggeries which do not meet the water quality standards.
- Installation of treatment plants for new factories.
- Reforestation in the Qda. Maitana basin.

(2) Securement of Water Quantity

(a) To develop the water quantity of approx. 2.0 m³/s

- Construction of Ocumarito-Tuy III pumping system
- Construction of Guare Dam

(b) To reduce frequency of intake suspension due to odor, color, and turbidity

- Installation of treatment plants for factories
- Construction of a sand settling pond at water intake point

Institutional Measures

The following institutional measures are considered to achieve the targets:

- Provision of laws and regulations.
- Strengthening of organizational functions.
- Establishment of monitoring system and enforcement of laws and regulations.
- Establishment of an environmental fund and its use to assist factories and piggeries.
- Imposition of pollution charges for factories and piggeries which do not comply with the water quality standard.
- Establishment of educational program to promote public awareness.

5.2.2 Mid-Term Program

Structural Measures

The physical measures are mainly related to water quality improvement, most of which are proposed in the Short-Term Program. Additional measures in the Mid-Term Program are the construction of sand settling ponds on the tributaries, construction of sewerage systems, and reforestation in other locations. The

Summary

application of pollution control measures for factories in the Short-Term Program will be extended to the Mid-Term Program. Locations of the measures are presented in Fig. S-2.

- (1) Organic Pollution
 - Installation of treatment plants for new factories.
 - Installation of sewerage systems in the San Francisco de Yare and El Consejo areas and extension of Ocumare del Tuy.
- (2) Toxicants
 - Installation of treatment plants for new factories.
- (3) Turbidity
 - Installation of treatment plants for new factories.
 - Reforestation in the Qda. Maitana, Qda. Guayas, and Cagua River basins.
 - Sand settling ponds along the Upper Tuy River, Qda. Guayas, Qda. Maitana and Guare River.

Institutional Measures

Most of the measures proposed for the Short-Term Program are extended to the Mid-Term Program. The institutional measures applied are as follows:

- Enforcement of laws and regulations.
- Sustainable operation of monitoring systems.
- Sustainable use of an environmental fund to assist.
- Sustainable imposition of pollution charge.
- Educational program to promote public awareness.

The implementation schedule of the Master Plan is shown in Fig. S-3.

5.2.3 Priority Projects for Feasibility Study and Pre-Feasibility Study

Priority projects were selected for the feasibility and pre-feasibility studies. These priority projects are included in the Short-Term Program (1998-2003). The Mid-Term Program (2004-2010) will follow.

The feasibility study covered all structural measures for water quality improvement in the Short-Term Program, as well as the sand settling pond at water intake for securement of water quantity and all institutional measures. On the other hand, the pre-feasibility included the water resource development projects: Ocumarito-Tuy III pumping system and Guare Dam.

5.3 Cost Estimate

Preliminary cost estimates for the proposed project were calculated at the exchange rate of July, 1996 (US\$1 = ¥110 = Bs 470), as shown in the following tables.

(Unit: US\$ thousand)

Stage	Category	Target	Measures	Initial cost	O&M cost	Annual cost ^a
Short term	Structural measure	Water quality	Treatment for existing factories and piggeries***	** (11,998)	** (562)	(1,832)
			Treatment for newly constructed factories***	(10,791)	(470)	(1,657)
			Treatment of domestic wastewater (Ocumare del Tuy)	28,020	519	3,601
			Treatment of domestic wastewater (Las Tejerías)	12,700	319	1,716
			Reforestation	2,520	17	319
			(Sub-total)	43,240	855	5,636
		Water quantity	O-Tuy III pumping and Guare Dam	85,980	2,623	12,579
			Lessening color/odor	(2,057)	(90)	(316)
			Lessening turbidity (by sand settling pond)	2,610	61	348
			(Sub-total)	88,590	2,684	12,927
	Institutional measure	Monitoring	1,652	177	359	
		Public education	50	40	46	
		Environmental fund	24,846	177	2,853	
		(Sub-total)	26,548	394	3,258	
Total				158,378	3,933	21,821

* Annual Cost = Initial Cost × Annuity Factor + O&M Cost (Annuity factor is 0.11 for civil structures and 0.13 for electrical equipment)

** The cost excludes factories related to color/odor.

*** The cost is included in the Environmental fund.

Stage	Category	Target	Measures	Initial cost	O&M cost	Annual cost ^a
Mid term	Structural measure	Water quality	Treatment of newly constructed factories	(18,606)**	(810)	(2,856)
			Treatment of domestic wastewater (Ocumare del Tuy)	4,914	172	713
			Treatment of domestic wastewater (S. F. de Yare)	14,100	343	1,892
			Treatment of domestic wastewater (El Consejo)	13,100	300	1,741
		and quantity	Lessening turbidity (reforestation)	5,130	33	597
			Lessening turbidity (sand settling pond)	11,391	627	1,880
			(Sub-total)	48,635	1,475	6,823
			Institutional measure	Monitoring	0	177
	Public education	0		40	40	
	Environmental fund	18,606		120	2,167	
	(Sub-total)	18,606		809	2,384	
Total				67,241	2,284	9,207

^a Annual Cost = Initial Cost × Annuity Cost (0.11-0.13) + O&M Cost

** The cost is included in the Environmental Fund.

5.4 Financial Evaluation of the Master Plan

As for the treatment of industrial and piggery wastewater, supposing factories and piggeries avail themselves of the Environmental Fund, they will set aside around

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0.5% of their annual sales as repayment to the fund. This amount is regarded to be within their capability.

Between 1% and 2% of the monthly income of households will cover the cost for treatment of domestic wastewater in the four urban centers concerned, because 2% is believed to be the maximum limit households can afford as payment for sewerage services.

Regarding turbidity, basically, public financing through the annual allocation of around 0.3% of the budgets of MARNR, Miranda State, and Aragua State is proposed to cover the cost of reducing turbidity.

As for the securement of water quantity, households in the CMA (Caracas Metropolitan Area) should shoulder the cost because they are the main beneficiaries. The proposed additional water charges will correspond to about 0.17% of their monthly income, which is well within their financial affordability.

All the measures proposed under the project are found to be financially feasible, if the conditions for cost recovery mentioned above are met.

5.5 Summary of the Master Plan

Based on the study results, the outline of the Master Plan is prepared, as presented in Table S-2.

6. Feasibility Study of Priority Projects

The Feasibility Study was conducted for priority projects included in the Short Term Program as mentioned in 5.2.3.

6.1 Structural Measures

6.1.1 Installation of Treatment Plants for Factories and Piggeries

In the Master Plan, it was concluded that the main sources of BOD, toxicants and turbidity are the factory and piggery effluents. To achieve the set targets it is, therefore, necessary to install treatment plants for factories and piggeries that are not complying with the water quality standards.

In the Feasibility Study, the characteristics of the standard treatment plants were examined. According to the examination it is possible to estimate the cost to install treatment plants based on the category of the industry, as shown in the table below. The total cost required to install a treatment plant at the existing factories is US\$13,852,000 and that at factories newly built until 2003 is US\$9,965,000.

Installation Cost of Standard Treatment Plant

Treatment Plant Process	Industry	Scale	Quantity (m ³ /day)	Installation Cost (US\$ thousand)
Biological	Food	Small	40	250
		Middle	200	500
		Large	500	651
Biological plus Physical-chemical	Textiles	Small	30	149.7
		Middle	100	280
		Large	300	422.6
Physical-chemical	Chemical	Small	20	90
		Middle	40	170
		Large	100	225.4
Physical-chemical	Metal	Small	10	75.5
		Middle	30	188
		Large	100	339
Physical-chemical	Tannery	Small	50	230
		Middle	-	-
		Large	-	-
Sedimentation	Sand Quarries	Small	200	68
		Middle	-	-
		Large	-	-
Biological	Piggery	Small	5	29.8
		Middle	15	48
		Large	40	90

6.1.2 Sand Settling Pond at Toma de Agua

Water pollution resulting from high turbidity causes suspension of water intake. Moreover, high turbidity requires a large amount of O&M to remove the sediment deposited in the pre-treatment plant at Toma de Agua. To reduce the time of suspension as well as the cost of O&M, the necessity of sand settling pond at Toma de Agua was identified in the Master Plan.

In the Feasibility Study, the effectiveness of the sand settling pond was further examined and the dimensions of the proposed structure are outlined on a topographic map, scale 1/1,000. Based on the dimensions, the preliminary design and cost estimate were made. It is calculated that over a year the sand settling pond will remove 166,060 m³ of sediment, which corresponds to 71% of the sediment flowing into the pond. The sand settling pond is planned to naturally discharge into the Tuy River through the operation of the pond's gate. Thus, the sand settling pond will reduce the maintenance cost of extracting the sediment. Fig. S-4 shows the outline of the sand settling pond.

6.1.3 Sewage Treatment Plant

One of the major organic pollution sources is domestic wastewater, comprising 47% of the total BOD effluent load entering the Tuy River. To reduce the BOD effluent load, the necessity of sewage treatment plants for the urban areas of Ocumare del Tuy and Las Tejerías was identified in the Master Plan. Among the several treatment methods examined the trickling filter method was selected, mainly because of the low maintenance this form of treatment requires.

Summary

In the Feasibility Study, an additional study was made to determine the inflow quantity, quality and treated water quality targets for the sewage treatment plants.

The design features of the proposed treatment plants were examined and a preliminary design was drawn on a 1/1,000 topographic map. The cost was estimated based on this preliminary design. Outlines of the Ocumare del Tuy and Las Tejerfas sewage treatment plants are shown in Figures S-5 and S-6.

6.1.4 Reforestation

To achieve the turbidity target for the Mid-Term Program (SS=750 mg/l), an area of 10,200 hectares was proposed for reforestation. In the Feasibility Study, the most effective areas (3,400 ha) were selected to achieve the Short-Term target of 920 mg/l (refer to Fig. S-7). The reforestation plan includes selection of suitable tree species, the proposed construction of a tree nursery, and a planting and maintenance plan. The necessary costs were estimated based on this plan.

6.2 Feasibility Study for Institutional Measures

6.2.1 Provision of Laws and Regulations

In the Master Plan, the following points concerning the provision of laws and regulations were identified:

- The current environmental problems are covered by an existing legal framework consisting of about 35 laws and regulations.
- Complementary laws and regulations should be promulgated to give a more complete coverage of these laws and regulations.
- The necessary measures to be taken are to implement a fiscal incentive scheme, to create of an environmental fund and impose pollution charges, and to amend the water quality standards.

In this context, further study was carried out:

- For the fiscal incentive scheme, tax deduction for the cost of treatment plant was examined and it was clarified that the current tax reduction law be applied for this purpose.
- For the creation of an environmental fund and imposition of pollution charge, it is proposed to introduce a new law which includes the objective and administration.
- For the amendment of water quality standards, it is proposed that Type IB, Decree 833, is applied to the Tuy River, and that new standards for BOD and SS be included.

6.2.2 Proposed Organization for Implementation of Project

MARNR is presently in the process of strengthening its organization including decentralization of its function to state governments under the Venezuelan Environmental Management Project which is being financed by the World Bank and

some institutions under it may be reorganized like the Tuy River Basin Agency and Hidrocapital. In this study, however, it is presumed that present organization of the Tuy River basin Agency or, at least, its basic function of handling works in the basin will be maintained, because such function covering a wide area would be difficult to handle by decentralization to the local government.

Under the above assumption, MARNR will act as the counterpart institution, and the offices of the Tuy River Basin Agency and Hidrocapital will coordinate the execution through a Coordination Committee.

Since the Tuy River Basin Agency has no experience in executing a project of this magnitude, it is proposed to create a new section in the Agency, the Project Executing Unit (PEU) which will execute the works for the Agency. In the case of Hidrocapital, the works will be executed by the existing office of Management of Projects, Works and Contracts within the Vice-Presidency of Conservation and Development.

A general view of the execution of the several components of the project is shown in Fig. S-8.

6.2.3 Establishment of Monitoring System

To collect basic information on the state of the rivers, the necessity of the establishment of a monitoring system was identified in the Master Plan. In the Feasibility Study stage further study was undertaken putting emphasis on monitoring procedures including river conditions, monitoring frequency and monitoring items as well as the provision of necessary equipment and staff (refer to Fig. S-9). An estimate of costs including O&M was also undertaken.

6.2.4 Establishment of Environmental Fund

The main reason why the installation of factory and piggery treatment plants is not being promoted is because of lack of funding especially for medium and small size factories and piggeries. To encourage factory and piggery owners to install treatment plants, the establishment of an environmental fund was proposed in the Master Plan. In the Feasibility Study, the framework of the environmental fund was further studied in terms of function, financing, organization, etc.

It is proposed that the operation and management including screening loan applicants and the lending services of the environmental fund be carried out by an existing government banking organization such as FONCREI, CORPO-INDUSTRIA and/or FCA. The size of the Fund is US\$23,817 thousand for the installation of treatment plants. The breakdown is shown in the table below:

Summary

Industry	Scale	Nos.	Installation Cost of Treatment Plant(US\$)	
			Total	Per Industry
Factories	Large	17	6,200,000	364,700
	Middle	32	9,374,000	292,900
	Small	60	6,838,100	114,000
Piggeries	Large	11	900,000	82,000
	Middle	5	192,000	38,000
	Small	12	312,900	26,000
Total		137	23,817,000	173,800

The lending terms are tentatively proposed to be the annual interest rate of 6.8% (US\$ basis), the grace period of 3 years and the repayment period of 15 years.

6.2.5 Establishment of Pollution Charge

Under the current regulations on the environmental aspects it has not been possible to obtain a quick response from the industry and piggery owners to abide by the regulations. Further compulsory measures are therefore necessary to push them further to comply with the established water quality standards and, to attain this goal, pollution charges (PC) for factories and piggeries which do not comply with the water quality standard are considered.

Basically the pollution charge is set in the following manner:

- Selection of main pollution parameters like: BOD, SS, Cd, Hg, toxicants, etc.
- Estimation of cost of decontamination of water per unit volume (for example a cubic meter, or a liter), based on the selected parameters.
- The estimated cost to treat the waste water will be charged against industries or piggeries according to the degree of pollution they have. This will be the pollution charge.
- The pollution charge may be increased periodically (e.g., every year) in some percentage (e.g., 100%), to force polluters to abide by the regulations as soon as possible.

6.2.6 Establishment of Environmental Education Program

For the effective implementation of the environmental improvement project, the necessity of establishing an education program at the following levels was confirmed: (1) schools, (2) general public, and (3) factory and piggery operators. To clarify the framework of the education system the Feasibility Study put emphasis on the educational program for environmental awareness, organization and training of personnel, necessary equipment and materials, and the cost to sustain the system.

7. Project Evaluation

7.1 Effect of Implementation of Priority Projects

It is expected that the implementation of the Priority Projects will have an effect similar to that of the Master Plan, although the achievement will remain within the short-term target. The water quality of the Tuy River will improve and the present bad smelling and dirty colored water will change to that with less smell and more natural color, although it may not reach the condition where aquatic life will recover in the upper stream. Furthermore, as a substantial impact on the health of the people, the river water can be used as a safe water resource with less coliform and heavy metals for water supply to the Caracas Metropolitan Area.

7.2 Cost and Benefit

7.2.1 Financial Cost

Based on the preliminary design and design features of priority projects, the financial cost was estimated as summarized in the following table.

Project	Initial Cost	O&M Cost
Installation of Treatment Plants in Factories	(23,817)*	(1,903)
Construction of Sand Settling Pond for Intake	6,245	17
Construction of Sewerage System in Ocumare del Tuy	26,763	341
Construction of Sewerage System in Las Tejeiras	11,368	194
Reforestation in Priority Areas	3,347	-
Environmental Fund	24,017	177
Monitoring and Education System	658	116
Total	72,398	845

* The cost is included in the Environmental Fund.

7.2.2 Benefit

In general, some essential benefits from the implementation of environmental improvement projects are hard to evaluate in monetary terms. (Benefit is examined in monetary terms only to obtain an indicative figure and, the EIRR of 17.6% is obtained. See page I-55 of Sector I in Volume V.) Here, the benefit is presented in a descriptive manner.

Direct Benefits

As the direct benefit, the following are considered:

- Water quality improvement brings about better environment of Tuy river. The present dirty colored and bad smelling water will change to that with less smell and less dirty colored water.

Summary

- The removal of BOD and turbidity substances brings about the reduction of times of water intake suspension due to color, odor and turbidity. This also brings about a reduction of operation and maintenance cost for treatment of water.
- The Tuy River water can be used as a safe water resource with less coliform and heavy metals for water supply to the Caracas Metropolitan Area.

Indirect Benefits

As the indirect benefits the following effectiveness are expected:

- As the result of water quality improvement, the estate value along the river course will appreciate.
- Waterborne diseases will be reduced.
- The tourism resource value of the Tuy River basin will appreciate.
- The existence value of the Tuy River basin will appreciate.

7.3 Financial Evaluation

The total cost for the six F/S projects comes to US\$72 million. Its breakdown by project and by financial source is presented below.

(US\$ thousand)

Project	External Source	Government Budget	Total
Construction of Sand Settling Pond for Intake	6,245	-	6,245
Construction of Sewerage System in Ocumare del Tuy	9,367	17,396	26,763
Construction of Sewerage System in Las Tejerías	2,274	9,094	11,368
Reforestation in Priority Areas	3,347	-	3,347
Environmental Fund	24,017	-	24,017
Institutional Measures (Exc. Environmental Fund)	658	-	658
Total	45,908	26,490	72,398

As the above table shows, foreign resources amount to US\$46 million accounting for 63.0% of the total cost and local resources amount to US\$26 million accounting for 37%. It is recommended that the Venezuelan government starts discussion with international agencies such as the World Bank, IDB and OECF for financing the foreign resources.

Project	Cost-Bearer	Payment in Percentage	Payment (US\$)
Construction of Sand Settling Pond for Intake	Households in CMA	0.0145% of income	0.072 /month /household
Construction of Sewerage System in Ocumare del Tuy	Households (H) and Factories (F)/Piggeries (P) in Ocumare del Tuy	0.90% of income (H), 0.17% of sales (F/P)	4.56/month /(H), 9,625/year/(F), 398/year/(P)
Construction of Sewerage System in Las Tejerías	Households (H) and Factories (F)/Piggeries (P) in Las Tejerías	0.90% of income (H), 0.22% of sales (F/P)	4.45/month /(H), 12,456/year/(F), 515/year/(P)
Reforestation in Priority Areas	MARNR, Miranda State, Aragua State	0.048% of budget	234,000 /year
Environmental Fund	Factories, piggeries	0.59% of sales	33,406/year /factory 1,381/year /piggery
Institutional Measures (Exc. Environmental Fund)	MARNR	0.070% of budget	147,000/year

The above table summarizes the affordability of cost-bearers for the six projects. The repayment, O&M and replacement costs for "construction of sand settling pond for intake" will be met from the incomes of CMA households. Both the ratio to income and the amount of the charge per household will be very small.

The cost of "construction of sewage treatment plant in Ocumare del Tuy" will be borne by the households and factories/piggeries of that town. Both the ratio to income and the amount of the charge per household appear to be reasonable. Also, both the ratio to sales and the amount of the charge per factory/piggery appear to be reasonable.

The cost of "construction of sewage treatment plant in Las Tejerías" will be borne by the households and factories/piggeries of that town. Both the ratio to income and the amount of the charge per household appear to be reasonable. Also, both the ratio to sales and the amount of the charge per factory/piggery appear to be reasonable.

MARNR, Miranda State and Aragua State will together shoulder the cost for "reforestation in priority areas". The ratio of the payment to budget will be 0.048%, the annual payment coming to US\$234 thousand. This seems to be not a heavy obligation.

Each factory and piggery will outlay 0.59% of their sales as repayment to the Environmental Fund. It means that each factory and piggery will annually pay US\$33,406 and US\$1,381, respectively. This is not a heavy burden.

MARNR will shoulder the cost for "institutional measures other than the Environmental Fund". The ratio of the payment to budget will be 0.070%, the annual payment coming to US\$147 thousand. This seems to be not a heavy obligation.

As a conclusion it can be said that all the six projects under study as the short-term program are financially feasible.

Summary

8. Environmental Impact Assessment

Projects Require EIA

Environmental Impact Assessment (EIA) is required as part of a feasibility study to describe characteristics of the project and potential natural and social impacts resulting from project implementation. It will also propose a suitable approach to identify significant impact and impact sources, and proper measures should be suggested to mitigate adverse effects of the project.

Among the project components in the Feasibility Study, the following studies are required:

Project	Judgment by ACRT
Sewage Treatment Plant in Ocumare del Tuy	EIA required
Sewage Treatment Plant in Las Tejerías	EIA required
Sand Settling Pond at Water Intake	EIA not required, but evaluation of specific environment required
Reforestation in Priority Areas	EIA not required

Predictable Impact Item

Impact prediction is based on all activities relating to project implementation. Considering project characteristics, it has to lead to a positive way in improving present environments in the Tuy River basin. Nevertheless, adverse impacts can also be predicted in the process of implementation, and proper measures should be taken to protect or minimize negative effects accordingly. In parallel, impact significance is evaluated on each predictable impact item, which is picked up based on the study on environmental conditions as shown below:

Environmental Condition	Predictable Impact Items
Natural Conditions	Water quality of Tuy River, Sediment, Aquatic biology
Social Conditions	Generation of stench and insects, Illegal land use, Traffic congestion, Noise, Dust

Environmental Management Plan

Predictable impacts and appropriate measures for construction of sewage treatment plants and sand settling pond can be put to practical use for the preparation of the environmental management plan.

Managing item for construction of these structures is specified in each stage of project implementation describing impact source, measuring standard and strategic approach. Management location and responsible organization should also be mentioned in this regard. The overall view of environmental management plan is shown in Table S-3 (Sewerage Treatment Plant) and Table S-4 (Sand Settling Pond).

Environmental Monitoring Plan

Based on the identification of natural and social environmental impacts, monitoring should be carried out as follow-up action after facility construction. In general, it should be undertaken in such a way that the Tuy River Basin Agency or the Hidrocapital should establish a monitoring system as proposed in this study and be engaged in regular site inspection, field measurement and sample analysis. The matrix of environmental monitoring plan is presented in Table S-5 (Sewerage Treatment Plant) and Table S-6. (Sand Settling Pond).

9. Pre-Feasibility Study on Securement of Water Quantity

9.1 Subject Plans for Pre-Feasibility Study

Subject plans for pre-feasibility study are as follows:

(1) Effective Utilization of Existing Reservoirs

Ocumarito Reservoir is full to capacity for 4.3 months of the year on average. During this period, water is spilled from the Ocumarito Reservoir and flows down to lower reaches without utilization at Toma de Agua. Accordingly, the utilization plan for the Ocumarito River is studied to minimize spill at Toma de Agua in the rainy season (refer to Fig. S-10 and S-11).

(2) Development of New Dams

Construction of dams on tributaries to minimize spill at Toma de Agua in the rainy season is considered. Guare Dam and El Peñón Dam are the possible ones (refer to Fig. S-12). El Peñón Dam Plan is considered in combination with the effective utilization of existing reservoirs.

9.2 Unit Benefit for the Securement of Water Quantity

Unit benefit for the calculation of benefit of the water resources development plan was determined. Two kinds of values are deemed applicable for the unit benefit in the present study; namely, the unit construction cost of the Tuy IV-Taguaza-Cuira system and the annual production cost of the Tuy System used by Hidrocapital for the evaluation of new projects.

The following table presents a summary of the values obtained in the above analysis (for detail, see Sector F).

System	Unit construction/Marginal cost (US\$/m ³)
Taguaza-Taguacita Interconnection	0.262
Tuy IV-Taguaza (overall)	0.143
Tuy IV-Cuira	0.109
Annual production cost of Tuy System	0.327

Summary

As the unit benefit, the annual production cost of the Tuy System was applied considering the effectiveness of the project implementation in comparison with the present system.

9.3 Results of the Pre-Feasibility Study

The optimum size for each plan was first selected in the pre-feasibility study. Further, comparison study was made among the plans with the optimum sizes. The following tables compare the efficiency of the optimum case as to Net Present Value (B-C), Benefit-Cost Ratio (B/C), and unit cost per cubic meter of water.

Plan	Capacity	Ave. annual diverted water		Const. Cost *3 \$mil	B-C *4 \$mil/yr	B/C	Unit Cost \$/m ³
		10 ⁶ m ³ /y r	m ³ /s				
Torrent div. of Súcuta	Q=1.34	5.84	0.19	16.4	-0.06	0.97	0.337
O-L div. *1	Q=2.0 m ³ /s	10.2	0.32	19.4	1.01	1.43	0.228
O-L div. with El Peñón Dam	Q=2.0 m ³ /s	13.9	0.44	41.0	-0.61	0.88	0.371
O-Tuy III pumping	Q=5.0 m ³ /s	20.3	0.64	9.88	4.00	2.52	0.130
Guare Dam	Eff.40×10 ⁶ m ³ *2 Dam height: 61m	55.4	1.76	76.1	8.19	1.82	0.179

Note: *1: O-L div.: Ocumarito-Lagartijo diversion
 *2: Effective storage capacity
 *3: Construction cost
 *4: Unit benefit is \$0.327

Based on this comparison results, the following conclusions are obtained:

- As the optimum plans, the use of Ocumarito River with pump and construction of Guare Dam are recommended to develop approximately 2.0 m³/s of water.
- As for the use of Ocumarito River, the pumping plan with a capacity of 5 m³/s is recommended. By the pump capacity, it is possible to divert the water of 0.64 m³/s on an average to the Tuy III system.
- As for the construction of Guare Dam, the optimum size is decided at 40×10⁶m³, gross storage capacity with a dam height of 60 m. With this capacity, the water of 1.76 m³/s on an average can be developed.

Since these results are still on a pre-feasibility level, it is necessary to conduct a more detailed study to identify the feasibility.

10. Conclusion and Recommendation

10.1 Conclusion

In this Study, the Master Plan to secure a potable water supply with acceptable water quality and to establish a sustainable pollution control system was formulated consisting of two stages, the Short-Term Program and the Mid-Term Program targeting the year 2010. To facilitate the realization of the Master Plan, priority projects in the Short-Term Program with the target year of 2003 were selected and their feasibility was examined. It is concluded that as a whole the priority projects are technically feasible and financially viable.

10.2 Recommendation

Arrangement for Project Implementation

(1) Justification of the Master Plan

The environmental improvement of the Tuy River is crucial; hence, the Master Plan formulated for the purpose should be considered as a part of the Venezuelan National Development Plan.

(2) Implementation of Priority Projects

The priority projects are technically feasible and financially viable as a whole; hence, it is recommended that they be promoted to the next stage of implementation at the earliest possible opportunity. (The necessary procedure toward implementation is shown in the ANNEX in Volume 3.)

(3) Arrangement of Loan from Available Financing Source

To implement the projects, it is necessary to obtain a loan from an international financing agency. Therefore, it is recommended that appropriate action be taken to arrange a loan from an available financing source.

(4) Promotion of Institutional Measures

The priority projects are composed of physical and institutional measures. To implement the physical measures smoothly, it is necessary to arrange the institutional measures first. Since most institutional measures with the exception of the Environmental Fund can be provided with less financial burden, it is recommended that the arrangement of institutional measures be promoted along with the arrangement of the loan.

(5) Promotion of Legal Arrangement

New laws are proposed to be enacted to establish the Environmental Fund and to impose pollution charges for the purpose of promoting the installation of sewage treatment plants by factories and piggeries. In this study, only the outlines of the laws are introduced, because the enactment of new laws will

Summary

need further study to clarify details such as scope, conditions, applicability, functions of authorities and so on. In this connection, it is recommended that a study should be started immediately by the Tuy River Basin Agency to define the contents of laws for the early realization of legal arrangements.

(6) Consideration of Restructuring and Decentralization

MARNR is presently in the process of strengthening its organization including decentralization of its function to state governments under the Venezuelan Environmental Management Project which is being financed by the World Bank, and some institutions under it may be reorganized like the Tuy River Basin Agency and Hidrocapital. In this study, however, it is presumed that the present organization of the Tuy River Basin Agency or, at least, its basic function of handling works in the basin is maintained. If ever the present organization is reorganized, it is recommended that its function to realize the project components proposed in this study is maintained considering the significance of the projects and the extent of the study area.

(7) Arrangement for Land Acquisition for Physical Measures

To implement the physical measures such as sewage treatment plants and sand settling pond, it is necessary to acquire land for the facilities. In this connection it is recommended that action be taken to acquire land for the structures as early as possible.

(8) Promotion of Cooperation and Understanding from Local People

For the execution of physical measures including the installation of treatment plants for factories and piggeries, the construction of sewerage system and reforestation, it is necessary to strengthen the cooperation and to deepen the understanding of local people. Information about the project should be advertised from time to time to obtain their cooperation and understanding.

(9) Consideration of Environmental Impact Assessment

In the study of environmental impact assessment, several impacts have been identified. Although these impacts are not serious, mitigating measures are proposed together with impact management and monitoring plans. For project implementation, these measures and plans should be taken into account.

Further Study in the Next Study Stage

(1) Study on Sewage Treatment Plant and Sewage Drainage Network

As the most suitable sewage treatment plant at present, the trickling filter method has been selected because of its technical and economical advantages, though it requires a larger space than the other systems like the activated sludge method. Since the adequacy of the system will depend on space availability and the sewage volume to be received, system improvement should be examined in stages in the future according to the future increase of

population. Also, development of sewage drainage network should be examined in the future according to the area of urban development.

(2) Study on the Establishment of Sewage Charge System

To establish the sewage charge system, it is necessary to firstly identify who should pay. Then the sewage charge to be imposed to polluters (and beneficiaries) will be set depending on their discharged wastewater volume (and amount of water consumption). In this F/S study, only the alternatives of cost bearers for the construction and O&M costs of the sewage system have been examined for financial evaluation. Hence, the sewage charge system as well as cost sharing should be examined further after confirmation of the cost by detailed design.

(3) Utilization of Sludge and Treated Wastewater

The sewage treatment plant will discharge sludge and treated wastewater as a result of the treatment process, and these are high in organic nutrients. Since these can be used as fertilizer for agricultural production, utilization of such products should be considered in neighboring farming areas.

(4) Construction of Sand Settling Pond

As a measure to secure the water quantity, a sand settling pond at Toma de Agua has been proposed and the effectiveness of this measure which depends on the sediment materials transported in the river has been confirmed based on the limited data observed in the feasibility study level. For the further study, it is necessary to collect more information on sediment materials in the river water.

(5) Securement of Water Quantity

For the securement of water quantity, several measures have been examined in the pre-feasibility study level to select the optimum ones. The measures include: (1) torrent diversion; (2) Ocumarito - Lagartijo diversion, (3) Ocumarito - Lagartijo diversion with El Peñón Dam, (4) Ocumarito - Tuy III system pumping, and (5) Guare Dam and it has been concluded that the Ocumarito - Tuy III system pumping and the Guare Dam have economic advantages and therefore selected as the Short-Term Program measures. Since the study for these measures has been only on the pre-feasibility level, it is necessary to conduct a feasibility study as early as possible.

(6) Items to be Examined for the Establishment of Pollution Charge

The following items are proposed to be further examined to establish the pollution charge: polluters and water quality levels for which pollution charge is to be applied, rate of charge, system of charge collection, and monitoring of polluters. These items should be examined by a further study by the Tuy River Basin Agency, which may be undertaken with technical cooperation from

Summary

JICA. For that purpose, references on legislation such as France, Spain, Germany and so on are proposed to be collected.

(7) Collection of More Information for Further Study

The study has been conducted based on the limited information collected. Since the information on water quality and quantity is essential to precisely analyze the environmental condition, more detailed data and information should be produced for further study through early establishment of the monitoring system.

FEATURES OF STRUCTURAL MEASURES OF THE PRIORITY PROJECTS

1. Installation of Treatment Plant for Factories and Piggeries

Condition	Number of Factories and Piggeries with Treatment				Cost(US\$1,000)	
	Fulfill Standard	Partly equipped but not fulfill Standard	No Treatment	Total	Installation	O&M
Existing	41	12	80	133	13,852	1,107
Built by 2003	-	-	-	44	9,965	796
Total	-	-	-	177	23,817	1,903

2. Sand Settling Pond at Toma de Agua

- Location: Right bank of the Tuy River near Toma de Agua
- Water Intake Point: 650 m upstream from the existing weir of intake at Toma de Agua
- Discharge Point: Immediately downstream of the existing weir of intake at Toma de Agua
- Pond Size: Length × Width × Depth = 100 m × 50 m × 3 m
- Reduction of Sediment Volume: 166,060 m³/year (71% of total sediment 19,595 m³/year flowing into the pond)
- Initial Cost: US\$6,245,000
- O&M Cost: US\$17,000
- Implementation: From 2000 to 2002

3. Sewage System in Ocumare Del Tuy

Design Condition

- Objective Area: 3,636 ha. (Urban area of Ocumare del Tuy, Piloncito and Santa Barbara)
- Population of the Objective Area: 114,135 in 2003 and 155,277 in 2010
- Water Quality of Inflow to Treatment Plant: (See table below)

Summary

Category	Target year 2010					Target year 2003				
	Daily Mean (m ³ /day)	LOAD (kg/day)		CONC (mg/l)		Daily Mean (m ³ /day)	LOAD (kg/day)		CONC (mg/l)	
		BOD	SS	BOD	SS		BOD	SS	BOD	SS
Domestic Wastewater	51,241	8,385	8,540	164	167	31,764	6,163	6,277	188	192
Industrial Wastewater	2,352	823	941	350	400	1,583	554	633	350	400
Total	53,594	9,208	9,481	172	177	34,347	6,717	6,910	196	201

* Concentration of industrial wastewater, Standard value of discharging to sewer

- Target Water Quality discharged from Treatment Plant: BOD 15 mg/l

Outline of Sewage Treatment Plant

- Method of Sewage Treatment Plant: Trickling filter method until 2003 and gradually transfer to activated sludge process method after 2003
- Area for Sewage Treatment Plant: about 40 has.
- Major Facilities: Pumping Station, Settling Tank, Trickling Filter, Sludge Thickeners, Sludge Digester, Gas Storage Tank, Sludge Drying Bed and Regulation Pond

Drainage Network

- Trunk drainage pipeline: 10.1 km in total
- Secondary drainage pipeline: 52.65 km in total

Cost and Schedule

- Construction Cost: US\$26,763,000
- O&M Cost: US\$341,000
- Implementation Period: 1998 to 2003 (First Stage) then continues according to urban expansion

4. Sewage System in Las Tejerías

Design Condition

- Objective Area: 495 has. (Urban area of Las Tejerías)
- Population of the Objective Area: 20,246 in 1990, 26,898 in 2003 and 30,825 in 2010
- Water Quality of Inflow to Treatment Plant

Category	Target year 2010					Target year 2003				
	Daily Mean (m ³ /day)	LOAD (kg/day)		CONC (mg/l)		Daily Mean (m ³ /day)	LOAD (kg/day)		CONC (mg/l)	
		BOD	SS	BOD	SS		BOD	SS	BOD	SS
Domestic Wastewater	8,785	1,581	1,611	180	183	6,550	1,380	1,405	211	215
Industrial Wastewater	6,860	2,401	2,744	350	400	4,826	1,689	1,931	350	400
Total	15,645	3,982	4,354	255	278	11,376	3,069	3,336	270	293

*Concentration of industrial wastewater, standard value of discharging to sewer

- Target Water Quality discharged from Treatment Plant: BOD 25 mg/l

Outline of Sewage Treatment Plant

- Method of Sewage Treatment Plant: Trickling filter method
- Area for sewage Treatment Plant: about 20 has.
- Major Facilities: Pumping Station, Settling Tank, Trickling Filter, Sludge Thickeners, Sludge Digester, Gas Storage Tank, Sludge Drying Bed and Regulation Pond

Drainage Network

- Trunk drainage pipeline: 12.68 km in total
- Secondary drainage pipeline: 4.3 km in total

Cost and Schedule

- Construction Cost: US\$ 11,368,000
- O&M Cost: US\$ 194,000
- Implementation Period: 2000 to 2003

5. Reforestation in Priority Areas

- Location of reforestation area: 3,400 ha in Maitana River Basin
- Reduction of Suspended Solid Volume: 22,080 m³
- Tree Type Adopted: Cuji for the fire resistance belt and Cliriscidia sp. and Bauhinia for the mixed plantation
- Planting Density: 1,344 trees/ha
- Blocking of Reforestation Area: 5 blocks, which is further divided into compartments from 100 ha to 300 ha.

Summary

- **Nursery Plan:** Utilization of Existing nursery station of MARNR of 0.28 ha and new nursery of 1.3 ha is built inside of the proposed sewage treatment plant at Las Tejerías.
- **Construction Cost:** US\$ 3,347,000 (O&M Cost: Negligible)
- **Implementation Period:** from 1998 to 2003

TABLES

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Table S-1 (1/2) Summary of Key Issues for Water Quality

Major Problem

Organic Pollution	Toxicant	Turbidity
<ul style="list-style-type: none"> - Destruction of original function (place of aquatic life) of the river - Problem on water supply - Suspension of intake - Use of much chlorine (effect to human health) - High treatment cost for color, odor, etc. 	<ul style="list-style-type: none"> - Potential damage to human health - Problem on water supply - Suspension of intake - Effect to human health 	<ul style="list-style-type: none"> - Destruction of esthetic environment of the river - Problem on water supply - Suspension of intake - High pre-treatment cost to remove sediment

Indicator

Organic Pollution	Toxicant	Turbidity
- BOD (coliform is represented by BOD)	- Heavy metals (Pb, Cr, Cu, Zn)	- SS

Pollution Source

Organic Pollution	Toxicant	Turbidity
Factory: Alcohol, Food, Textile, Others Piggery Residence	Factory: Metal plating, Tannery, Others	Factory: Sand quarry, organic pollution Basin: Basin erosion

Ongoing Pollution Control Efforts (Technical Measure)

Organic Pollution	Toxicant	Turbidity
<u>Factories and Piggeries</u> <ul style="list-style-type: none"> - Most of the factories have plans to install treatment plants prepared with the assistance of a consultant - There are also studies by GTZ for the installation of treatment plants of several representative factories and for improvement in production process <u>Domestic Wastewater</u> <ul style="list-style-type: none"> - Sewerage networks (could be used in the future) have been established in major urban centers 	<u>Factories</u> <ul style="list-style-type: none"> - Treatment is basically conducted 	<u>Factory (Sand Quarry)</u> <ul style="list-style-type: none"> - Some are installed with sand settling ponds, and in these factories, turbidity of effluent is less <u>Other Factories</u> <ul style="list-style-type: none"> - Same with the items in the column of factories for organic pollution <u>Countermeasure for use</u> <ul style="list-style-type: none"> - Hidrocapital uses pre-treatment for removal of turbidity <u>Basins erosion</u> <ul style="list-style-type: none"> - No countermeasures are conducted

Present Problems (Technical Aspect)

Organic Pollution	Toxicant	Turbidity
<u>Factories and Piggeries</u> <ul style="list-style-type: none"> - Only 50% of the factories have treatment plant and actual installation of treatment plants is not progressing well due to lack of funds <ul style="list-style-type: none"> - In addition, necessity of (to be continued) 	<u>Factory</u> <ul style="list-style-type: none"> - Due to bad maintenance, toxicant flows from some factories. - Factories lack in technical staff for maintaining treatment plants and O&M is not properly conducted <ul style="list-style-type: none"> - Necessity of treatment to 	<u>Factory (Sand Quarry)</u> <ul style="list-style-type: none"> - Actual installation of the plants is not in good progress due to lack of funds - Necessity of treatment to meet the water quality standard is not well recognized by owners, thus education is necessary <u>Other Factories</u>

Table S-1 (2/2) Summary of Key Issues for Water Quality

(continued from the previous page)

<p>treatment to meet the water quality standards is not well recognized by owners, thus education is necessary</p> <ul style="list-style-type: none"> - Factories lack technical staff for maintaining treatment plants and O&M is not properly conducted <p><u>Domestic Wastewater</u></p> <ul style="list-style-type: none"> - Treatment plants are either not installed or inoperable except in some residential complexes and the overall treatment rate is very low 	<p>meet the water quality standard is not well recognized by owners, thus education is necessary</p>	<ul style="list-style-type: none"> - The same with the items in the column of factories and piggeries for organic pollution <p><u>Countermeasure for use</u></p> <ul style="list-style-type: none"> - Cost for pre-treatment is high for the removal of sediment <p><u>Basins erosion</u></p> <ul style="list-style-type: none"> - No countermeasures are being conducted
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Institutional Measures already Undertaken and Present Problems

Organic Pollution	Toxicant	Turbidity
<p style="text-align: center;"><u>Laws and Regulations</u></p> <p style="text-align: center;">Laws and regulations are sufficient to a large extent.</p> <div style="border: 1px solid black; padding: 5px; width: fit-content;"> <p>Current water quality standards Decree No.883 do not include a limit for BOD; it should be included</p> </div> <ul style="list-style-type: none"> - Installation of treatment plants by factories is not progressing well; provision of necessary laws and regulations to enhance the installation is needed 		
<p style="text-align: center;"><u>Enforcement of Laws</u></p> <ul style="list-style-type: none"> - Enforcement of these laws and regulations are not adequately conducted. - Application of punitive action is necessary in combination with a strong support system. - Monitoring is conducted with the assistance of GTZ; strengthening of the monitoring system is necessary for the enforcement of the laws. 		
<p style="text-align: center;"><u>Organization and Operational Management</u></p> <ul style="list-style-type: none"> - Training in environmental aspect is needed for the technical personnel of ACRT - Strengthening of function of ACRT is needed - Budget of ACRT is not sufficient 		
<p style="text-align: center;"><u>Public Awareness of the Environment</u></p> <ul style="list-style-type: none"> - Environmental education is performed by ACRT; it should be strengthened - Seminars focusing on manufacturers have been conducted by the program of GTZ; it should be strengthened - Appropriate countermeasures should be taken for forest fires that cause devastation of the basin and resultant erosion and sediment discharge 		

Table S-2 (1/2) SUMMARY OF MASTER PLAN

Stage	Category	Objective	Project	Outcome	Procedure	Timing	Responsible agency #1	Effectiveness #2 (US\$1,000/ton/day)	Economic priority (US\$1,000)	Financial cost (US\$1,000)	Method of cost recovery	Report reference
Short Term Program	Technical measure	Water quality improvement	Installation of treatment plant to existing factories and piggeries	Reduction of BOD pollution of 0.49 kg/day	Installation of treatment plant to factories with support of institutional measures	2000-2003	(1) Factory and piggeries owners (2) ACRIT	\$3,864 /ton/day	4	\$11,998	Factory and piggeries owners pay the cost	6.1.1 (Vol. 2)
			Installation of treatment plant to factories (newly constructed)	Reduction of SS pollution	Installation with support of institutional measures	2000-2003	(1) Factory owners (2) ACRIT	\$2,473/ton/day	3	\$10,791	-do-	6.1.1 (Vol. 2)
			Installation of sewage treatment plant and its operation	Reduction of BOD pollution of 0.67 ton/day, SS and Toxicant	Installation of sewage treatment plant in the area of Ocunimiro del Tuy	1997-2003	(1) ACRIT (2) State Gov.	\$1,333/ton/day	2	\$28,020	Charge to households and factories	6.1.1 (Vol. 2)
			Reforestation	Reduction of BOD pollution of 4.07 ton/day*5	Installation in the area of Las Tejerias	2000-2003	(1) ACRIT (2) State Gov.	\$422 /ton/day	1	\$12,700	- do -	
			O-Tuy III pumping and construction of Quare dam	Reduction of Turbidity of 35 mg/l	Reforestation in Matina basin	1997-2003	(1) ACRIT (2) State Gov.	\$9.1/mg/l	1	\$2,520	Government pay the cost	6.1.1 (Vol. 2)
			Installation of sand settling pond and operation	Securement of water quantity by newly developed water of 2.0 m ³ /s	Construction of pump and dam	1997-2003	(1) Hydrocapital	\$6,290/m ³ /s	1	\$85,980	Charge to households in CMA	6.1.2 (Vol. 2)
			Installation of treatment plant to factories	Securement of water quantity of 0.023 m ³ /s	Installation of sand settling pond at Tomic de Agua	1997-2003	(1) Hydrocapital	\$15,130/m ³ /s	3	\$2,610	-do-	6.1.1 (Vol. 2)
			Provision of law and regulation and operation	Securement of water quantity of 0.024 m ³ /s	Installation of treatment plant to factories related to odor and color	1997-2003	(1) Factory and piggeries owners (2) ACRIT	\$13,167/m ³ /s	2	\$2,057	-do-	6.1.1 (Vol. 2)
			Strengthening of the function of organization and operation	Strengthening of control of factory effluent	Approval from higher authority	1997-2003	(1) MARNR (2) CORDIPLAN	N.A.	N.A.	N.A.	N.A.	6.1.3 (Vol. 2)
			Establishment/operation monitoring system	Strengthening of enforcement for necessity action taken by agency concerned	Approval from higher authority	1997-2003	(1) ACRIT (2) MARNR	N.A.	N.A.	N.A.	N.A.	6.1.3 (Vol. 2)
Institutional measure	Assurance of water quality and water quality improvement		Establishment/operation environmental fund and operation	Collection of basic information	Confirmation of budgetary allocation	1997-2003	(1) ACRIT (2) MARNR	N.A.	N.A.	1,652	Government pay the cost	6.1.3 (Vol. 2)
			Establishment/operation pollution charge	Assistance for necessary works for environment improvement	Establishment of new law	1997-2003	(1) ACRIT (2) FONCRESI/CORP-INDUSTRIA	N.A.	N.A.	24,846	Repayment by borrowers	6.1.3 (Vol. 2)
			Establishment/operation public education system	Promotion of installation of treatment plant for factories/piggeries	Establishment of new law	1997-2003	(1) ACRIT	N.A.	N.A.	N.A.	N.A.	6.1.3 (Vol. 2)
				Awareness by public on significance of environment problem	Approval from higher authority	1997-2003	(1) ACRIT (2) State Gov., private sector	N.A.	N.A.	50	Government pay the cost	6.1.3 (Vol. 2)

*1 (1): Implementing Agency/Body (2): Related Agency/Body
 *2 Cost Effectiveness = Annual Cost / Outcome (Annual Cost = Initial Cost x annuity factor (0.11 to 0.13) + O&M Cost)
 *3 Priority is confirmed through the pre-feasibility study
 *4 The cost shows that establish the Environmental Fund including loan amortizations for factories and piggeries
 *5 Outcome at the Boca de Cagua
 N.A.: not applicable

Table S-2 (2/2) SUMMARY OF MASTER PLAN

Stage	Category	Objective	Project	Outcome	Procedure	Timing	Related agency *1	Effectiveness *2 (US\$1,000)	Economic priority	Financial cost (US\$1,000)	Method of cost recovery	Report reference
Mid Term Program	Technical measure	Water quality improvement and Securement of water Quantity	Installation of treatment plant to factories (newly constructed)	Reduction of BOD pollution of 1.17 ton/day	Installation of treatment plant to factories with support of institutional assistance	2004-2010	(1) Factory	\$2,441/ton/day	2	\$18,606	Factory owners pay the cost	6.1.1 (Vol.2)
			Installation of sewage treatment plant and its operation	Reduction of BOD pollution of 0.55 ton/day	Installation of sewage system in the area of S.F. de Yare	2004-2010	(1) ACRT (2) State Gov.	\$3,440/ton/day	4	\$14,100	Charge to households and factories	6.1.1 (Vol.2)
			Installation of sewage treatment plant and its operation	Reduction of BOD pollution of 0.27 ton/day	Extension of sewage system in the area of Occurre del Tuy	2004-2010	(1) ACRT (2) State Gov.	\$2,640/ton/day	3	\$4,914	Charge to households and factories	6.1.1 (Vol.2)
			Installation of sewage treatment plant and its operation	Reduction of BOD pollution of 2.30 ton/day	Installation of sewage system in the EL Consejo	2007-2010	(1) ACRT (2) State Gov.	\$757/ton/day	1	\$13,100	Charge to households and factories	6.1.1 (Vol.2)
			Reforestation	Reduction of turbidity of 70 mg/l	Reforestation in two tributaries (Oda, Guayas and Cabuy)	2004-2010	(1) ACRT (2) State Gov.	\$8.5/mg/l	1	\$5,130	Government pay the cost	6.1.1 (Vol.2)
			Sand settling pond in tributaries	Reduction of turbidity of 225 mg/l	Construction in 4 tributaries	2004-2010	(1) ACRT	\$8.4/mg/l	2	\$11,391	Government pay the cost	6.1.1 (Vol.2)
			Sustainable enforcement of monitoring	Sustainable collection of basic information	Continuous operation	2004-2010	(1) ACRT	N.A.	N.A.	Continuation of Short Term	Government pay the cost	6.1.4 (Vol.2)
			Sustainable enforcement of strengthening of control	Strengthening of enforcement for necessity action taken by agency concerned	Continuous operation	2004-2010	(1) ACRT	N.A.	N.A.	Continuation of Short Term	Government pay the cost	6.1.3 (Vol.2)
			Sustainable enforcement of public education	Education for school, manufacturers and inhabitants	Continuous operation	2004-2010	(1) ACRT	N.A.	N.A.	Continuation of Short Term	Government pay the cost	6.1.3 (Vol.2)
			Sustainable enforcement of application of environmental fund	Assistance for necessary works for environment improvement	Continuous operation	2004-2010	(1) ACRT	N.A.	N.A.	US\$18,606	Repayment by borrowers	6.1.3 (Vol.2)
			Sustainable enforcement of application of pollution charge	Promotion of installation of treatment plant for factories and pipelines	Continuous operation	2004-2010	(1) ACRT	N.A.	N.A.	N.A.	N.A.	6.1.3 (Vol.2)

*1 (1): Responsible Agency/Body (2): Related Agency/Body *2 Cost Effectiveness = Annual Cost/Outcome (Annual Cost = Initial Cost x 0.11 + O&M Cost) N.A.: not applicable

Table S-3 Environmental Management Plan for the Installation of Sewerage Treatment Plant at Ocumare del Tuy and Las Tejerias

Managing Item	Source of Impact	Measuring Standard of Impact	Managing Approach	Management Location	Managing Agency Concerned
(Pre-Construction Stage)					
-Social unrest	-Project location -Land acquisition	-Compensation -Public protest/ demonstration & project disturb	-Negotiation -Public hearing -Presidential decree No.184 (Expropriation Law)	-Project site -All project-affected communities	-MARNR -Tuy Agency -Local Government -Regional Government
(Construction Stage)					
-Noise	Operation of heavy equipment	Noise level : 65 dB (Leq) (Decree No.2217)	-Control of number or speed of vehicles/ equipment -Working hour -Equipment operators	-Residential area -School, clinic	-Tuy Agency -Local Government
-Air pollution and traffic congestion	-Mobilization of equipment -Civil works	-Quality standard (Decree No.638) -Traffic congestion frequency/duration	-Covering materials with sheet -Watering road -Selection of spoil site	-Construction site -Public road & access road	-Tuy Agency -Local Government
-Water quality of the river	All civil works relating to the project	Water quality standard according to Decree No.883	-Effort to minimize spilt soil into the river -Protective net at downstream direction	-Construction site -Sewage pipe setting location	-Tuy Agency
-Sediment	Earth works (embankment / filling)	Contents of Cr, Ni, Pb Cu and Zn in sediment	-No use of such materials for embankment -Proper method of disposal in dumping site	Construction site	-Tuy Agency
-Aquatic biology	Embankment / filling for flood protection	Presence and density of benthos, plankton and necton	-Effort to minimize degradation of water quality -Preservation of natural ecology	Tuy river at Project site (sampling point as determined in EIA)	-Tuy Agency
-Employment and economic growth	Project implementation	-Willingness to participate in project -Increase in family income	Recruitment of local manpower	Municipalities of Santos Michelena and Tomas Lander	-Tuy Agency -Local Government
(Post-Construction Stage)					
-Illegal land use of project site	-Project location -Land acquisition	-No. of squatters -Illegal land use	-Effort to gain public comprehension -Control of illegal land use	Proposed site for sewerage treatment plant	-MARNR -Tuy Agency -Local Government -Regional Government
-Generation of stench and insects	Sewerage treatment plant	Public complaint, protest and reaction	-Treatment method and system -Proper operation and maintenance	Sewerage treatment plant	-Tuy Agency
-Disposal of sludge	Sewerage treatment plant	Sludge composition (contents of toxic substances)	-Sludge disposal system -Proper operation and maintenance	-Final disposal site -Sewerage treatment system	-Tuy Agency -Mascoser -Local Government
-Sewage canals/pipes	Domestic/Industrial wastewater	Function of sewerage system	-Proper maintenance of sewerage network -Educating people	Each community concerned	-Tuy Agency -Local Government

**Table S-4 Environmental Management Plan for the Construction
of Sand Settling Pond at Water Intake**

Managing Item	Source of Impact	Measuring Standard of Impact	Managing Approach	Management Location	Managing Agency Concerned
(Pre-Construction Stage)					
-Social unrest	-Project location	-Compensation -Public protest/ demonstration & project disturb	-Negotiation -Public hearing	-Construction site -All project-affected land	-Hidrocapital -MARNR -Tuy Agency -Local Government
(Construction Stage)					
-Noise	Operation of heavy equipment	Noise level : 65 dB (Leq) (Decree No 2217)	-Control of number or speed of vehicles/ equipment -Working hour -Equipment operators	Village(s) close to project site	-Hidrocapital -Tuy Agency -Local Government
-Air pollution and traffic congestion	-Mobilization of equipment -Civil works	-Quality standard (Decree No.638) -Traffic congestion frequency/duration	-Covering materials with sheet -Watering road -Selection of spoil site	-Construction site -Public road & access road	-Hidrocapital -Tuy Agency -Local Government
-Water quality of the river	All civil works relating to the project	Water quality standard according to Decree No.883	-Effort to minimize spilt soil into the river -Protective net at downstream direction	-Construction site -Water intake facility	-Hidrocapital -Tuy Agency
-Sediment	Earth works (embankment / filling)	Contents of Cr, Ni, Pb Cu and Zn in sediment	-No use of such materials for embankment -Proper method of disposal in dumping site	Construction site	-Hidrocapital -Tuy Agency
-Aquatic biology	All civil works relating to the project	Presence and density of benthos, plankton and necton	-Effort to minimize degradation of water quality -Preservation of natural ecology	Tuy river at Project site (sampling point as determined in EIA)	-Tuy Agency
-Employment and economic growth	Project implementation	-Willingness to participate in project -Increase in family income	Employment of local manpower	San Francisco de Yare and other nearby villages	-Hidrocapital -Local Government
(Post-Construction Stage)					
-Illegal land use of project site	-Project location	-No. of squatters -Illegal land use	-Effort to gain public comprehension -Control of illegal land use	Proposed site for sand settling pond and its surrounding area	-Hidrocapital -MARNR -Tuy Agency -Local Government
-Water intake and pre-treatment facility	Sand settling pond	-Turbidity -Pumping operation	-Introduction of mechanical sand settling system -Proper operation and maintenance	-Sand settling pond -Intake facility	-Hidrocapital -Tuy Agency
-Flushed sediment	Sand settling pond	Volume of flushed sediment	-Flushing operation -Proper maintenance of facility	-Flushing gate -Downstream of intake weir	-Hidrocapital -Tuy Agency
-Sewage canals/pipes	Domestic/industrial wastewater	Function of sewerage system	-Proper maintenance of sewerage network -Educating people	Each community concerned	-Tuy Agency -Local Government

Table S-5 Environmental Monitoring Plan for the Installation of Sewerage Treatment Plant at Ocumare del Tuy and Las Tejerías

Monitoring Item	Monitoring Method	Location	Monitoring Frequency	Duration	Monitoring Agency
Illegal land use of project site	Field visit and confirmation	Proposed site for sewerage treatment plant	Every 6 months	No limit defined	-MARNR -Tuy Agency -Local Government
Noise	Measured by noise level meter	Residential area close to project site	Once a month	Construction period	Tuy Agency
Dust and traffic congestion	Field inspection and measurement	-Construction site -Urban area	Once a month	Construction period	Tuy Agency
Sediment	Field inspection and measurement	Sampling points as selected in EIA	Every 6 months	Till year 2010	Tuy Agency
Aquatic biology	-Field inspection -Sample analysis	Sampling points as selected in EIA	Every 6 months	Till year 2010	Tuy Agency
Water quality of the Tuy River	Test and analysis of sample waters in laboratory	Sampling points as selected in EIA	Every 6 months	Till year 2010	Tuy Agency
Groundwater quality	Test and analysis of sample waters in laboratory	Sampling points (deep well) as selected in EIA	Every 6 months	Till year 2010	Tuy Agency
Inflow of wastewater	Sample analysis in laboratory	Inlet of sewerage treatment plant	Once a week	No limit defined	Tuy Agency
Outflow of wastewater	Sample analysis in laboratory	Outlet of sewerage treatment plant	Once a week	No limit defined	Tuy Agency
Disposal of sludge	-Field inspection -Sample analysis	-Sewerage treatment plant -Disposal site	Once a month	No limit defined	-Tuy Agency -MARNR
Water supply operation	-Pump operation hours -Volume of pre-treated water	Pre-treatment plant	Every 3 months	Till year 2010	Hidrocapital
Public health	Collection of inform. on waterborn diseases	Distrito Sanitario No.2	Every 3 months	Till year 2010	Tuy Agency
Generation of stench and insects	Public opinion and field inspection	-Sewerage treatment plant -Residential area	Every 3 months	Till year 2010	Tuy Agency
Operation and maintenance of facility	Field inspection	-Sewerage treatment plant -Project-related communities	Every 6 months	No limit defined	Tuy Agency

Table S-6 Environmental Monitoring Plan for the Construction of Sand Settling Pond at Water Intake

Monitoring Item	Monitoring Method	Location	Monitoring Frequency	Duration	Monitoring Agency
Illegal land use of project site	Field visit and inspection	Construction site and its surrounding areas	Every 6 months	No limit defined	-MARNR -Hidrocapital -Local Government
Noise	Measured by noise level meter	Communities close to project site	Once a month	Construction period	Tuy Agency
Dust and traffic coagestion	Field inspection and measurement	-Construction site -Artery road to urban center	Once a month	Construction period	Tuy Agency
Sediment	Field inspection and measurement	Sampling points as selected in EIA	Every 6 months	Till year 2010	Tuy Agency
Aquatic biology	-Field inspection -Sample analysis	Sampling points as selected in EIA	Every 6 months	Till year 2010	Tuy Agency
Water quality of the Tuy River	Test and analysis of sample waters in laboratory	Sampling points as selected in EIA	Every 6 months	Till year 2010	Tuy Agency
Flushed sediment	-Field inspection -Volume of flushed sediment	-Sand settling pond -Downstream of intake weir	Once a month	Till year 2010	-Hidrocapital -Tuy Agency
Turbidity	Sample analysis in laboratory	Pre-treatment plant	Once a week	No limit defined	Hidrocapital
Water supply operation	-Pump operation hours -Volume of flushed sediment	Pre-treatment plant	Every 3 months	Till year 2010	Hidrocapital
Operation and maintenance of facility	Field inspection	Sand settling pond	Every 3 months	No limit defined	Hidrocapital
	-Volume of pre-treated water				
Public health	Collection of inform. on waterborn diseases	Distrito Sanitario No.2	Every 3 months	Till year 2010	Tuy Agency
Generation of stench and insects	Public opinion and field inspection	-Sewerage treatment plant -Residential area	Every 3 months	Till year 2010	Tuy Agency
Operation and maintenance of facility	Field inspection	-Sewerage treatment plant -Project-related communities	Every 6 months	No limit defined	Tuy Agency

FIGURES



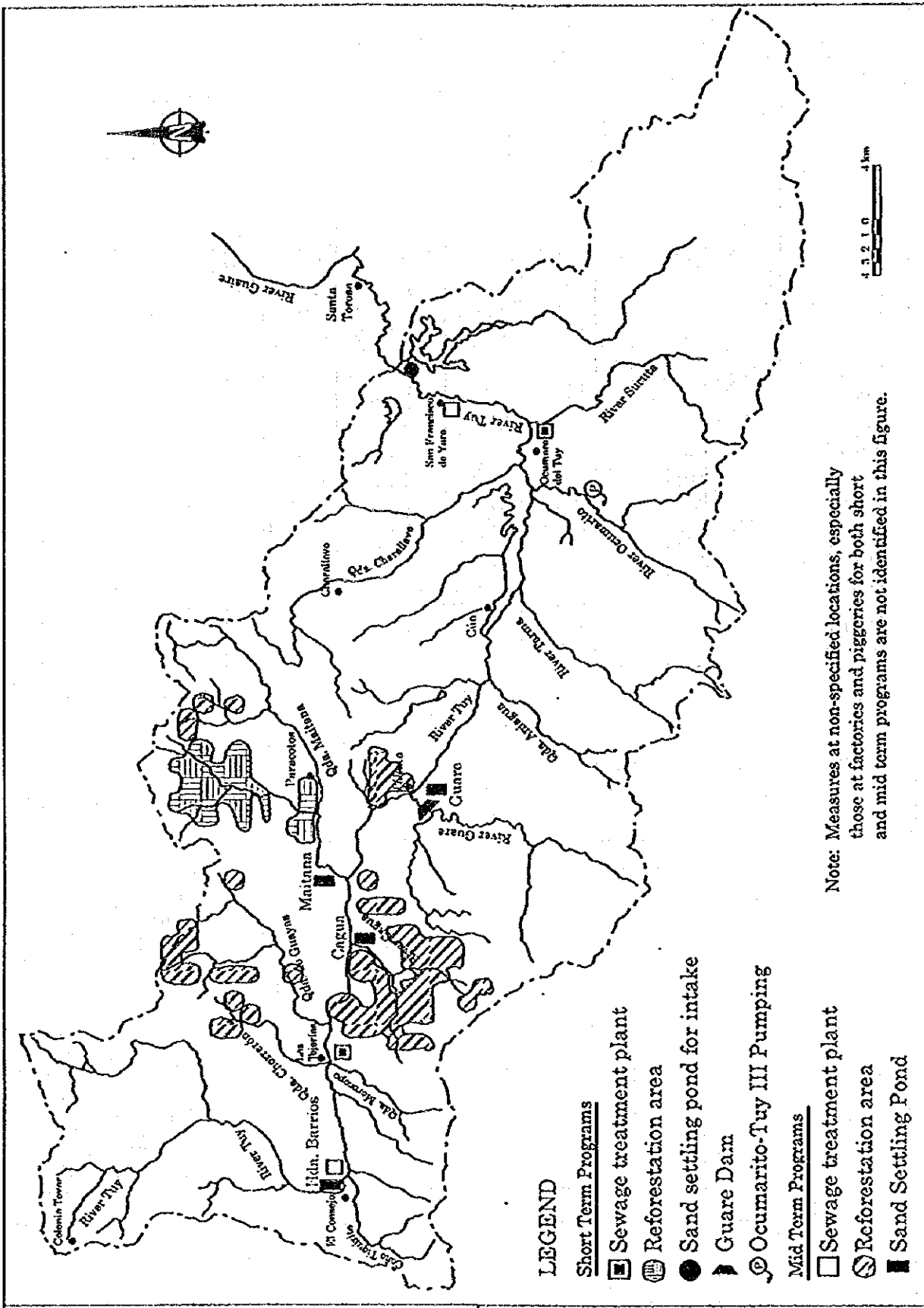
	1996												1997							
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Field Study		First						Second				Third					Fourth			
Home Office Study	Preparatory					First								Second					Third	
Study Phase	Phase I												Phase II							
Report	▲ IC/R					▲ BR/R(1)	▲ IT/R							▲ PR/R(2)			▲ DF/R		▲ F/R	
Workshop/Seminar							▲ Workshop									▲ Workshop	▲ Seminar			
Steering Committee					▲		▲			▲			▲			▲				

Note: IC/R: Inception Report
 PR/R: Progress Report
 IT/R: Interim Report
 DF/R: Draft Final Report
 F/R: Final Report

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Fig. S-1 Study Schedule



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Fig. S-2 Location of Structural Measures

Item	Year													
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Short Term Program														
<i>Structure Measure</i>														
Water quality														
Factory (Food/non-food)														
Existing														
Newly developed														
Domestic wastewater														
Ocumare del Tuy														
Las Tejerias														
Turbidity														
Reforestation														
Water quantity														
Securement of water														
Ocumarito-Tuy III Pumping														
Guare Dam														
Factory														
For color/odor														
Turbidity														
Sand settling pond for intake														
<i>Institutional Measure</i>														
Laws and Regulations		Improvement												
Organization		Strengthening												
Monitoring		Establishment of system					Application							
Public education		Establishment of program					Application							
Environmental Fund		Establishment of system					Application							
Pollution Charge		Establishment of system					Application							
Mid Term Program														
<i>Structure Measure</i>														
Water quality														
Factory (Food/non-food)														
Newly developed														
Domestic wastewater														
Ocumare del Tuy														
San Francisco de Yare														
El Consejo														
Turbidity														
Reforestation														
Sand settling pond for tributary														
<i>Institutional Measure</i>														
Sustainable enforcement														
Monitoring														
Strengthening of Control														
Public education														
Environmental Fund														
Pollution Charge														

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Fig. S-3 Implementation Schedule of the Master Plan

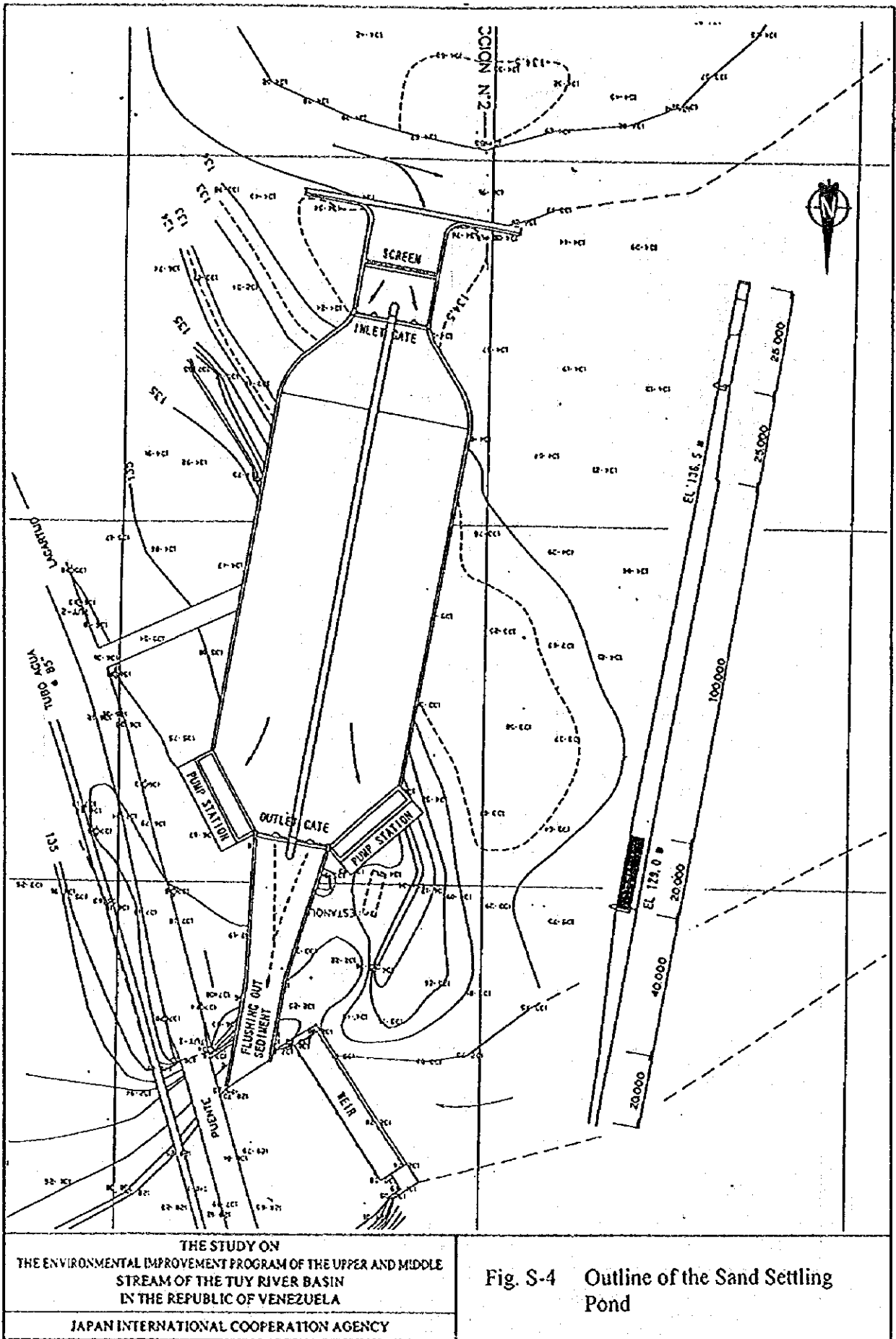
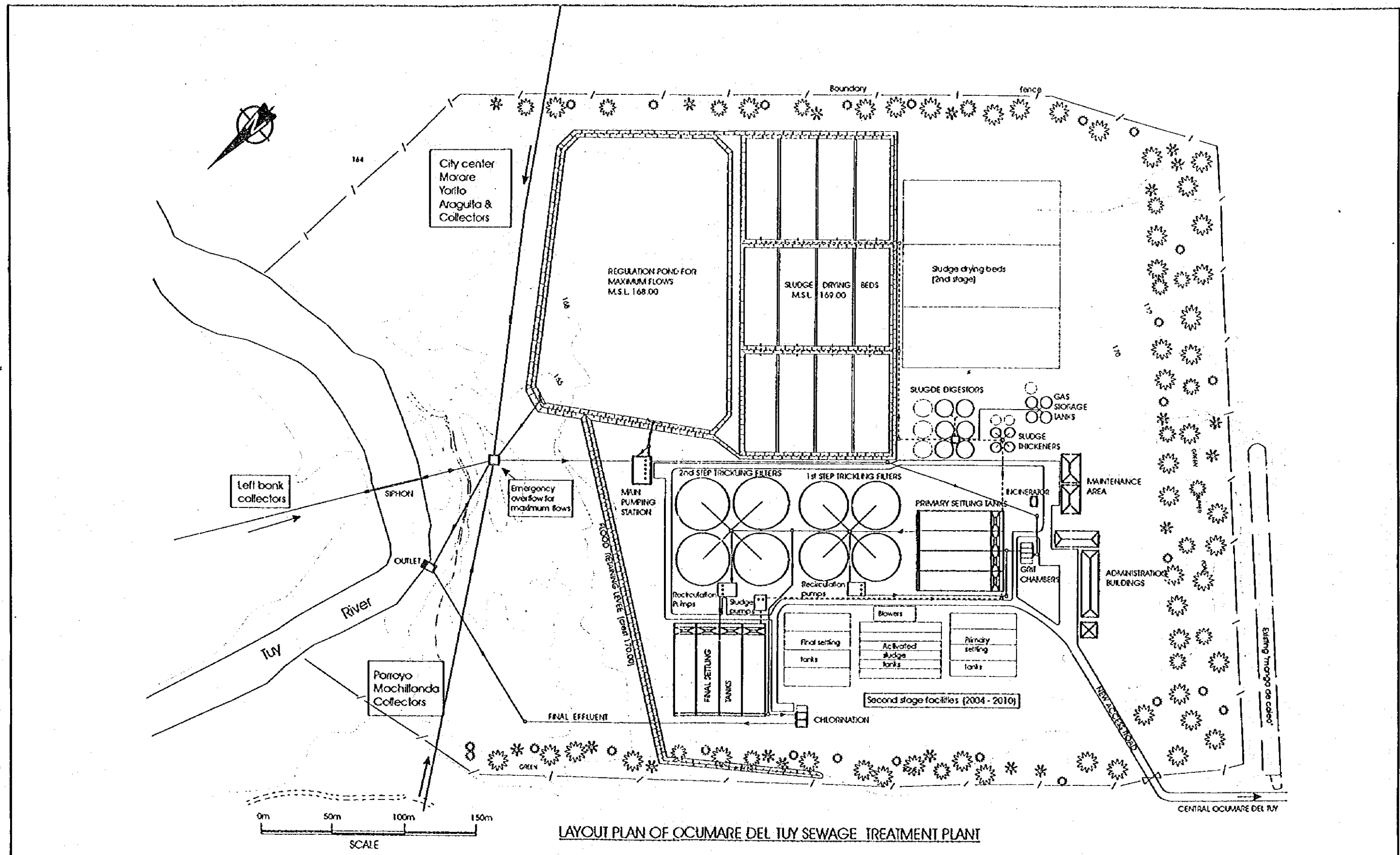


Fig. S-4 Outline of the Sand Settling Pond

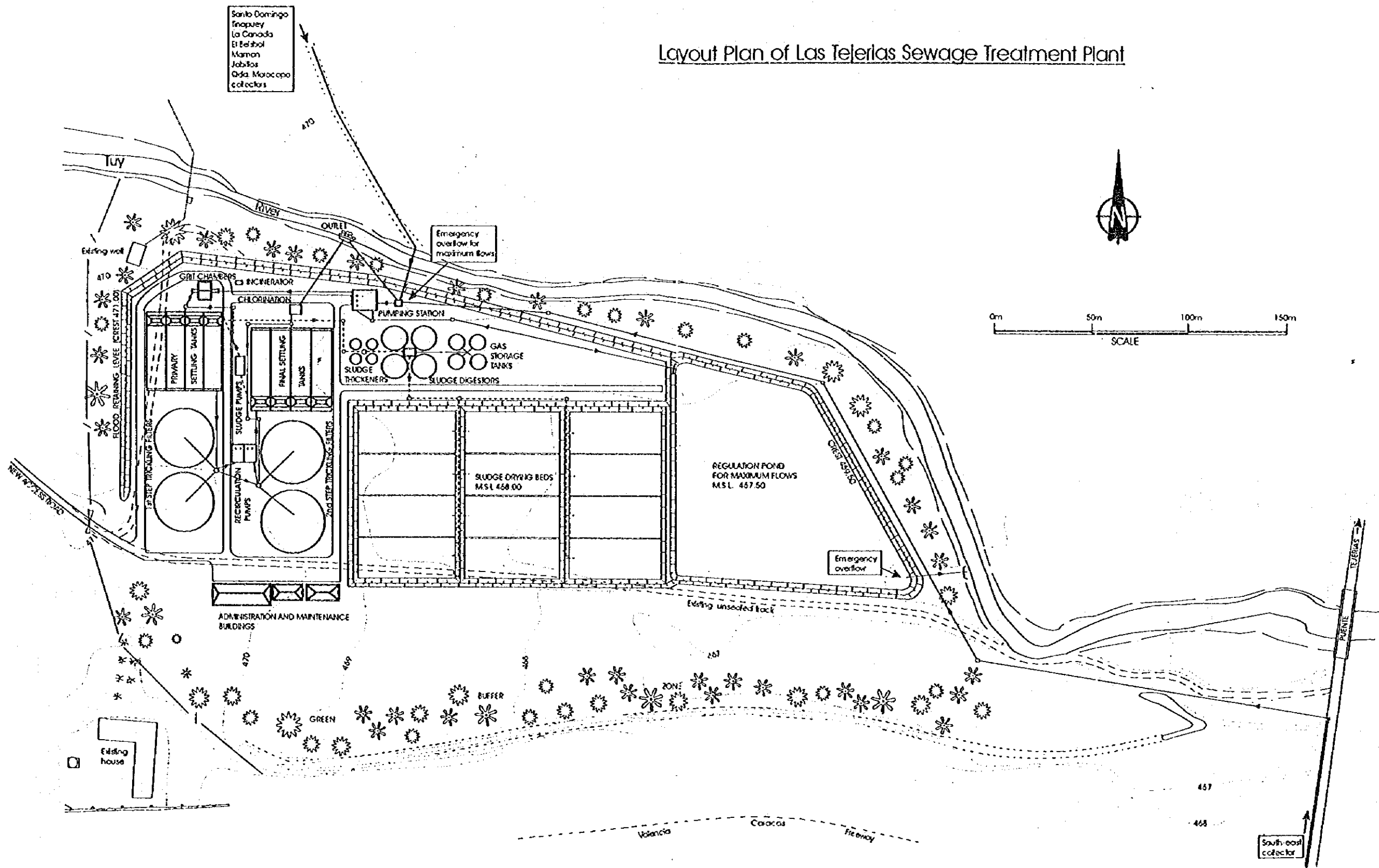


LAYOUT PLAN OF OCUMARE DEL TUY SEWAGE TREATMENT PLANT

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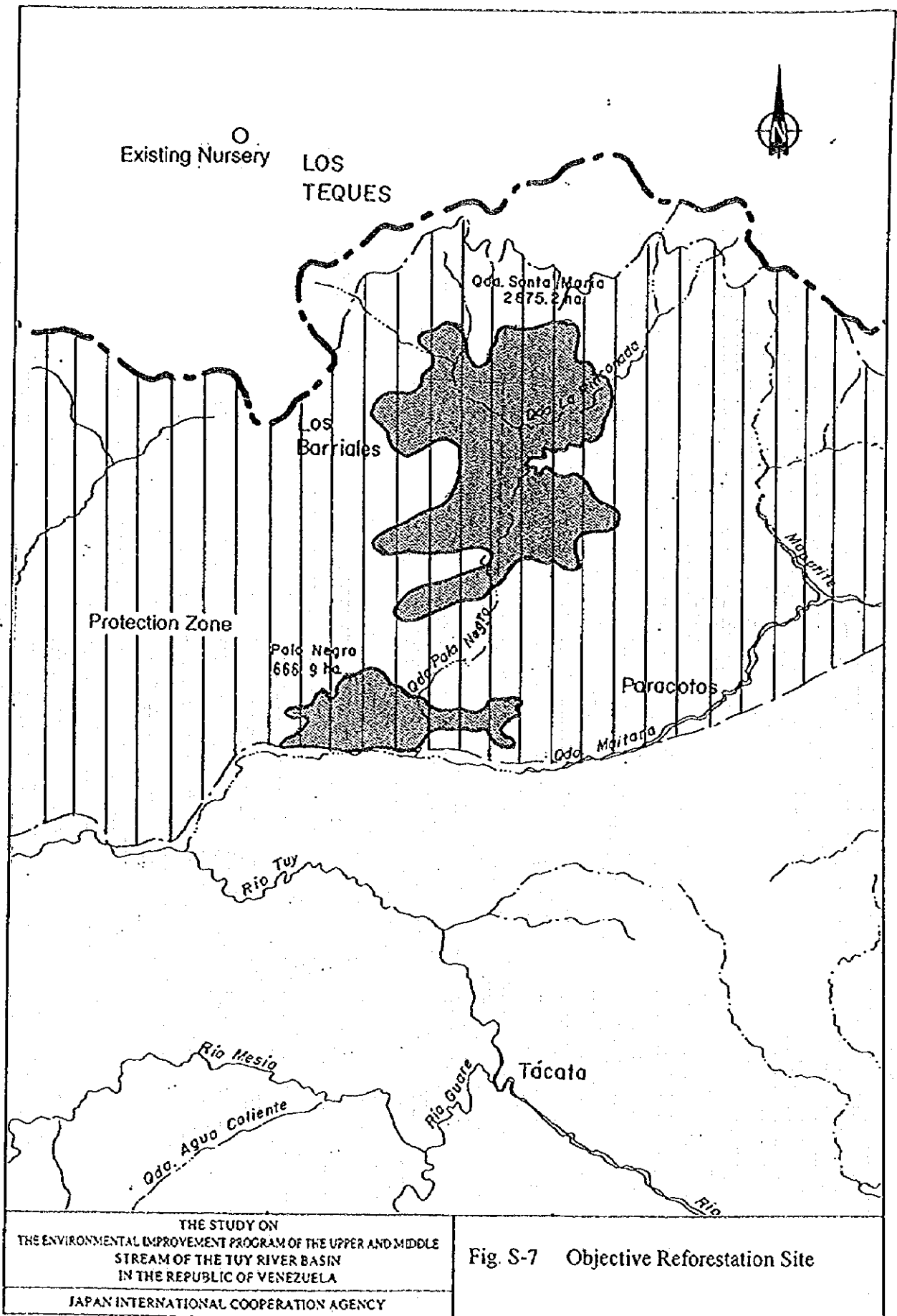
Fig. S-5 Outline of the Sewage Treatment Plant (Ocumare del Tuy)

Layout Plan of Las Tejerlas Sewage Treatment Plant



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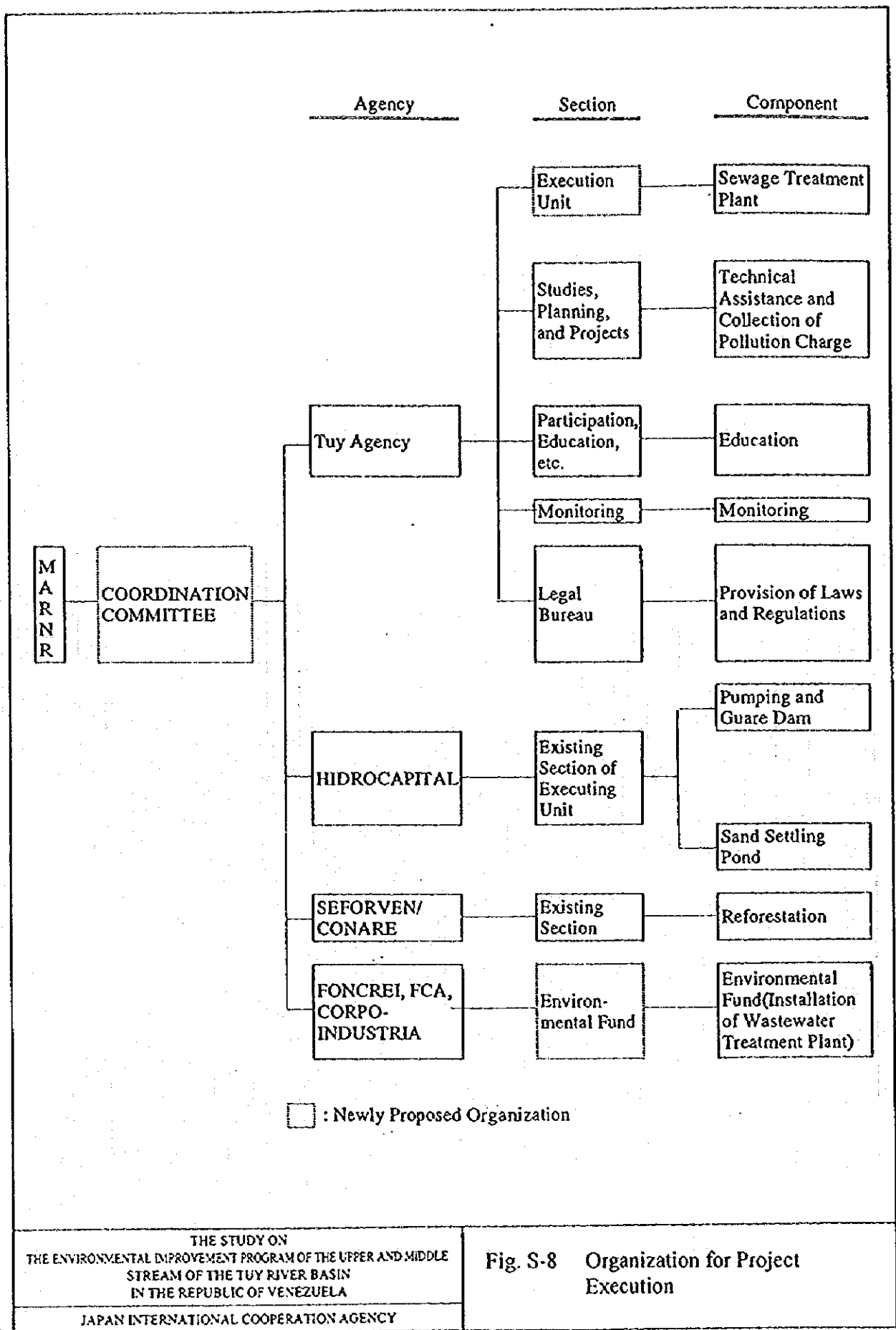
Fig. S-6 Outline of the Sewage Treatment Plant (Las Tejerlas)



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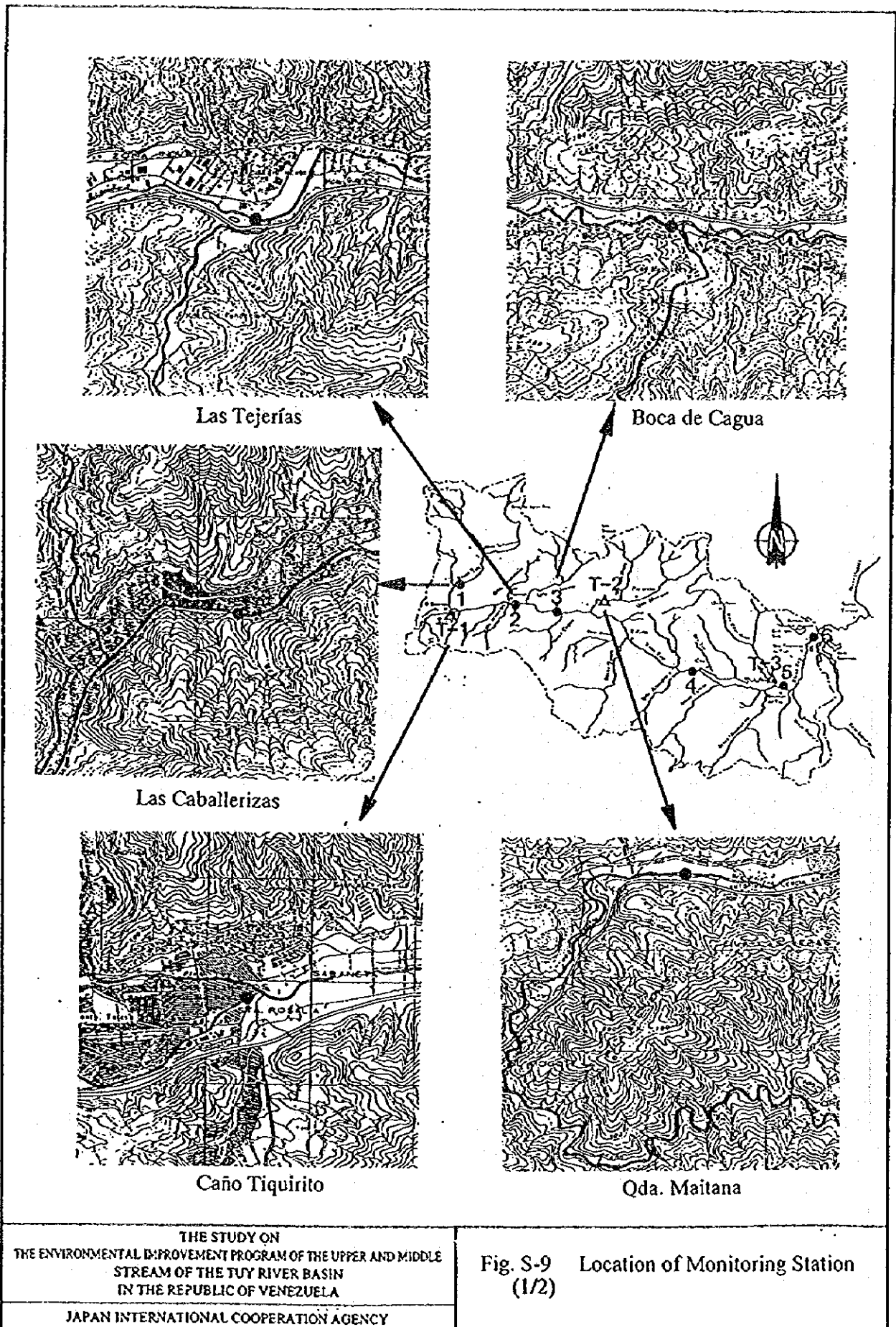
Fig. S-7 Objective Reforestation Site



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Fig. S-8 Organization for Project Execution



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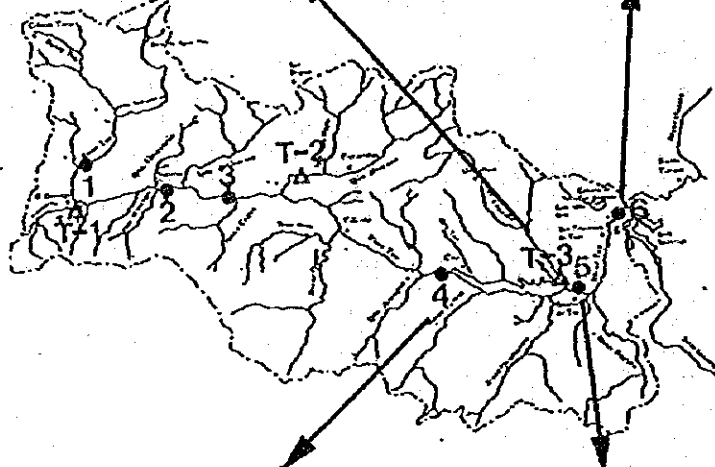
Fig. S-9 Location of Monitoring Station
 (1/2)



Oda. Charallave



S.A. de Yare



Cua Bridge



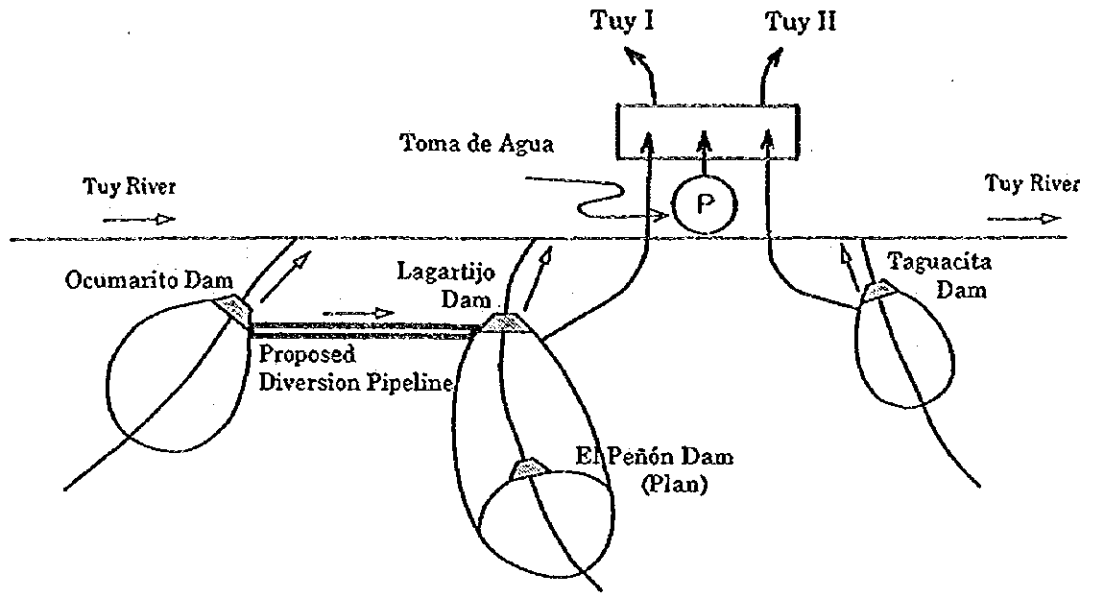
Ocumare Bridge

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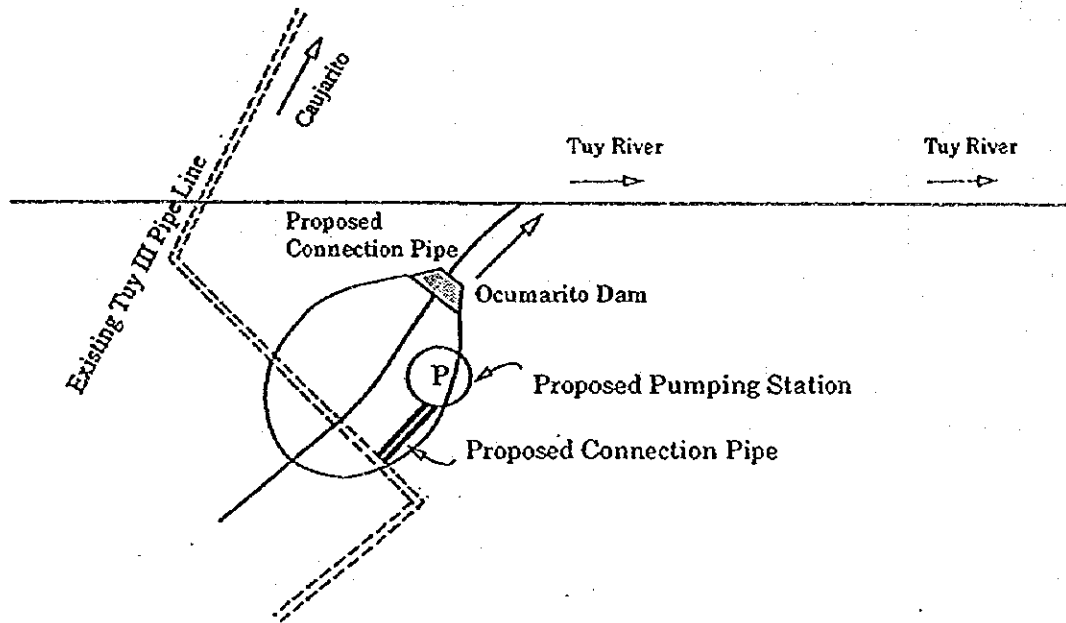
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Fig. S-9 Location of Monitoring Station
(2/2)

Ocumarito - Lagartijo Diversion Plan



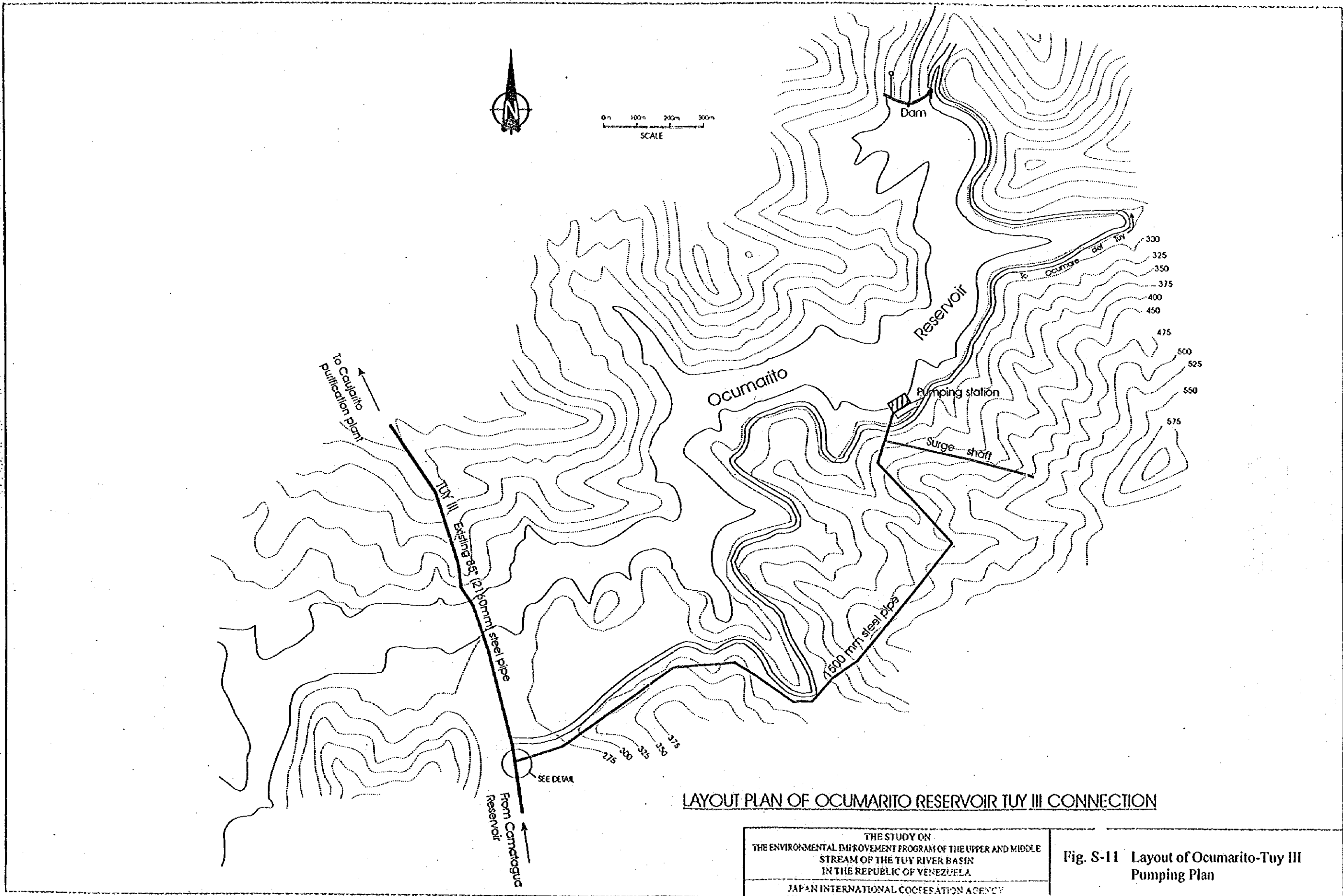
Pumping Plan to Tuy III Pipeline

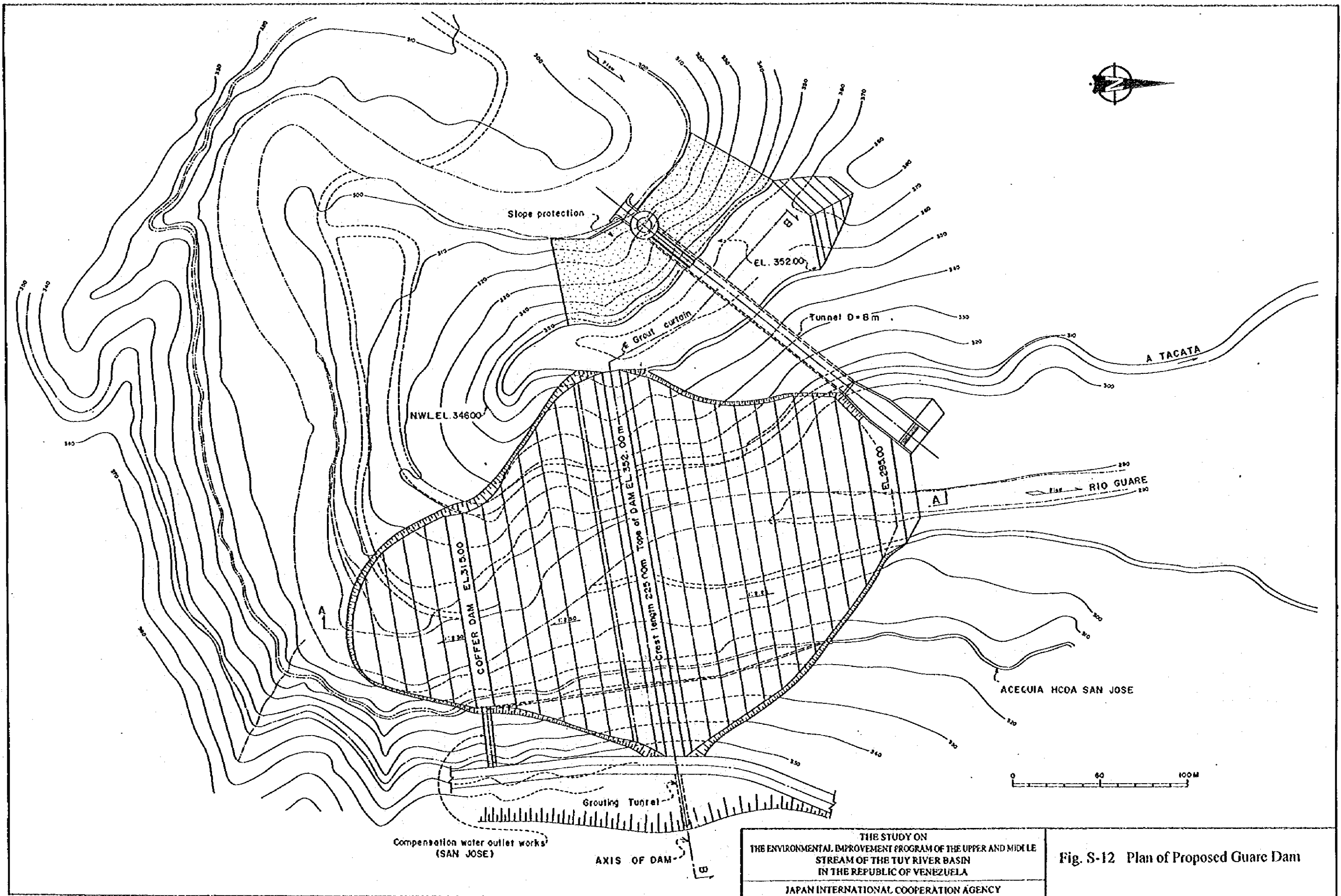


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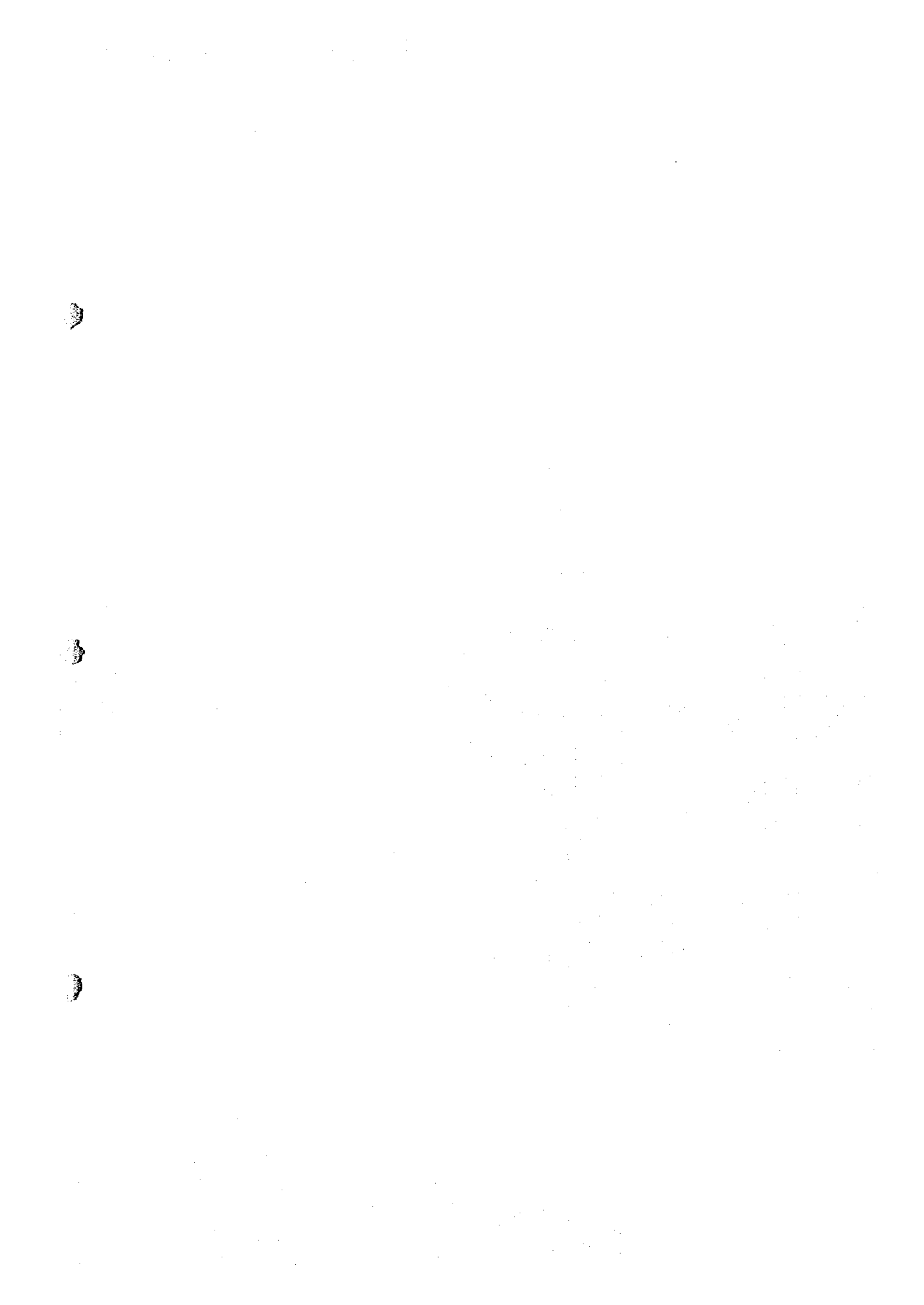
Fig. S-10 General Concept for Utilization of the Ocumarito River

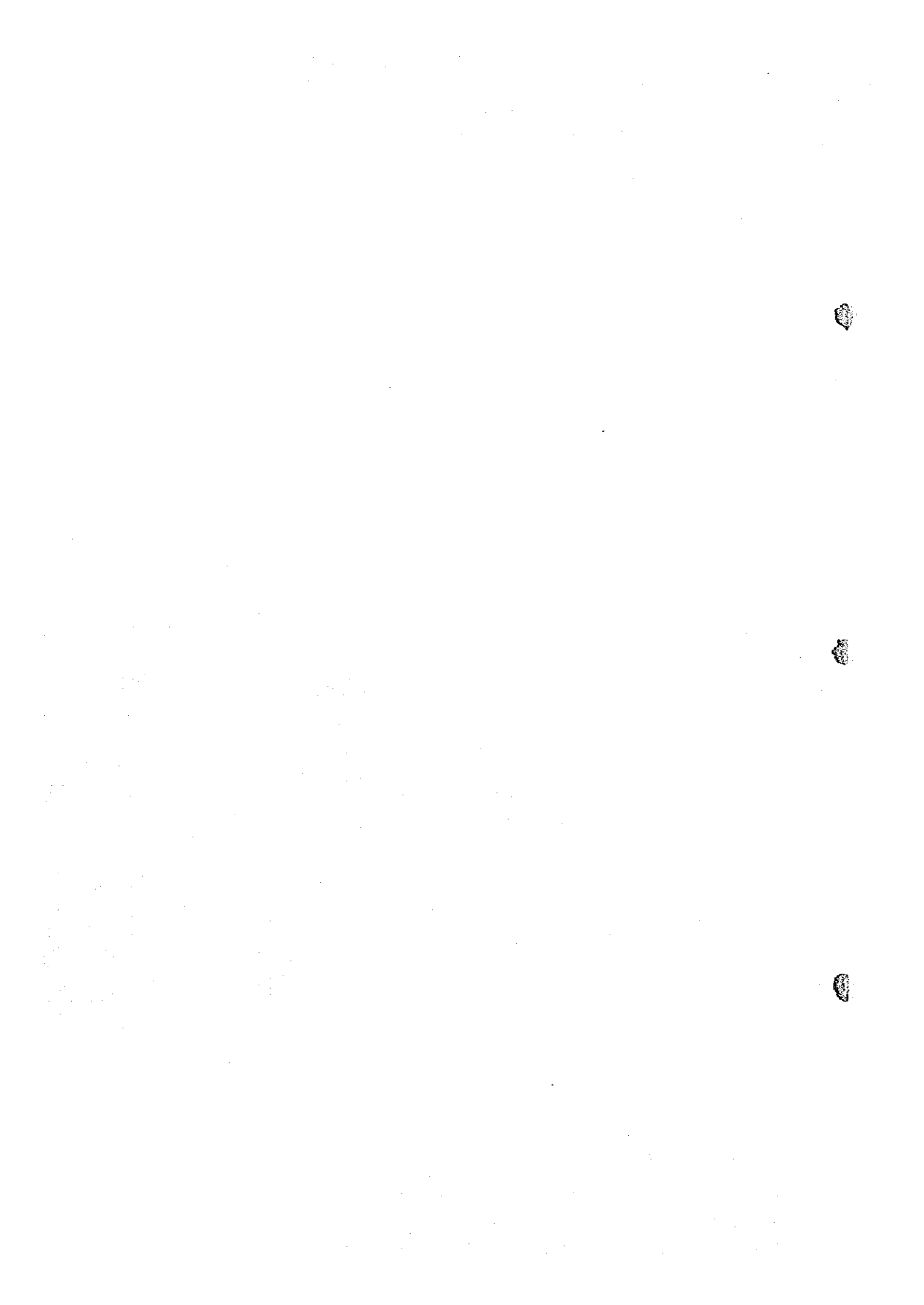




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Fig. S-12 Plan of Proposed Guare Dam





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