JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
NATIONAL INSTITUTE OF DEVELOPMENT (INADE)
THE REPUBLIC OF PERU

THE STUDY
ON
THE INTEGRATED WATER POLLUTION CONTROL
FOR
PUNO INTERIOR BAY OF LAKE TITICACA
IN
THE REPUBLIC OF PERU

MAIN REPORT

JANUARY 2000

PACIFIC CONSULTANTS INTERNATIONAL, TOKYO
in association with
ENVIRONMENTAL TECHNOLOGIC CONSULTANT CO., LTD., TOKYO

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Estimate of Base Cost: as of 1998 price

Foreign Currency Exchange Rates:

Currency	Exchange Rate / US$
Peruvian Nuevo Sol (S/.)	3.15
Japanese Yen (¥)	116.70

(31 December, 1998)

Numerical Notation: Decimal marker : "." (period)
Digit separator : "," (comma)

PREFACE

In response to a request from the Government of the Republic of Peru, the Government of Japan decided to conduct a master plan and a feasibility study on The Integrated Water Pollution Control for Puno Interior Bay of Lake Titicaca in the Republic of Peru and entrusted the study to the Japan International Cooperation Agency (JICA).

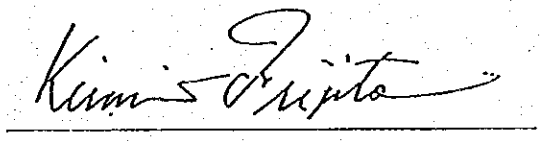
JICA selected and dispatched a study team headed by Mr. Tsutomu Kurihara of Pacific Consultants International (PCI) to Peru, three times between September 1998 and January 2000. In addition, JICA set up an advisory committee headed by Mr. Hidenori Aya, Professor of Musashi Institute of Technology, between September 1998 and January 2000, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Peru and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Peru for their close cooperation extended to the Team.

January, 2000



Kimio Fujita
President
Japan International Cooperation Agency

THE STUDY ON THE INTEGRATED WATER POLLUTION CONTROL
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PUNO INTERIOR BAY OF LAKE TITICACA
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January, 2000

Mr. Kimio Fujita
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Dear Sir,

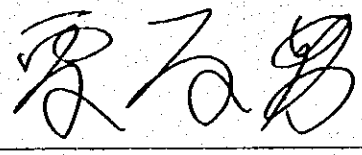
We are pleased to submit to you the final report entitled "The Study on The Integrated Water Pollution Control for Puno Interior Bay of Lake Titicaca in the Republic of Peru". This report has been prepared by the Study Team in accordance with the contracts signed on 16 September 1998 and 20 April 1999 between Japan International Cooperation Agency and Pacific Consultants International.

The report examines the existing conditions of Puno Interior Bay of Lake Tititcaca and presents the results of master plan of the integrated water pollution control and feasibility study for priority project concluded in the master plan.

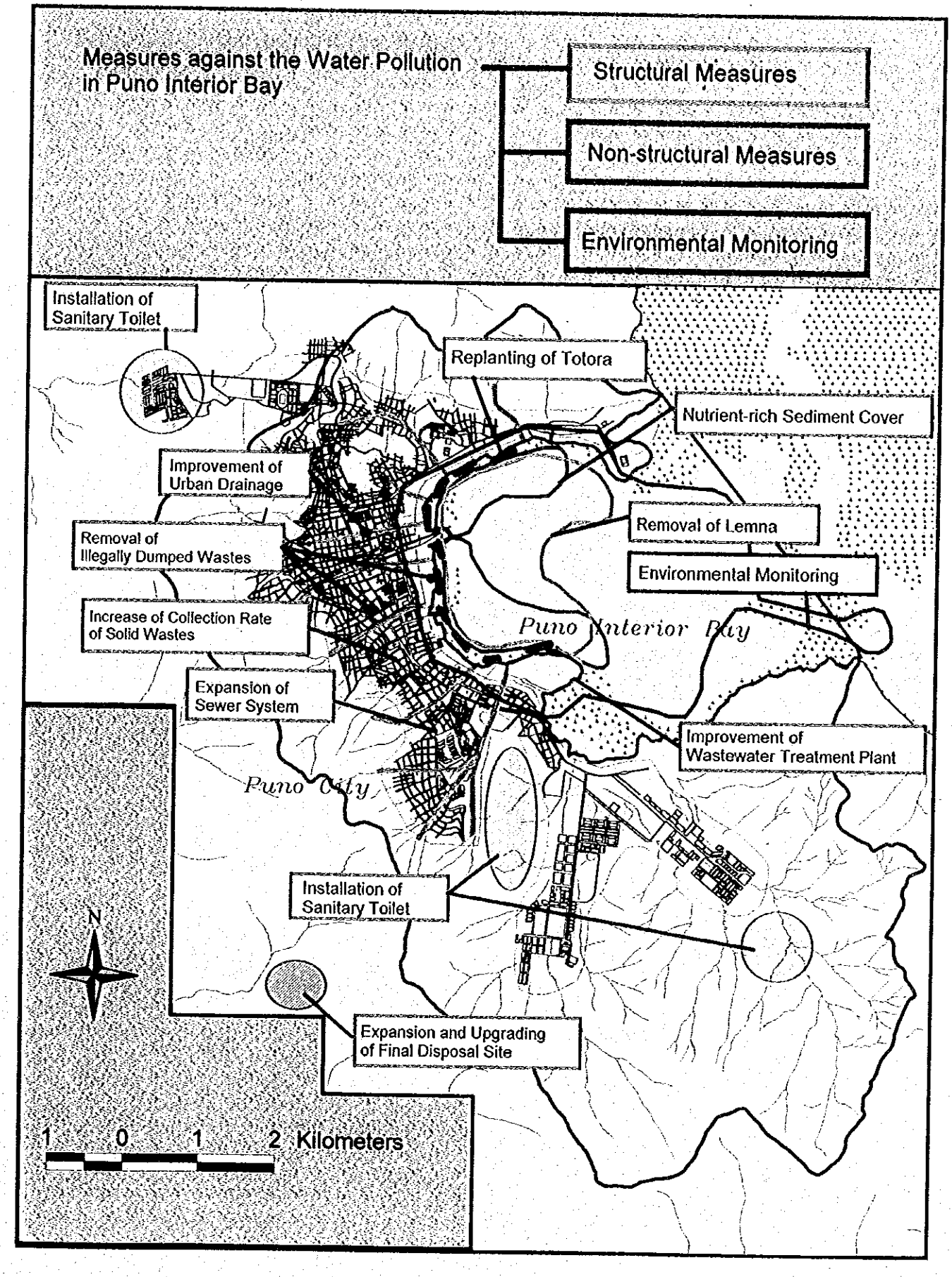
The report consists of the Summary, Main Report, Supporting Report and Data Book. The Summary summarizes the results of all studies. The Main Report contains the existing conditions, the master plan, the feasibility study, and conclusions and recommendations. The Supporting Report includes technical details of contents of the Main Report. In addition, Data Book has been prepared and is submitted herewith.

All members of the Study Team wish to express grateful acknowledgement to the personnel of your Agency, Advisory Committee, Ministry of Foreign Affairs, Ministry of Construction, Ministry of Health and Welfare, Environment Agency and Embassy of Japan in Peru, and also to officials and individuals of the Republic of Peru for their assistance extended to the Study Team. The Study Team sincerely hopes that the results of the study will contribute to the improvement of water pollution of Lake Titicaca in the Republic of Peru and that friendly relations of both countries be promoted further by this occasion.

Yours faithfully,



Tsutomu Kurihara
Team Leader



Proposed Integrated Water Pollution Control Plan for Puno Interior Bay

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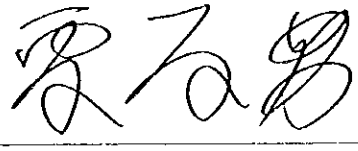

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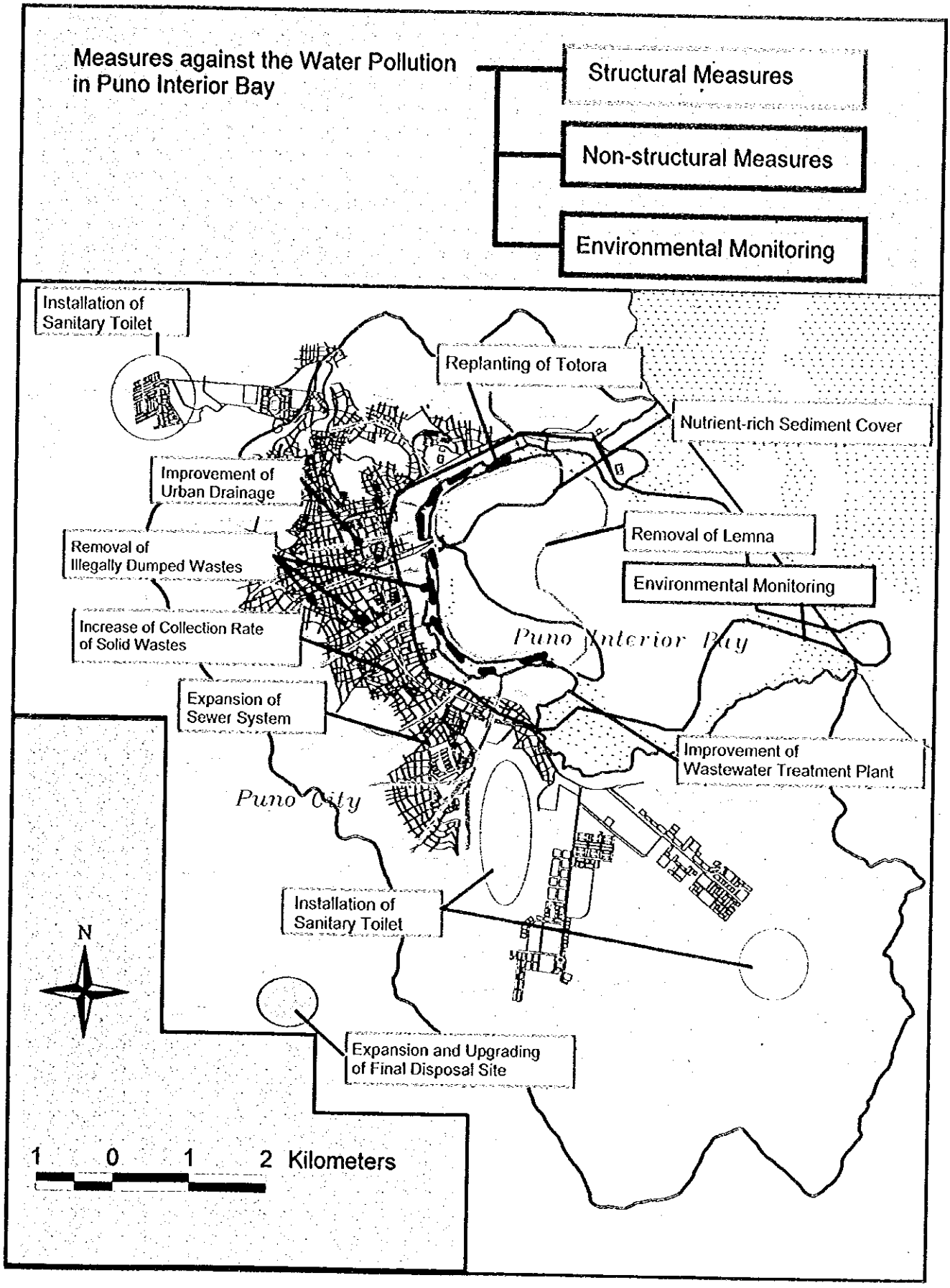

Proposed Integrated Water Pollution Control Plan for Puno Interior Bay

ABSTRACT

1. BACKGROUND

Puno Interior Bay is suffering from progressive water pollution and eutrophication caused by inflow of sewage and other wastes from Puno city. As a typical feature, beneficial large hydrophyte such as Totora (reed) has been decreasing while floating *Lemna* (duckweed) have developed in large quantity and covers a wide lake surface.

Under these circumstances, this Study was conducted by the Study Team of the Japan International Cooperation Agency (JICA) in cooperation with the National Institute of Development (INADE) from September 1998 to January 2000.

The Study area covers Puno Interior Bay (about 17 km^2) and its surrounding catchment area (about 36 km^2).

2. INTEGRATED WATER POLLUTION CONTROL PLAN FOR PUNO INTERIOR BAY

2.1 FRAMEWORK OF THE INTEGRATED WATER POLLUTION CONTROL PLAN

(1) Targets

1) Water Quality of Puno Interior Bay

Recovery of the acceptable water quality as it used to be in the 1970's

2) Scenery of Puno Interior Bay

- Reduction of *Lemna* distribution
- Reduction of littered solid wastes to an insignificant level

3) Ecosystem of Puno Interior Bay

- Rehabilitation of Totora belt, fish, benthos and submerged macrophytes
- Conservation of habitats for wild birds

4) Public Health Conditions of Puno Interior Bay and Puno City

- Reduction of littered wastes in the watershed and the lake
- No bacterial and parasite contamination in the watershed and the lake

(2) Target Year

Short-term target year : the year 2008
Mid-term target year : the year 2015
Long-term target year : the year 2025

2.2 STRUCTURAL MEASURES

(1) Wastewater Control

1) Planning Conditions

	Year	1998	2008	2015	2025
Population of Puno City	Total	108,457	139,076	160,508	185,004
	Sewerage served	50,107 (46%)	97,631 (70%)	125,731 (78%)	157,253 (85%)
Daily Ave.	Wastewater Flow	77.2 l/s	128.6 l/s	170.0 l/s	224.0 l/s
Pollution Load (kg/day)	BOD_5	2,255	4,393	5,658	7,076
	T-N	551	1,074	1,383	1,730
	T-P	63	122	157	197

2) Proposed Plan

a. On-site system

On-site facility : Pit Latrine (0.7 W × 0.7 L × 1.5 H = 0.74 m^3)

Pit emptying : Small (vacuum) pit emptying machine (500 L/unit)

Sludge disposal : Truck (loading capacity: 2 ton)

b. Off-site system

Wastewater collection system

Sewer Total Length = 136,234 m

Phase 1 (1998-2008) Length = 23,396 m

Phase 2 (2009-2015) Length = 46,832 m

Phase 3 (2016-2025) Length = 66,007 m

Pump Station E.B. EL PUERTO

Submersible pump (5.25 l/s, 8.6 m, 1.2 kW, 1 set (+1))

Wastewater treatment plant

Pump station Submersible pump (200l/s, 8.6m, 30kW, 2 sets (+1))

Aerated lagoon 3 basins

Coagulant dosing equipment

Sedimentation pond 3 basins

Inlets for facultative lagoons

Primary lagoon 1 basin (existing facultative lagoon)

Secondary lagoon 1 basin (existing facultative lagoon)

Outlet facility for the second facultative lagoons

Constructed wetland (Totora) 34 basins (sub-surface flow type)

3) Project Cost

a. On-site system (for small pit emptying machine and truck)

Total investment cost : S/.1,248,000 Soles (not including IGV)

O/M cost : (not including IGV)

Year	2008	2015	2025
Cost (thousand S/./year)	237	195	171

b. Off-site system

Total investment cost : S/.91,189,800 Soles (not including IGV)

O/M cost : (not including IGV)

Year	2008	2015	2025
Cost (thousand S/./year)	757	1,109	1,447

(2) Solid Waste Management

1) Planning Conditions

	Year	1998	2008	2015	2025
Quantity of Solid Waste	Generated (t/day)	67.0	85.9	101.5	126.2
	Collected (t/day)	34.0 (51%)	58.3 (68%)	81.9 (81%)	126.2 (100%)

2) Proposed Plan

a. Collection and Transport

	Year	2008	2025
Required Number of Solid Waste Collection Vehicle	12 m^3 compactor	1	2
	4 m^3 compactor	7	15
	6.8 m^3 dump	1	5
	Tricycle	5	5
Manpower		153	204

b. Final Disposal Site

According to the technical guideline issued by DIGESA, 10 sanitary landfill sites having acreage of 20,000 m2 - 37,000 m2 are to be constructed stepwise. At the sites, heavy equipment will be also required.

3) Project Cost

Total investment cost : S/.89,232,800 Soles (not including IGV)

O/M cost : (not including IGV)

Year	2008	2025
Cost (thousand S/./year)	1,401	2,115

(3) Other Measures

1) Urban Drainage System

a. Proposed Plan

- enlargement and lining of existing channels
- construction of additional drainage ways
- construction of check dams and drop structures to control flow velocity and sediment
- separation of drainage ways and sanitary sewer system

b. Project Cost

Total cost : S/.8,543,200 Soles (not including IGV)

2) In-Lake Management

a. Removal of Duckweed (*Lemna*)

Proposed Plan

Regular removal of *Lemna* by a low-draft barge harvesting equipment (harvesting rate: 30~40 t/day) is proposed.

Project Cost

Total investment cost : S/.378,000 Soles (not including IGV)

O/M cost : S/.36,800 Soles/year (not including IGV)

b. Cover of Bottom Sediment

Proposed Plan

The areas for the sediment cover is the western part of Puno Interior Bay where the water depth is smaller than 3.5 m and the equipment can be operated. Possible covering material is silty sand which is distributed along the navigation channel of Puno Interior Bay.

- Sediment Covering Area : 2,400,000 m^2
- Covering thickness : 0.30 m
- Covering volume : 720,000 m^3

Project Cost

Total cost : S/.23,310,700 Soles (not including IGV)

c. Replanting of Reed (Totora)

Proposed Plan

Major processes of the rehabilitation of Totora are a multiplication of seedling Totora and a planting of multiplied Totora. The seedling Totora should be planted along the western shore of Puno Interior Bay.

- Unit Totora belt : length = 200 m, width = 40 m
- Number of unit : 18 units
- Total of planting area : 14.4 ha

Project Cost

Total cost : S/.158,300 Soles/year (not including IGV)

2.3 NON-STRUCTURAL MEASURES

(1) Proposed Plan

The following measures are proposed.

1) The institutional consolidation plan;
2) The public education program;
3) The enlightenment campaign (installation of *the Clean Day)*;
4) The enforcement of environmental regulations.

(2) Project Cost

Total investment cost : S/.579,600 Soles (not including IGV)

O/M cost : S/.516,300 Soles/year (not including IGV)

2.4 Environmental Monitoring

(1) Proposed Plan

1) Monitoring Program for Effluents

Food and processing industries (4 workshops)
Slaughter house (1 facility)
Espinar wastewater treatment plant (1 facility)

2) Monitoring Program for Water Bodies

a. Physical and Chemical Conditions

Lake water (7 main points, 5 supplementary points)
Drainage channels (5 points)
Lake sediment (12 points)

b. Biological Conditions

Lake water (Plankton,Benthos and Macrophytes)

(2) Project Cost

Total investment cost : S/.246,000 Soles (not including IGV)

O/M cost : S/.184,200 Soles/year (not including IGV)

2.5 Implementation Program

Implementation program for the Integrated Plan are summarized in *Table 1.* Among the proposed components, the sewerage systems improvement, the solid waste management and the environmental monitoring should be implemented as first priority projects in Puno.

The sediment cover should be implemented when the measures against the external pollution load does not produce the expected effects.

Besides the structural measures, no-structural measures should be started as early as possible in order to formulate citizen's awareness and understanding for the Integrated Plan. Citizen's awareness and understanding are indispensable to promote the structural measures.

3. FEASIBILITY STUDY

3.1 SELECTION OF PROJECT

In the Integrated Water Pollution Control Plan for Puno Interior Bay, each measure has been ranked considering its priority.

1st: Improvement/Upgrading of Sewerage Systems
2nd: Improvement/Upgrading of Solid Waste Management
3rd: Improvement of Urban Drainage Systems
4th: In-lake Measures (cover of the bottom sediment, removal of *Lemna*, rehabilitation of Totora)

With regard to sewerage network, the feasibility study has been already completed and the German Government will offer a financial assistance for the project as it is feasible. As a result, the improvement / upgrading of solid waste management by the year 2008 has been selected for the feasibility study.

3.2 DESIGNING

(1) Waste Collection

1) Proposed Plan

a. Necessary numbers of collection vehicles

			2002	2003	2004	2005	2006	2007	2008
2025-100%	Vehicle	12m3 Compactor	1	1	1	1	1	1	1
		Ditto(Existing)	1	1	1	1	-	-	-
		4m3 Compactor	1	2	2	2	4	4	5
		Ditto(Existing)	2	2	2	2	2	2	2
		6.8m³Dump Truck	1	1	1	1	1	1	1
		5 t Dump Truck	2	2	2	2	1	1	1
	Total (unit)		8	9	9	9	9	9	10
	Supplement Capacity(t/d)		22.6	28.0	28.0	33.4	38.8	38.8	44.2
	Existing Capacity(t/d)		34.4	34.4	34.4	17.2	17.2	17.2	17.2
	Total Capacity(t/d)		57.0	62.4	62.4	50.6	56.0	56.0	61.4
	Collection Quantity(t/d)		42.51	44.84	47.24	49.88	52.61	55.41	58.33
	Direct carried waste(t/d)		1.59	1.62	1.64	1.67	1.69	1.72	1.74

(2) Final Disposal Site

The following table shows the required capacity for waste in total.

	Waste Generation (Incl. Direc. carried in)	Wastes Hauled	Wastes Hauled	Volume of Wastes	Covering Soil	Necessary Volume	Volume Accumulated
	t/day	t/day	t/yr	m^3/yr	m^3/yr	m^3/yr	m^3
1998	68.41	35.49	12,954	18,506	4,626	23,131	23,131
2008	87.63	60.07	21,926	31,322	7,829	39,152	236,252

3) Necessary Equipment to be Installed

Bulldozer, Backhoe, Dump Truck, Truck Scale, Generator are required for Sanitary Landfill.

3.3 IMPLEMENTATION PLAN

In order to construct a sanitary landfill, one year is necessary as a preparation year. Therefore, the construction work will start in 2001.

3.4 PROJECT COST

Construction cost	9,113,000 Soles
Equipment	3,738,000 Soles
Operation and Maintenance Cost	9,682,000 Soles
GRAND TOTAL	22,533,000 Soles
	(not including IGV)

3.5 PROJECT EVALUATION

Implementation of the project will have the social effects such as an improvement of sanitary conditions and an improvement of tourism development potential.

FIRR would exceed 7 % if revenue will be significantly increased by an increase of the waste handling charge or by an establishment of new funds such as environment fee, or if the state government will allocate subsidies or low-interest funds to Puno Provincial Municipality.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 EVALUATION OF THE INTEGRATED PLAN

The whole plan requires a large amount of investment even if reasonable techniques are applied to each component projects. However, the financial status of the local government in Puno is too serious to realize the Plan. Even if the local government of Puno succeed in increasing the revenue with a maximum effort, strong financial support by the state government will still be indispensable.

There will be various benefits accruing from this plan. If this plan can not start, the environment of Puno will become worse and worse. As the result, Lake Titicaca will be dirty and fishery activities will be damaged and the sightseeing business will be also diminished. The effects were estimated from current business volume. The value of EIRR is 15%, higher than the opportunity cost (the cost is assumed as 10% in Peru), and the cumulative profits is plus. So it can be said that the proposed Integrated Plan is viable from the economic point of view.

The Plan will essentially contribute to the environmental improvement of Puno Interior Bay. Organic pollution load will be reduced to the targeted level which used to be in/before the 1970's. Consequently, the target of the plan against the organic pollution in Puno Interior Bay will be achieved by the year 2008, and the favorable condition will last for a long period. Although the Plan will also produce negative effects through the phases of planning, construction and operation, it is evaluated that all impacts are minor or temporary and able to be mitigated within an acceptable level.

4.2 RECOMMENDATIONS

Puno Interior Bay is a part of Lake Titicaca. Not only the people who live there but also the Peruvian nation and foreign tourists have enjoyed the outstanding environment of the lake. Therefore they have to return the profits, in other word, provide the labor or the funds required for the environmental improvement of the lake. The economic benefit will surpass the total costs of the Plan. It means that the Plan is worthy to implement. However it is too hard for the local governments or residents to bear all costs when their financial difficulties are taken into account. The state government's financial assistance such as subsidies or low-interest funds are indispensable to realize the Plan. Furthermore, it is recommended to establish the system to raise the funds widely from the users or polluters of the lake environment.

Table 1 Implementation Schedule of The Integrated Water Pollution Control Plan for Puno Interior Bay

Proposed Plan			Priority	Year
Measures	Component			2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
External Pollution Load Reduction	Sewerage Systems	Sewer Expansion	1	
		WWTS Improvement	1	
	Sanitary Toilet		2	
	Urban Drainage		3	
Solid Waste Management	Removal of Illegally Dumped Wastes		2	
	Increase of Collection Rate		1	
	Expansion/Upgrade of Final Disposal Site		1	
In-Lake Management	Removal of *Lemna*		2	
	Cover of Bottom Sediment		4	
	Replanting of Totora		3	
Non-Structural Measures	Environmental Education & Campaign		1	
	Citizen's Participation		1	
	Institutional Strengthening		1	
	Land Use Management		3	
	Livestock Farming Management		4	
	Regulation of Effluents		2	
Environmental Monitoring			1	

Construction

Operation

THE STUDY
ON THE INTEGRATED WATER POLLUTION CONTROL FOR PUNO INTERIOR BAY OF LAKE TITICACA IN THE REPUBLIC OF PERU

(MAIN REPORT)

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ABBREVIATIONS

1. Peruvian Organizations

ALT :	Binational Autonomous Authority of Lake Titicaca
APECO :	Peruvian Association of Conservation
CAPET :	Chamber of Fishery in Titicaca
CONAM :	National Environmental Council
DIGESA :	General Administration of Environmental Health, Ministry of Health
EMSAPUNO :	Municipal Enterprise for Potable Water and Sewerage
ENAFER :	National Railroad Company
GOP :	The Government of Peru
INADE :	National Institute of Development
INADUR :	National Institute of Urban Development
INEI :	National Institute of Statistics and Information
INRENA :	National Institute of Natural Resources
MITINCI :	Ministry of Industry, Tourism, Integration and International Trade Negotiations
MTCVC :	Ministry of Transport, Housing and Construction
PELT :	Special Binational Project for Lake Titicaca
PRONAA :	National Program of Nutrition Assistance
PRONAP :	National Program of Potable Water and Sewerage
SENAMHI :	National Service of Meteorology and Hidrology
SUNASS :	National Superintendence of Sanitation Service
SUNAT :	National Superintendence of Taxes
UNA :	National University of The Altiplano – Puno

2. Japanese/International Organizations

CEPIS :	Pan American Center for Sanitary Engineering and Environmental Sciences, WHO
GOJ :	The Government of Japan
IBRD :	International Bank for Reconstruction and Development (World Bank)
IDB :	Inter-American Development Bank
IMF :	International Monetary Fund
JICA :	Japan International Cooperation Agency
JST :	JICA Study Team
KfW :	German Bank for Reconstruction
OECD :	Organization for Economic Cooperation and Development
WHO :	World Health Organization

3. Measuring Units

1) Physical

mm	:	millimeter(s)
cm	:	centimeter(s)
m	:	meter(s)
km	:	kilometer(s)
ha(s)	:	hectare(s)
l, ltr	:	liter(s)
g, gr	:	gram(s)
kg	:	kilogram(s)
t, ton	:	tonnage(s)
s, sec	:	second(s)
min	:	minute(s)
h(hrs)	:	hour(s)
d(dys)	:	day(s)
y, yr(yrs)	:	year(s)

2) Chemical

mg/l	:	milligram(s)

3) Others

a.s.l.	:	above sea level
inh/ha	:	inhabitants per hectare
nos/l	:	numbers per liter

4. Monetary Terms

¥	:	Japanese Yen
US$	:	United States Dollar
S/.	:	Peruvian Nuevo Sol
DM	:	Deutsche Mark

5.Others

BOD	:	Biological Oxygen Demand
CIF	:	Cost, Insurance and Freight
COD	:	Chemical Oxygen Demand
Chl-a	:	Chlorophyll-a
D/D	:	Detailed Design
D/S	:	Definitive Study
DF/R	:	Draft Final Report
DID	:	Densely Inhabited District
DL	:	Datum Line

DO	:	Dissolved Oxygen
E/S	:	Engineering Service
EIA	:	Environmental Impact Assessment
EIRR	:	Economic Internal Rate of Return
F/R	:	Final Report
F/S	:	Feasibility Study
FDS	:	Final Disposal Site
FIRR	:	Financial Internal Rate of Return
FY	:	Fiscal Year
GDP	:	Gross Domestic Products
GNP	:	Gross National Products
IC/R	:	Inception Report
IEE	:	Initial Environmental Evaluation
IGV	:	General Sales Tax (Impuesto General a las Ventas)
IT/R	:	Interim Report
M/P	:	Master Plan
MSL	:	Mean Sea Level
N	:	Nitrogen
NGO	:	Nongovernmental Organization
P	:	Phosphorous
P/R	:	Progress Report
S/W	:	Scope of Work
SS	:	Suspended Solids
STP	:	Sewage Treatment Plant
SWM	:	Solid Waste Management
TDS	:	Total Dissolved Solids
VAT	:	Value Added Tax
WWTP	:	Wastewater Treatment Plant
WWTS	:	Wastewater Treatment System

CHAPTER – I INTRODUCTION

CHAPTER - I

INTRODUCTION

1. BACKGROUND OF THE STUDY

The City of Puno is expected to experience a substantial growth of population in the future due to newly emerging communities in the outskirts of the city in addition to population influx. However, improvement and expansion of urban infrastructure has fallen behind the rate of such population growth and most of the sewage is directly discharged into Puno Interior Bay without treatment. Besides, there are other problems, such as inflow of solid wastes into the interior bay during rainfall because of insufficient waste collection system.

The Bay is suffering from progressive water pollution and eutrophication caused by inflow of sewage and other wastes from Puno city. Beneficial large hydrophyte such as Totora (a kind of reed) has been decreasing while *Lemna* (duckweed) has developed in large quantity and covers a wide lake surface. In order to overcome the lake water environmental problems, both the state and the local governments are wrestling with countermeasures against pollution of the Bay, but could not yet implement any specific measures.

In view of the background described above, the Government of Peru requested the Government of Japan in September, 1995, for technical cooperation for the conduct of the Study on the Integrated Water Pollution Control of Puno Interior Bay of Lake Titicaca. In response to this request, the Government of Japan dispatched a Preparatory Study Team in July, 1996, which held meetings with the Government of Peru and other authorities concerned and reached an agreement on the Scope of Work (S/W) concerned to this study.

According to the S/W, this Study was conducted by the Study Team of the Japan International Cooperation Agency (JICA) in cooperation with the National Institute of Development (INADE) from September 1998 to January 2000.

2. OBJECTIVES OF THE STUDY

The objectives of this study are as follows:

1) To formulate a Master Plan of integrated water quality improvement of Puno Interior Bay.

2) To conduct a feasibility study (F/S) on priority project(s) identified from the Master Plan.

3) To transfer technology to counterpart personnel in the course of the Study.

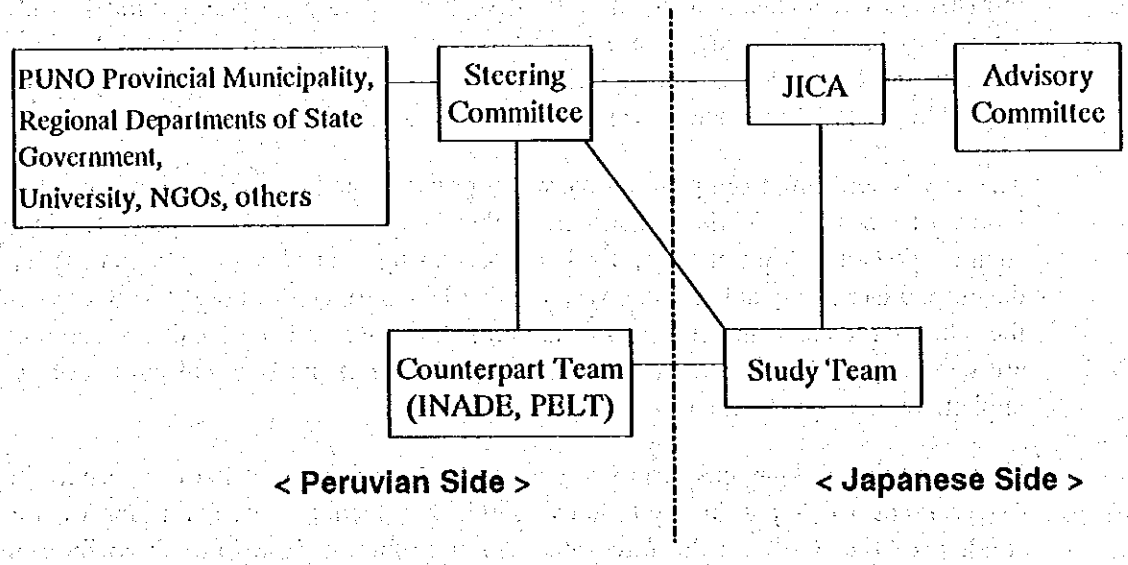
3. STUDY AREA

This study will cover Puno Interior Bay (about 17 km^2) and its surrounding catchment area (about 36 km^2). The study area is as shown in *Figure I.1*.

4. STUDY ORGANIZATION

(1) Overall study organization

The overall study organization is shown below:



(2) Members of the Study Team

The members of the Study Team are as follows:

Assignment	Name
Team Leader	Tsutomu Kurihara
Hydrology/Water Quality	Masahiro Kawachi
Natural Environment and Ecology	Marcus .R. Chambers
Wastewater and Stormwater Management Planning	Koji Yoshina
Solid Waste Management Planning	Akio Kuramochi
Urban Planning	Hiroshi Matsuo
Facility Design and Cost Estimation (wastewater)	Toru Yagi
Facility and Equipment Design and Cost Estimation (solid waste)	Ryousuke Okamura
Facility Design and Cost Estimation (bottom sediment)	Hikaru Maki
Organization and Institution	Yasuhira Minami
Economic and Financial Evaluation	Takio Oshio
Study Administration	Yosuke Abe

(3) Members of the Advisory Committee

The members of the Advisory Committee are as follows:

Assignment	Name
Chairman/ Environmental Sanitation	Hidenori Aya Professor, Department of Civil Engineering, Faculty of Engineering, Musashi Institute of Technology
Waste Water Treatment Planning	Mamoru Suwa Researcher, Advanced Waste Water Treatment Division, Public Works Research Institute, Ministry of Construction
Solid Waste Management	Takahide Tatsunari Senior Researcher, Japan Waste Research Foundation
Lake water Quality Control Planning	Kiyoshi Nomura Chief, The Water Environment Division, Shiga Prefectural Institute of Public Health and Environment Science

(4) Members of the Counterpart Team

National Institute of Development (INADE)

Albert YAMAMOTO MIYAKAWA (Chief)
Máximo HATTA SAKODA / Juan Carlos SEVILLA GILDEMEISTER (General Manager)
Esperanza SANO (Counselor of Chief)
Plinio GUTIÉRREZ DEL POZO (Manager of Studies)
Cristina MASUDA MATSUURA (Chief of Technical, Financial and International Cooperation Office)

Special Binational Project for Lake Titicaca (PELT)

Ariel BERMEJO LIRA / Julián BARRA CATACORA (Executive Director)
Hugo RODRIGUEZ BENAVIDES (Director of Agriculture and Fishery Development)
Héctor SALINAS FRANCO (Director of Studies)
Juan José OCOLA SALAZAR (Coordinator)

(5) Members of the Steering Committee

Ministry of Health

Eloy Enríquez Encinas (Regional Director of Puno)

Ministry of Education

José Luis Choque Mamani (Regional Director of Puno)

The Navy

Dane Markovinovic (Captain of Puno Port)

National University of The Altiplano – Puno (UNA)

Fernando Cáceda Diaz (President of UNA)

Ministry of Transport, Housing and Construction (MTCVC)

Angel Achata Núñez (Regional Director)

Ministry of Fishery

Arturo Blondet Gago (Regional Director)

Ministry of Industry and Tourism (MITICI)

Juana García Pineda (Regional Director)

National Program of Nutrition Assistance (PRONAA)

Ricardo Orbegoso Carrasco (Director)

Basic Sanitation Municipal Utility of Puno (EMSAPUNO)

Rogelio Flores Franco (General Manager)

Ministry of Agriculture

Gustavo Ibarra Imata (Regional Director)

Transitional Council of Regional Administration (CTAR-PUNO)

Ramón Serruto Colque (Executive President)

Central Office for the Barrios of Puno (CUBUP)

Félix Flores Mamani (President)

Ecology and Environment Multisectorial Committee

Gregorio Ticona Gomez (President; Mayor of Municipality of Puno Province)

National Institute of Development (INADE)

Plinio Gutiérrez del Pozo (Manager of Studies)

Special Binational Project for Lake Titicaca (PELT)

Ariel Bermejo Lira / Julián BARRA CATACORA (Executive Director)

5. CONTENTS OF THE REPORT

The Study reports prepared are as follows:

Main Report (English)

Main Report (Spanish)

Supporting Report (English)

Summary Report (English)

Summary Report (Spanish)

Data Book (English)

The main report presents the summarized results of the whole study. It consists of 11 chapters. The existing basic data concerning the study area are shown in *Chapter II*. The exising physical, chemical and biological conditions of Puno Interior Bay are shown in *Chapter III*. The framework of the Integrated Water Pollution Control Plan for Puno Interior Bay is shown in *Chapter IV*, as basic policies and targets of the plan. As components of the Integrated Water Pollution Control Plan for Puno Interior Bay, structural measures, non-structural measures and environmental monitoring are discussed in *Chapter V*, *Chapter VI*, *Chapter VIII*, and *Chapter IX*. *Chapter V* shows the existing sewerage system and the master plan for its development, as a component of the integrated plan. *Chapter VI* shows the existing solid waste management and the master plan for its development. *Chapter VII* shows the other structural measures including urban drainage improvement or in-lake management such as internal load reduction or replanting Totora. *Chapter VIII* shows the non-structural measures which encourage or support the structural measures. *Chapter IX* shows the master plan for the environmental monitoring which detects the water pollution problems and checks the effects of the measures. *Chapter X* shows the feasibility study on the solid waste management project selected from the master plan. *Chapter XI* shows conclusions and recommendations to encourage the implementation of the Integrated Water Pollution Control Plan for Puno Interior Bay

The supporting report describes in detail the same contents presented in the main report.

The Spanish versions of reports are prepared as reference.

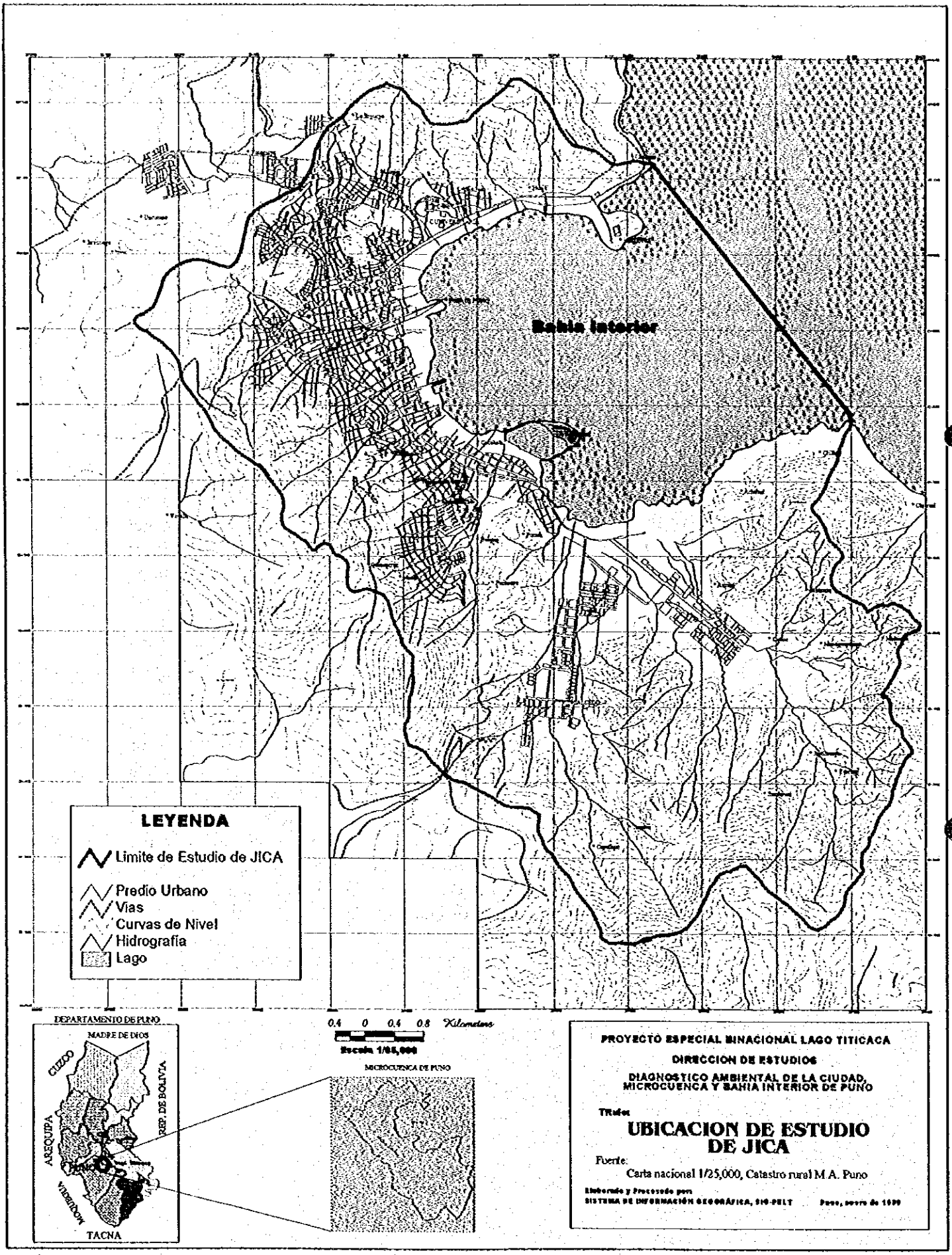


Figure I.1 Study Area

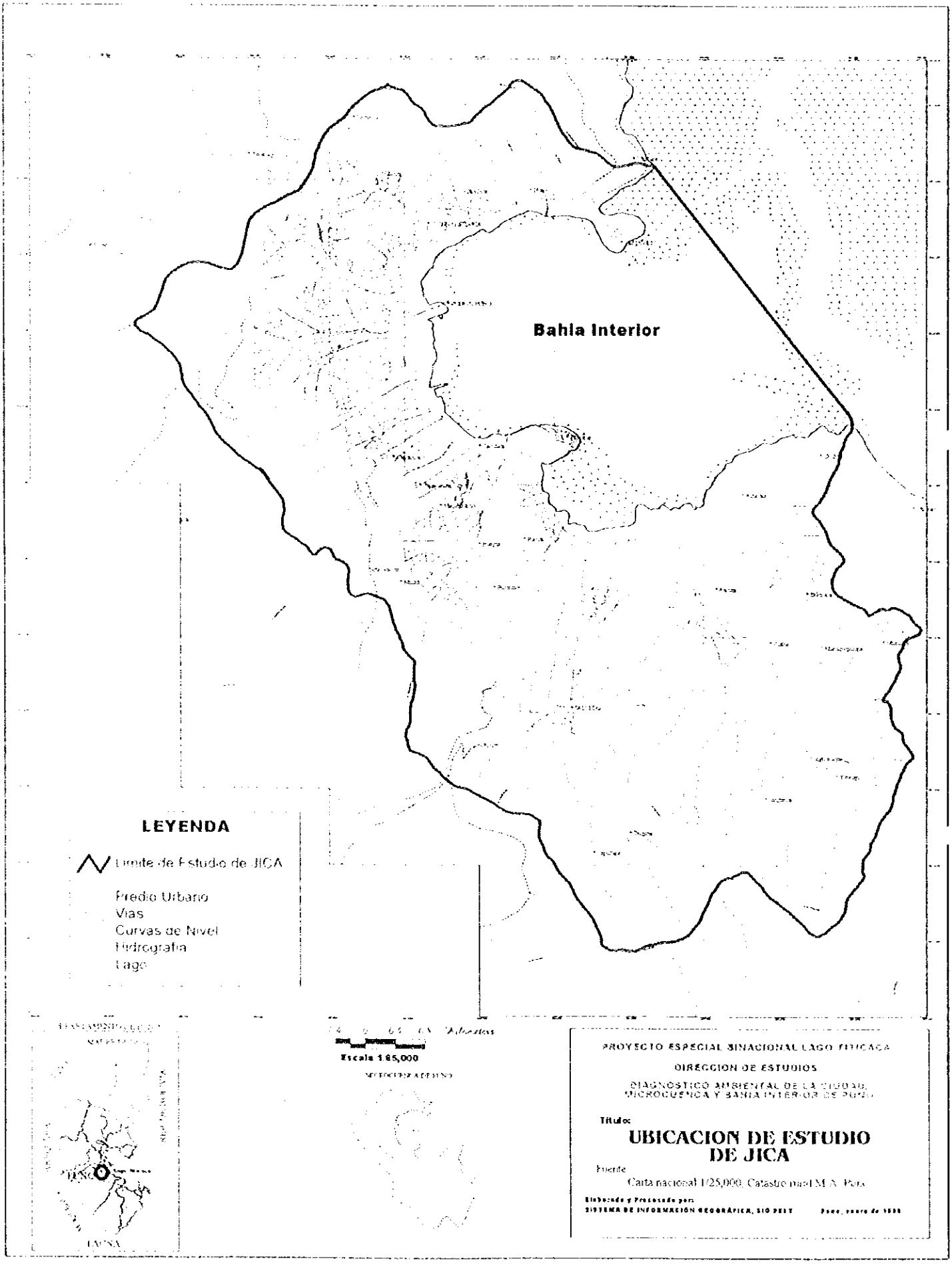


Figure I.1 Study Area