

**JAPAN INTERNATIONAL
COOPERATION AGENCY (JICA)**

**EMPRESA NICARAGÜENSE DE ACUEDUCTOS
Y ALCANTARILLADOS SANITARIOS (ENACAL)**

**THE STUDY ON IMPROVEMENT OF
WATER SUPPLY SYSTEM
IN MANAGUA IN THE REPUBLIC OF
NICARAGUA**

FINAL REPORT

Volume I : Executive Summary

DECEMBER 2005

**NIHON SUIDO CONSULTANTS CO., LTD.
ASIA AIR SURVEY CO., LTD.**

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FINAL REPORT

- Volume I : Executive Summary (English Version)
- Volume II : Main Report (English Version)
- Volume III : Supporting Report – Part 1 (English Version)
- Volume IV : Supporting Report – Part 2 (English Version)
- Volume V : Executive Summary (Spanish Version)
- Volume VI : Main Report (Spanish Version)

PREFACE

In response to the request made by the Government of the Republic of Nicaragua, the Government of Japan decided to conduct the Study on Improvement of Water Supply System in Managua in the Republic of Nicaragua and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Nicaragua a study team headed by Mr. Sadanobu SAWARA of Nihon Suido Consultants, Co., Ltd. five times between July 2004 and December 2005. The study team was composed of members from Asia Survey Co., Ltd and Nihon Suido Consultants, Co., Ltd. JICA also established an Advisory Committee headed by Mr. Yoshiki OOMURA, senior advisor of the Institute for International Cooperation JICA, which, from time to time during the course of the study, provided specialist advice on technical aspects of the study.

The team held discussions with the officials concerned of the Government of the Republic of Nicaragua, and conducted field surveys of the study area. Upon returning to Japan, the team conducted further studies and prepared the present report.

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

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

December 2005

Etsuo KITAHARA
Vice President
Japan International Cooperation Agency

December 2005

Mr. Etsuo KITAHARA
Vice President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

Dear Sir,

We are pleased to submit to you this Final Report on the Study on Improvement of Water Supply System in Managua in the Republic of Nicaragua. This report incorporates the views and suggestions of the authorities concerned of the Government of Japan and your Agency. It also includes the comments made on the Draft Final Report by Empresa Nicaragüense de Acueductos y Alcantarillados Sanitarios (ENACAL) and other authorities concerned of the Republic of Nicaragua.

The Final Report comprises a total of six volumes as listed below.

- Volume I : Executive Summary (English Version)
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The report contains our findings, conclusions and recommendations with regard to the formulation of a Long-term Improvement Plan of the water supply system in Managua up to the year 2015 and identification of a Priority Project which is proposed to be implemented in the short- to medium-term future.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Health, Labour and Welfare of the Government of Japan for their valuable advice and suggestions. We also wish to express our deep appreciation to the relevant officers of ENACAL and other authorities concerned of the Government of Nicaragua for their close cooperation and assistance extended to us during our investigations and study.

Very truly yours,

讚 良 貞 信

Sadanobu SAWARA
Team Leader, Study on Improvement
of Water Supply System in Managua
in the Republic of Nicaragua

ABSTRACT

Although having an adequate supply capacity, the existing water supply system in Managua can not meet the current water demand satisfactorily. It is largely because of the inefficiency of the water transmission and distribution systems and the high levels of leakage and wastage which combined accounts for 45% of the volume of water distributed into the distribution system. As a result, there are three distinct areas, namely San Judas, Schick and Laureles Sur, in the study area, where the current extremely poor water supply condition is recognized as one of the most critical social problems in Managua. Further, ENACAL has not been able to deal effectively with the recent rapid increase in water demand in the Esquipulas, Jaguitas, Ticuantepe and Nindiri areas and in areas along the Carretera Masaya.

Our assessment indicated that the total water supply capacity in Managua would gradually decrease in years to come. In some of the existing wells used by ENACAL, the current arsenic and/or nitrate concentrations already exceed the maximum allowable limit of the drinking water standards. The volume of intake from Lake Asososca will need to be decreased in the future in order to protect the lake from possible contamination. Due to a backlog of repairs and maintenance, many wells and well pumps are not functioning at present or being barely operated at significantly low production rates. In the absence of regular replacement programs, many wells and well pumps have already been used beyond their normal useful life.

Policies and Goals of Long-term Improvement Plan (LIP)

Policies		Goals	
1.	Rehabilitation and protection of existing water sources	(1)	The total production capacity of existing sources will be sustained.
		(2)	Water quality of existing sources will be protected.
		(3)	Safety of water supply will be assured.
2.	Reduction of leakage/wastage	(1)	Water resources will be conserved.
		(2)	The volume of water that can be delivered to customers will increase.
		(3)	Large-scale investments for the development of new water sources can be deferred.
		(4)	Revenues from water sale will increase.
		(5)	Public awareness on the efficient use (conservation) of water will increase.
3.	Increase in the efficiency of water transmission and distribution systems	(1)	The state of water being distributed over the entire city area can be assessed precisely.
		(2)	O&M of the water supply system will become easier and ENACAL will be able to deal with problems in a more prompt and appropriate manner.
		(3)	The equity of water service will be enhanced by strengthening supplies to areas where water supply conditions are currently extremely poor.
		(4)	The economic growth of the region will be sustained by strengthening supplies to areas where rapid developments have been taking place in recent years.
		(5)	Old water transmission pump stations will be rehabilitated.
		(6)	Secondary/tertiary distribution mains and service connections will be installed to cater for increased service populations in the future.
4.	Establishment of a basic financial framework for the management of water services in Managua	(1)	ENACAL will spend a sufficient level of expenses for the O&M of the existing water supply system in Managua.
		(2)	Depreciation expenses will be recovered through tariffs and used for the replacement/rehabilitation of deteriorated equipment and facilities.
		(3)	Financial evaluation of the water services in Managua will become possible.

Taking all of these problems into account, a basic strategy for developing a long-term water supply improvement plan for Managua up to the year 2015 was established. The strategy is to implement, according to the priority, both physical and non-physical measures required to achieve the goals set for each of the four basic policies shown in the table above.

Measures Required for “Rehabilitation and Protection of Existing Water Sources” and Their Priority (1/2)

Measures	Description	Priority
1A Restoration of the design production capacity of the Managua I Well Field.	- The current production capacity of the Managua I Well Field (53,000 m ³ /day) will be increased by 18,000 m ³ /day to its design production capacity (71,000m ³ /day). The work will include the renewal of 1 well (W7) and rehabilitation of 4 wells (E4, W3, W6 & W8) through cleaning of wells and replacement of well pumps.	High
1B Restoration of the design production capacity of the Managua II Well Field.	- The current production capacity of the Managua II Well Field (44,000 m ³ /day) will be increased by 12,000 m ³ /day to its design production capacity (56,000m ³ /day). The work will include the renewal of 1 electric transformer (P11) and 1 electric panel (P13); and rehabilitation of 4 wells (P6, P8, P1 & P16) through cleaning of wells and replacement of well pumps.	High
1C Stage-wise rehabilitation and renewal of aged wells and well pumps	(a) 10 wells that are currently malfunctioning or barely operated at significantly low production rates will be rehabilitated. The work will include the rehabilitation of 6 wells in Zona Baja (No.17, No.18, No.22, No.24, No.25 & No.80), 1 well in Zona Alta (No.31) and 3 wells in Zona Alta Superior (No.71, No.75 & No.108) through cleaning of wells and replacement of well pumps.	High
	(b) 22 wells, of which well pumps will have been in service for more than 20 years in 2010 will be rehabilitated. The work will include the rehabilitation of 1 well in Zona Baja, 7 wells in Zona Alta and 14 wells in Zona Alta Superior through cleaning of wells and replacement of well pumps.	Medium
	(c) 18 wells, of which well pumps will have been in service for more than 20 years in 2015 will be rehabilitated. The work will include the rehabilitation of 8 wells in Zona Baja, 4 wells in Zona Alta and 6 wells in Zona Alta Superior through cleaning of wells and replacement of well pumps.	Low
	(d) 10 wells which will have been in service for more than 30 years in 2010 will be renewed. The work will include the renewal of 4 wells in Zona Baja, 1 well in Zona Alta and 5 wells in Zona Alta Superior.	Medium
	(e) 6 wells which will have been in service for more than 30 years in 2015 will be renewed. The work will include the renewal of 5 wells in Zona Baja and 1 well in Zona Alta Superior.	Low
1D Taking measures against wells that have relatively high levels of nitrate concentrations	(a) No.8 and No.10 wells in Zona Baja will be abandoned and substitute wells will be constructed in the San Judas area by 2010. The work will include the construction of 3 new wells and a raw water supply main (PVC150 : 1.0km).	High
	(b) No.9 well in Zona Baja will be abandoned and substitute wells will be constructed in the Esquipulas area by 2015. The work will include the construction of 2 new wells and a raw water supply main (PVC150 : 1.0km).	Low
1E Taking measures against wells that have relatively high levels of arsenic concentrations	(a) Four wells, namely No.27, No.28, No.29 and No.46 will be abandoned and substitute wells will be constructed in the Jaquitas area by 2010 to supply areas that are currently supplied by these four wells. The work will include the construction of 5 new wells, a water tank (4,000m ³) and distribution mains (DIP300 to 450 :2.9km & PVC250 : 1.1km).	High
	(b) Direct distribution from Well No.57 will be discontinued. Water from this well will be first transported to the Altamira Tank for mixing with water from other sources and then distributed from the tank. Water from Well No.68 will continuously be sent to the Las Americas Tank (as is the case at present) for mixing with water from the Managua II well field. Direct distribution from Well No. 112 will be discontinued. Water from this well will be first sent to the Las Americas Tank for mixing with water from the Managua II well field and then distributed from the tank. Direct distribution from Well No.30 will be discontinued. Water from this well will be mixed with water from the neighboring Well No.31 before it is distributed to customers. Water from Wells No.77 and No.78 will continuously be injected directly into the 900 mm diameter distribution trunk main (as is the case at present) and thus it will be mixed with water from the Las Mercedes well field.	Low
	(c) Four existing wells, namely No.11, No.52, No.91 and No.14 (Las Mercedes No.9) will be abandoned by 2015.	Low

Measures Required for “Rehabilitation and Protection of Existing Water Sources” and Their Priority (2/2)

1 F	Reduction in the volume of abstraction from Lake Asososca.	- The volume of abstraction from Lake Asososca will in the long run be reduced to approximately 30,000m ³ /day with a view to maintaining the water level of the lake high enough to prevent the intrusion of groundwater into the lake.	Low
1G	Establish control over the use and development of groundwater by the private sector	- Usage and development of groundwater by the private sector will be controlled strictly with a view to maintaining the sustainability of public water services. Private wells will be metered and both water and sewerage charges will be collected from users by ENACAL based on metered consumptions.	High
1H	Establish control over the construction and operation of facilities which otherwise could contaminate groundwater	- Construction and operation of gas stations and other chemical manufacturing/storage facilities will be controlled strictly with a view to preventing them from spilling gasoline and other hazardous chemicals into the ground.	High
1I	Continuous monitoring and evaluation of water quality at sources by ENACAL	- ENACAL will analyze water quality of all the existing water sources twice a year (once in the dry season and the other in the wet season), covering all the water quality parameters included in the National Drinking Water Quality Standards. Wells currently having an arsenic concentration between 6.0 µg/l and 8.0 µg/l will be tested for arsenic four times a year (every three months). The results of the analyses will be evaluated and countermeasures will be explored when problems are encountered.	High
1J	Increase the analytical capacity of ENACAL's laboratory	- ENACAL's staff in the laboratory will receive adequate training in analytical skills required for the measurement of the concentrations of heavy metals (using an atomic absorption spectroscopy) and pesticides (using a gas chromatograph). UPS (Uninterrupted Power Supply) devices will be installed in the laboratory to protect these analytical equipment from sudden electricity surges and power failures.	High

Measures Required for “Reduction of Leakage/Wastage” and Their Priority (1/2)

Measures	Description	Priority
2A	Micro-sectoring of the distribution network and implementation of leakage and wastage reduction measures	<p>(a) The existing distribution network in Zona Baja will be divided into 170 micro sectors and measures for reducing leakage and wastage will be implemented in each of the established micro sectors. The work will include the procurement of vehicles and valves, measurement of minimum night flows, and detection/repair of approximately 32,000 visible/invisible leaks. High</p> <hr/> <p>(b) The existing distribution network in Zona Alta will be divided into 100 micro sectors and measures for reducing leakage and wastage will be implemented in each of the established micro sectors. The work will include the procurement of valves, measurement of minimum night flows, and detection/repair of approximately 20,000 visible/invisible leaks. Medium</p> <hr/> <p>(c) The existing distribution network in Zona Alta Superior will be divided into 110 micor sectors and measures for reducing leakage and wastage will be implemented in each of the established micro sectors. The work will include the procurement of valves, measurement of minimum night flows, and detection/repair of approximately 28,000 visible/invisible leaks. Low</p>
2B	Replacement of aged water meters.	- Water meters that have already been in service for more than 10 years will be replaced. The work will include the replacement of 72,000 meters. High
2C	Enabling the existing Commercial Department to play more integrated roles in reducing leakage, wastage and illegal connections and in increasing revenues from water sale	- Four units, namely LAU (Leakage Abatement Unit), ICCU (Illegal Connection Control Unit), AIPU (Asentamiento Improvement Program Unit), and CMBU (Customer Metering and Billing Unit) will be established within the existing Commercial Department, and each unit will be staffed by personnel who has experience in that particular field. High

Measures Required for “Reduction of Leakage/Wastage” and Their Priority (2/2)

2D	Review/revision of the existing water tariff structure	- Existing water tariffs for domestic customers will be reviewed and revised with a view to providing more consistent incentives for the efficient use of water. The limit of essential (subsistence) consumption for an average household will be established and subsidized tariffs will only be applied to metered consumption below that limit. Subsidized tariffs will never be applied to un-metered connections. Relatively high levels of fixed charges will be applied to un-metered domestic customers to provide a stimulus to encourage such customers to request the installation of a meter.	High
2E	Review/revision of "Reglamento de Servicios al Usuario"	- "Reglamento de Servicios al Usuario" will set forth that (a) water meters will in principle be installed within the premises of customers and (b) customers will be held liable for any damages except normal wear and tear to water meters, including tampering. It will also set forth that (a) water meters will in principle be installed aboveground and (b) ENACAL has a right to decide the location and method of meter installation at its own discretion. Fines and penalties for illegal users will be increased.	High
2F	Strengthening ENACAL's capacity in meter reading, billing and collection	- Registry of customers will be reorganized and updated. Classification of customers by use category will be defined more clearly and applied without discrimination. Meter readers will be trained in social communication skills. Meter reading, billing and collection systems will be related to the geographic coverages of macro sectors. Information on meter reading, billing and collection will be managed exclusively by CMBU (Customer Metering and Billing Unit) of the Commercial Department but will be shared with other units and departments of ENACAL through a computer network.	High
2G	Increasing public awareness	- ENACAL will implement campaigns through the mass media (TV, radio and newspapers) to increase public awareness on issues such as water conservation, illegal connections and payment of water charges. Curriculums for primary and secondary schools will include tours of water supply facilities. Government will designate March 22nd as the "Nicaraguan Water Day" and ENACAL will organize exhibitions and arrange an inspection tour of water supply facilities on that particular day. In the dry season, ENACAL will send loudspeaker-mounted vehicles to areas where water is relatively abundant asking residents to stop watering roads/gardens or	High
2H	Improvement of water supply and sanitation conditions in low-income settlements through community participatory approaches	(a) Databases on approximately 166 low-income settlements in Managua will be developed. Information compiled in the databases will include ages of the settlement, total number of households, average household size, ownership of land titles, water supply conditions, sanitary environments, conditions of other infrastructure (roads, electricity, telephone, sewerage, solid wastes disposal), community organizations, and priority needs of residents.	High
		(b) Pilot projects will be implemented through community participatory approaches to improve water supply and sanitation conditions in 3 low-income settlements each selected from Type A, Type B and Type C settlements. The work will include the procurement of 2 vehicles and consultancy/NGO services, supply/installation of 750 water meters, provision of 750 new water service connections and 1,160 new sewerage service connections, and construction of internal water/sewerage reticulation systems.	High
		(c) Water supply and sanitation conditions in 81 Type A settlements will be improved through community participatory approaches. The work will include the procurement of 2 vehicles and consultancy/NGO services, supply/installation of 27,000 water meters, provision of 9,000 new sewerage connections, and construction of internal sewerage reticulation systems.	High
		(d) Water supply and sanitation conditions in 52 Type C settlements will be improved through community participatory approaches. The work will include the procurement of 2 vehicles and consultancy/NGO services, provision of 12,500 new water connections and 12,500 new sewerage service connections, and construction of internal water and sewerage reticulation systems.	High
		(e) Water supply and sanitation conditions in 30 Type B settlements will be improved through community participatory approaches. The work will include the procurement of 2 vehicles and consultancy/NGO services, supply/installation of 6,000 water meters, provision of 6,000 new water connections and 12,000 new sewerage service connections, and construction of internal sewerage reticulation systems.	Medium

Measures Required for “Increasing in the Efficiency of Water Transmission and Distribution Systems” and Their Priority

Measures	Description	Priority
3A Macro-sectoring of the distribution system	- The existng distribution network will be divided into a number of hydraulically-isolated macro sectors with a view to ensuring appropriate matching of water sources with their supply areas. The work will include the installation of 101 valves (50 ~ 800mm) for the isolation of macro sectors and 31 bulk water meters (150 ~ 800mm) for the measurement of flows into macro sectors.	High
3B Improvement of water supply conditions in the San Judas, Schick and Laureles Sur areas and extension of water supply to the Jaguitas and Esquipulas areas	(a) Wate supply conditions in the San Judas area will be improved. The work will include the construction of a water tank (2,000m3), a transmission pump station (74kw), a transmission main (PVC150 : 1.5km) and distribution mains (DIP300 : 0.3km & PVC250 : 2.3km).	High
	(b) Water supply conditions in the Schick and Laureles Sur areas will be improved. Water supply will be extended to the Esquipulas and Jaquitas areas where many housing development schemes are being implemented. The work will include the construction of a water tank (5,000m3), a transmission main (DIP300 : 1.0km) and distribution mains (DIP300 ~ 500 : 6.6km & PVC150 ~ 200 : 5.6km).	High
3C Strengthening of water supplies in Veracruz and areas along the Carretera Masaya	- Water supply in Veracruz and areas along the Carretera Masaya will be strengthened. The work will include the construction of a transmission pump station (150kw), a transmission main (PVC250 : 4.1km), a distribution pump station (225kw) and a distribution main (DIP350 : 0.6km).	High
3D Strengthening of water supplies in Ticuantepe and Nindirí	(a) Water supply in Ticuantepe will be strengthened. The work will include the construction of a new well and a raw water supply main (PVC150 : 1.0km).	High
	(b) Water supply in Nindirí will be strengthened. The work will include the construction of a new well and a raw water supply main (PVC150 : 4.0km).	High
3E Strengthening of water supply in Zona Baja	- Water supply capacity in Zona Baja will be strengthened in the medium- and long-term future to compensate the reduction in the volume of abstraction from Lake Asososca and the relocation of 3 wells to higher elevation areas. The work will include the construction of a pump suction well (1,000m3), a transmission pump station (300kw) and a transmission main (DIP450 : 4.4km).	Low
3F Rehabilitation of water transmission pump stations	- Existing transmission pump stations including those located at Asososca and km8 will be rehabilitated. The work will include the replacement of pumps and electric panels at existitng pump stations (Total pumping capacity:1,500kw).	Medium
3G Provision of small diameter distribution pipes and service connections to cator for the increased service population in the future	(a) Provision of secondary and tertiary distribution mains to cater for the increased service population during the 10 years from 2005 to 2015. The work will include the construction of small diameter distribution mains (PVC 50 ~ 250) to supply 49,500 new service connections.	Medium
	(b) Provision of service connections to cater for the increased service population during the 10 years from 2005 to 2015. The work will include the installation of 49,500 new metered service connections.	Medium

Measures Required for “Establishment of a Basic Financial Framework for the Management of Water Services in Managua” and Their Priority

Measures	Description	Priority
4A Establishment of an independent financial account for the water services in Managua	- ENACAL will establish an independent financial account for the water services in Managua. To this end, the ENACAL's current financial account will be divided into two, one covering the water services in Managua and the other covering the water services in the rest of the country.	High
4B Tariff increase	- Domestic tariffs in Managua will be increased at least to the level of the domestic tariffs currently applied in Matagalpa. At the same time, a special low tariff block (lifeline tariff block) for a subsistence monthly consumption will be provided in tariff structures to protect the extremely poor. The poor will be allowed to pay connection charges in installments over a long period of time.	High
4C Minimizing headquarters' expenses and establishing appropriate rules for the division of such expenses	- ENACAL will minimize its headquarters' expenses and establish appropriate rules for dividing such expenses between different financial accounts.	High
4D Training	- ENACAL's staff in the Financial Department will receive training on issues such as "Revenue Requirements", "Water Tariff Structures", "Cross-subsidization of Water Tariffs", "Depreciation" and "Cost Recovery".	High

Table below shows the estimated project costs of the proposed Long-term Improvement Plan (LIP). They are expressed in United States Dollars using the currency exchange rates of US\$1.0 = JPY106.0900 = EUR0.7583 = C\$16.2834 publicized by the Central Bank of Nicaragua on 10 December 2004. Base Costs are estimated based on the December-2004 price. Other assumptions used in the estimate are as follows:

- Engineering fees (D/D and C/S) : 7% of Base Cost
- Physical Contingency: 5% of (Base Cost + Engineering Fees)
- Price Contingency: 3.9%p.a. (starting from 2006)
- Project Administration Cost: 2.5% of (Base Cost + Engineering Fees + Physical Contingency + Price Contingency)

Preliminary Cost Estimates of Proposed Long-term Improvement Plan (US\$ 1,000)

Measures/Items		First Stage (2006 to 2010)			Second Stage (2010 to 2015)			Total (2006 to 2015)		
		Donor	ENACAL	Total	Donor	ENACAL	Total	Donor	ENACAL	Total
1.	Rehabilitation and protection of existing water sources	8,217	6,850	15,068	0	6,058	6,058	8,217	12,908	21,125
2.	Reduction of leakage/wastage	22,197	325	22,522	9,354	14,057	23,411	31,551	14,383	45,933
3.	Increasing in the efficiency of water transmission and distribution systems	9,126	9,440	18,566	0	14,501	14,501	9,126	23,941	33,067
4.	Establishment of a basic financial framework for the management of water services in Managua	0	0	0	0	0	0	0	0	0
Total Base Cost		39,540	16,615	56,155	9,354	34,616	43,970	48,894	51,231	100,126
Engineering Fees (D/D & C/S)		2,768	1,163	3,931	655	2,423	3,078	3,423	3,586	7,009
Physical Contingency		2,115	889	3,004	500	1,852	2,352	2,616	2,741	5,357
Price Contingency		6,338	2,645	8,982	2,712	14,016	16,728	9,050	16,661	25,710
Project Administration Cost		0	1,802	1,802	0	1,653	1,653	0	3,455	3,455
Total Project Cost		50,761	23,113	73,875	13,221	54,561	67,782	63,982	77,674	141,656

Of the various projects included in LIP, those ranked “high” in priority were selected to form the Priority Project (PPT). Table below shows the preliminary cost estimates of PPT. Currency exchange rates and other assumptions used in the cost estimates are the same as that used in the case of LIP.

Preliminary Cost Estimates of Proposed Priority Project (US\$ 1,000)

Measures/Items		First Stage (2006 to 2010)			Second Stage (2010 to 2015)			Total (2006 to 2015)		
		Donor	ENACAL	Total	Donor	ENACAL	Total	Donor	ENACAL	Total
1.	Rehabilitation and protection of existing water sources	8,217	0	8,217	0	0	0	8,217	0	8,217
2.	Reduction of leakage/wastage	22,197	0	22,197	9,354	0	9,354	31,551	0	31,551
3.	Increasing in the efficiency of water transmission and distribution systems	9,126	0	9,126	0	0	0	9,126	0	9,126
4.	Establishment of a basic financial framework for the management of water services in Managua	0	0	0	0	0	0	0	0	0
Total Base Cost		39,540	0	39,540	9,354	0	9,354	48,894	0	48,894
Engineering Fees (D/D & C/S)		2,768	0	2,768	655	0	655	3,423	0	3,423
Physical Contingency		2,115	0	2,115	500	0	500	2,616	0	2,616
Price Contingency		6,338	0	6,338	2,712	0	2,712	9,050	0	2,616
Project Administration Cost		0	1,269	1,269	0	331	331	0	1,600	1,600
Total Project Cost		50,761	1,269	52,030	13,221	331	13,551	63,982	1,600	65,582

THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN MANAGUA IN THE REPUBLIC OF NICARAGUA

FINAL REPORT Volume I : Executive Summary

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Abbreviations and Acronyms

ACDI	Canadian Agency for Institutional Development
AIPU	Asentamiento Improvement Program Unit
ALMA	Managua Municipality
AMAT	Water Supply Company of Matagalpa
AMUNIC	Association of Municipalities of Nicaragua
ANC	Non-revenue Water
ANISA	Nicaraguan Association of Sanitary and Environmental Engineering, Nicaragua Chapter of AIDIS
AN	National Assembly
ASDI	Swedish Agency for Cooperation
ATP	Affordability to Pay
BCIE	Central American Bank for Economic Integration
BID	Inter-American Development Bank
BIRF, B.M	International Bank for Reconstruction and Development, World Bank
BCN	Central bank of Nicaragua
BOD	Biochemical Oxygen Demand
B/C	Benefit-Cost Ratio
C\$	Córdoba (Currency of Nicaragua)
CABEI	Central American Bank for Economic Integration
CAPS	Committees for Potable Water and Drainage
CAPRE	Regional Coordinating Committee of Institutions for potable water and drainage of Central America, Panama and Dominican Republic
CEPIS	Pan-American Center for Sanitary and Environmental Engineering for OPS
CI	Cast Iron
CIDA	Canadian International Development Association
CIRA	Center for Investigations of Aquatic Resources
CMBU	Customer Metering and Billing Unit
CNRH	National Commission of Hydraulic Resources
COD	Chemical Oxygen Demand
CONAPAS	National Commission of Potable Water and Sanitary Sewer System
COSUDE	Switzerland Development Cooperation
C/S	Construction Supervision
D/D	Detailed Design
DI	Ductile Iron
DO	Dissolved Oxygen
DULEX	Dukedom of Luxemburg - Development
E & M	Electrical & Mechanical
EBIT	Earning Before Interest and Taxes
EBITDA	Earning Before Interest, Taxes, Depreciation and Amortization
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
ENACAL	Nicaraguan Company of Aqueducts and Sewer Systems
ENTRESA	Nicaraguan Company of Electrical Transmission SA
EMAJIN	Water Supply Company of Jinotega
ENEL	Nicaraguan Company of Electricity
EPA, USEPA	Environmental Protection Agency, USA
EU	European Union
EUR	Euro (Currency of European Union)
FAD	Spanish Fund for Development Support

FIRR	Financial Internal Rate of Return
FISE	Social Investment fund for Emergency
FMI (IMF)	International Monetary Fund
FY	Financial (or Fiscal) Year
GDP	Gross Domestic Product
GI	Galvanized Iron
GIS	Geographical Information System
gpm	U.S.A.Gallon per Minute (equal to 3.785 liters per minute)
GPS	Global Positioning System
GRN	Government of Republic of Nicaragua
GTZ	Gesellschaft fur Technische Zusammenarbeit (German Assistance Agency)
HDPE	High Density Polyethylene
HRD	Human Resources Development
HWL	High (or Head) Water Level
IAA	Intendencia of Aqueducts and Sewer System
IBRD	International Bank for Reconstruction and Development
ICB	International Competitive Bidding
ICCU	Illegal Connection Control Unit
IDA	International Development Association
IDB	Inter-American Development Bank
IDC	Interest During Construction
IDR	Institute of Rural Development
IEE	Initial Environmental Examination
in	Inch
INAA	Nicaraguan Institute of Aqueducts and Sewer Systems
INATEC	National Technological Institute
INIFOM	Nicaraguan Institute of Municipal Development
INE	Nicaraguan Institute of Energy
INEC	Nicaraguan Institute of Statistics and Census
INETER	Nicaraguan Institute of Territorial Studies
INTUR	Nicaraguan Institute of Tourism
IVA	Value Added Tax
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
JPY	Currency of Japan (Yen)
KfW	Kreditanstalt Fur Wiederaufbau (Credit Institute for Reconstruction)
kV	Kilovolt
LAQUISA	LABORATORIOS QUIMICOS, S.A.
LAU	Leakage Abatement Unit
LCB	Local Competitive Bidding
LIDECONIC	League for the Defense of Consumer of Nicaragua
LIP	Long-term Improvement Plan (proposed in this study)
lpcd	Liters per Capita per Day
LRMC	Long Run Marginal Cost
MAGFOR	Ministry of Agricultural and Forestry
MARENA	Ministry of the Environment and natural resources
MCM	Million Cubic Meters
MHCP	Ministry of Finance and Public Credit
MIFIC	Ministry of Development, Industry and Trade
MINREX	Ministry of Foreign Affairs
MINSA	Ministry of Health
mg/l	Milligram per Liter
MLD	Million Liters per Day

MMC	Millions of cubic meters
MNF	Minimum Night Flow
MPa	Mega Pascals
MTI	Ministry of Transport and Infrastructure
MW	Megawatt
NDF (FDN)	Nordic Development Fund
NGO	Non-Government Organization
MPN	Most Probable Number
NPV	Net Present Value
NRW	Non-revenue Water
NTON	Nicaraguan Obligatory Technical Standards
WHO	World Health Organization
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
OPEC	Organization of Petroleum Exporting Countries
OPS	Pan-American Health Organization
O & M	Operation and Maintenance
PAHO	Pan-American Health Organization
PE	Polyethylene
PED	Managerial Plan for Development
PFI	Plan for Institutional Strengthening
PIU	Project Implementation Unit
PND	National Development Plan
PNUD	United Nations Development Program
PPT	Priority Project (proposed in this study)
ppm	Parts per Million
ppb	Parts per Billion
psi	Pound per Square Inch
p.a.	Per Annum
PSP	Private Sector Participation
PRSP	Poverty Reduction Strategy Paper
PVC	Polyvinyl Chloride
RAAN	Autonomous Region North Atlantic
RAAS	Autonomous Region South Atlantic
RASNIC	Networks for potable water and drainage in Nicaragua
SCADA	Supervisory Control and Data Acquisition
SCF	Standard Conversion Factor
SER	Shadow Exchange Rate
SECEP	Secretariat for Coordination and Strategy of the Presidency
SGPRS	Strengthened Growth and Poverty Reduction Strategy
SIAF	Financial Management Information System
SIDA	Swedish International Development Cooperation Agency
SINAPRED	National System for the prevention, mitigation and attention to disasters
SISEP	Superintendence of Public Services
STP	Sewage Treatment Plant
SWISS – AID	Agency of Switzerland for Cooperation for Development
TELCOR	Nicaraguan Institute of Telecommunication and Post
TOR	Terms of Reference
TWL	Top Water Level
UE	European Union
UFW	Unaccounted-for Water
U.K.	United Kingdom
UNAN	Autonomous National University of Nicaragua

UNDP	United Nations Development Program
UNICEF	United Nations Children's Fund
U.S.A	United States of America
USAID	United States Aid Agency
US\$	United States Dollars
WHO	World Health Organization
WS&S	Water Supply and Sanitation
WTP	Willingness to Pay
Xolotlan	Name for the Lake known as Lake Managua

I. INTRODUCTION

This document constitutes the Volume I : ‘Executive Summary’ of the Final Report on the “Study on Improvement of Water Supply System in Managua in the Republic of Nicaragua (hereinafter referred to as the ‘Study’)”, which has been undertaken since July 2004 by a team of consultants (hereinafter referred to as the ‘Study team’) under the auspices of the Japan International Cooperation Agency (hereinafter referred to as the ‘JICA’) with the main objectives of (i) formulating a long-term improvement plan for the water supply system in Managua up to the year 2015, and (ii) identifying priority projects that are to be implemented in the short to medium terms. Empresa Nicaragüense de Acueductos y Alcantarillados Sanitarios (hereinafter referred to as ‘ENACAL’), the state enterprise which is currently responsible for the provision of water and wastewater management services in the Study area, is the Executing Agency of the Study. The Study area comprises the entire administrative area of Managua city plus urban areas of Ticuantepe and Nindirí located alongside the Carretera Masaya. JICA and ENACAL agreed to implement the Study upon signing the “Minutes of Meeting on the Scope of Works for the Study” in Managua on March 2, 2004.

The Study team started the first field work in Nicaragua on July 19, 2004. Since then until mid October 2004, the Study team concentrated its efforts on collecting data and information that are related to the existing water services in Managua. Those efforts included field inspections of existing water supply infrastructure and meetings with managers of ENACAL’s various departments, the presidents of INNA (Instituto Nicaragüense de Acueductos y Alcantarillados) and CONAPAS (Comisión Nacional de Agua Potable y Alcantarillado Sanitario y Saneamiento), and local representatives of multilateral and bilateral donor agencies that have been providing assistance to ENACAL such as JICA, IDB (Banco Interamericano de Desarrollo), AECI (Oficina Técnica de Cooperación, Embajada de España en Nicaragua), Consejero Económico y Comercial Embajada de España, and KfW (Agencia del KfW para América Central). In the meantime, the Study team also conducted various field surveys and measurement works in order to avail itself of additional information on the existing conditions of the water services in Managua. They included: leakage/wastage surveys in 10 selected areas; measurements of flows and pressures at more than 25 locations in the distribution network; water consumption and awareness surveys on randomly-selected 450 domestic users, 100 commercial/institutional users and 50 industrial users; and water quality sampling and analysis of samples taken from both existing and prospective water sources and from 10 household taps selected at random within the existing distribution system.

In late October 2004, the Study team prepared the Interim Report and submitted it to JICA and ENACAL. The report presented the progress of the Study made by mid October 2004 and the Study team’s initial assessments of various technical, financial and institutional problems revolving around the existing water service in Managua. Based on those assessments, the report also presented the Study team’s recommendations on basic policies and strategies for the formulation of a long-term improvement plan of the water supply system in Managua up to the year 2015. The Study team made slide presentations of the report to the management of ENACAL and the representatives of other government agencies, such as INAA, INETER (Instituto Nicaragüense de Estudios Territoriales) and FISE (Fondo de Inversión Social de Emergencia), in Managua on October 28 and 29, 2004. In a meeting held in Managua on January 20, 2005 with the members of the Steering Committee of the Study, the Study team also presented the outcome of the Study and the basic strategies for the formulation of a long-term water supply improvement plan. Comments received from participants during these presentation meetings became valuable inputs into subsequent stages of the Study and in preparing study reports.

Relatively high levels of arsenic and lead concentrations were detected at some of the 10 existing water sources that were subjected to the water quality analysis during the first field work in Nicaragua. In this respect, a consensus was reached among parties concerned that this is an issue directly affecting the safety of water supply, and therefore that a supplemental water quality analysis covering a greater number of existing wells in the study area should be carried out during the second field work in Nicaragua to find out the extent of the problem. The parties also agreed that the long-term improvement plan and the priority project to be proposed in the Final Report should be reviewed and finalized taking the outcome of the supplementary water quality analysis into account.

The second field work in Nicaragua started in July 2005 and included a supplementary water quality analysis which examined arsenic and lead concentrations of a large number of existing wells within the study area. Based on the outcome of the water quality analysis, the long-term improvement plan and the priority project were reviewed and finalized, and ultimately the Final Report was prepared.

The Final Report comprises a total of six volumes as listed below.

- Volume I : Executive Summary (English Version)
- Volume II : Main Report (English Version)
- Volume III : Supporting Report – Part 1 (English Version)
- Volume IV : Supporting Report – Part 2 (English Version)
- Volume V : Executive Summary (Spanish Version)
- Volume VI : Main Report (Spanish Version)

In the early 1990s, JICA conducted a similar study called “The Study on Water Supply Project in Managua” with the objective of urgently developing new water sources and thereby mitigating water shortages in the capital city, which had resulted from a huge influx of population during and after the civil war in the 1980s. Completed in 1993, this study recommended medium- and long-term underground water development schemes which included the development of new well fields at two locations in the southeast of the city. Based on the recommendation, JICA subsequently implemented two grant aid projects, namely ‘Managua I Project’ and ‘Managua II Project’. They were completed in 1997 and 2000 respectively. In each of these projects, a new well field and associated water transmission and distribution facilities were constructed. Combined, these two well fields are now supplying approximately one-thirds of water currently used in the city.

It is recommended that ENACAL make use of this JICA study effectively. In this regard, ENACAL is advised to open up dialogue with donors on the earliest possible occasion to discuss about their financial assistance for the implementation of the priority project proposed by this study. It is hoped that, just like the 1993 JICA study, this study will provide the basis for the subsequent implementation of the proposed priority project and thereby contribute to the improvement of the water services in Managua, the capital city of Nicaragua.

II. OUTCOME OF THE STUDY

II-1. Water Balance Study

The daily maximum water demand in the Study area was estimated at 397,739 m³/day in 2015. On the other hand, our assessment of existing water sources indicated that the total sustainable yield from them would be 402,950 m³/day in 2015, which consists of 372,950 m³/day from both existing and relocated wells and 30,000 m³/day from Lake Asososca. It should be noted that the abstraction from Lake Asososca is proposed to be gradually reduced from the current 56,500 m³/day to 30,000 m³/day in 2015 in order to protect the water quality of the lake from contamination.

Figure S-1 shows the total potential yield from existing sources against the projected daily average and maximum water demands. It is envisaged that the total water demand in the Study area will gradually decrease over the 10 years from 2010 and 2015 despite the steady increase in domestic and non-domestic demands during the same period. This is because of the accelerated reduction in leakage and wastage envisaged in this Study. It is proposed that leakage and wastage combined should be reduced from the current 45% to 25% in 2015.

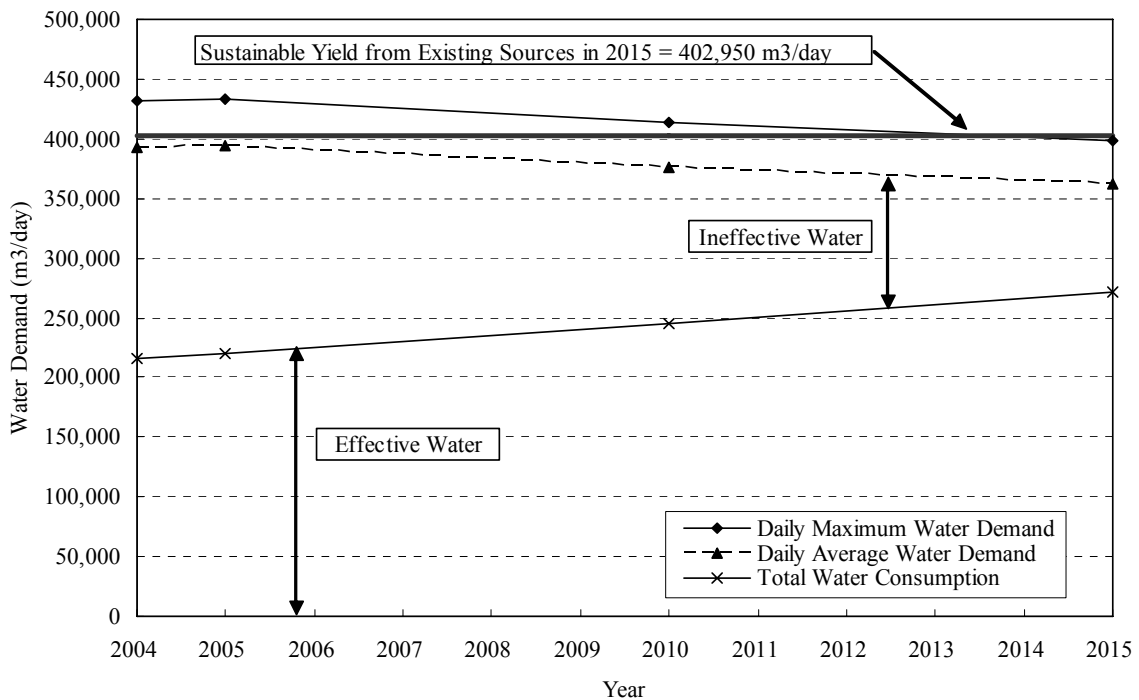


Figure S-1 Potential Yield of Existing Sources vs Water Demand

Figure S-1 shows that although the sustainable yield in 2015 from existing water sources would be able to satisfy the projected daily maximum demand in 2015, there would be a deficit of supply capacity against the projected daily maximum demands in years before 2015. This implies that until 2015 the proposed reduction in the volume of abstraction from Lake Asososca would need to be implemented carefully so as to avoid any deficit of supply to meet the projected daily maximum demands. Finally, our water balance study concluded that existing water sources would be able to meet the water demand in the study area until the target year 2015.

II-2. Water Quality Analysis

This study included the water quality analysis of 10 existing water sources and 5 prospective water source both in the dry season and in the wet season. As a result of this water quality analysis, three existing wells were found to contain arsenic with concentrations exceeding the maximum allowable limit of the drinking water standard i.e.10 ppb and three existing wells were found to contain lead with concentrations higher than the maximum allowable limit of 10 ppb. In order to find out the extent of these water quality problems, a supplementary water quality analysis was then carried out by the study team to examine the arsenic concentrations of all existing ENACAL' s wells in the study area and the lead concentrations of 28 wells selected by the study team. The outcome of these water quality analyses and our recommendations based on the outcome are summarized as follows:

(A) Existing water sources

- (i) The lead concentrations were found to be lower than the detection limit in all of the 28 samples tested in the supplementary water quality analysis. For final confirmation, an additional sample was taken from each of the three wells where high lead concentrations were previously detected and retested. As a result, none of these additional samples exhibited lead concentrations above the detection limit. It was concluded from this supplementary analysis that lead is not a problem.
- (ii) Fifteen wells in Zona Baja and Zona Alta are found to contain arsenic with concentrations equal to or larger than 8 ppb. Among these, four wells have arsenic concentrations exceeding the maximum allowable limit of the drinking water standard (10 ppb). On the other hand, arsenic concentrations of existing wells in Zona Alta Superior are generally low. All the existing wells in the study area were classified into four categories shown in **Table S-1** based on their current arsenic concentrations. It is recommended that countermeasures for Category A wells should be completed as soon as possible since their current concentrations already exceed 10 ppb. It is recommended for Category B wells that countermeasures should have been completed by 2015, target year of the long-term improvement plan. The arsenic concentration shown in **Table S-1** is defined that it should be the arsenic concentration of the blended water, in case where water produced from more than one wells is merged at one place or otherwise get mixed before it is actually distributed to customers.

Table S-1 Classification of Existing Wells by Arsenic Concentration

Category	Arsenic Concentration: X (ppb)	Urgency to take actions	Actions
A	X > 10.0	Extremely High	Countermeasures should have been completed as early as possible.
B	8.0 < X < 10.0	High	Countermeasures should have been completed by 2015 at the latest.
C	6.0 < X < 8.0	Medium	No immediate action will be required. Instead, arsenic concentration should be closely monitored four times a year (every 3 months), based on which a decision should be made whether it is necessary to implement any countermeasures before 2015.
D	X < 6.0	Low	No action will be required before 2015 except that arsenic concentration should be monitored twice a year (once in the dry season and the other in the wet season) and the data obtained should be evaluated in respect of how the concentration changes with time.

All of the ENACAL's wells in the study area were classified based on their current arsenic concentrations. As a result, the following 15 wells were classified as Category A or B wells and countermeasures were proposed against them in this study. In 2003, the four Category A wells combined supplied 10,600 m³/day while the eleven Category B wells supplied a total of 37,200 m³/day. They were respectively equivalent to 2.7% and 9.3% of the total volume of water supplied in the same year i.e. 398,800 m³/day.

Category	Arsenic Concentration: X (ppb)	Nos. of Well	Well Identification No.	Water Supplied from the Wells in 2003 (m ³ /day)
A	X > 10.0	4	27,28,29,46	10,600
B	8.0 < X < 10.0	11	8,10,11,30,52,57,68,77,78,91,112	37,200

- (iii) ENACAL's records indicate that the nitrate concentration at No.10 well exceeded the maximum allowable limit of the drinking water standard in the past. The records also show that the nitrate concentrations at No.8 and No.9 wells doubled during the last decade to exceed the recommendation value of the drinking water standard at present. Water quality analysis conducted in this study revealed that No.8 and No.10 wells also contain relatively high concentrations of arsenic. It is recommended that these three wells should be abandoned in the long run for relocation to higher elevation areas.
- (iv) No sign of contamination by BTEX, trihalomethanes, or chlorophenols was detected at Lake Asososca. However, existing data indicate that the chloride concentration has been increasing in groundwater between the lake and the nearby industrial zone. It is advised that ENACAL implement precautionary measures to preserve the water quality of the lake.
- (v) Except for the arsenic and nitrate problems, water samples taken from existing water sources generally satisfy the requirements of the drinking water standards in Nicaragua. It should be noted however that although arsenic concentrations were examined at almost all the existing water sources, other important health-related parameters specified in the drinking water standards were examined only at a fraction of existing water sources. It is therefore recommended that ENACAL should examine the safety of water it distributes to its customers by testing, at least twice a year (each in the dry and wet seasons), the water quality of all the existing water sources in accordance with the requirements of the drinking water standards.

(B) Prospective water sources

- (i) Nicaragua Lake (Surface Water): Water is high in Aluminum and Iron. Except for these two parameters, the quality of water generally satisfies the requirements of drinking water quality standards. Among all the prospective water sources examined in this Study, this lake is considered to be most prospective in terms of water quality.
- (ii) Lomas Del Gavilan (Groundwater): Manganese exceeds its standard recommendation value. Otherwise, water is suited for drinking purposes. This source is considered to be second most prospective in terms of quality.
- (iii) Sierras Doradas (Groundwater): Lead, Aluminum, Magnesium and Potassium concentrations exceed their standard limits. The prospective of developing this source is low.
- (iv) Avinic No.4 (Groundwater): This irrigation well has high Arsenic and Iron concentrations and is therefore not recommendable for future development.
- (v) Cuatro Esquinas (Groundwater): Water in a dug well is high in Aluminum. Although it is otherwise suited for drinking purposes, this well appears to be quite susceptible to contamination in the future.

(C) Monitoring and evaluation of water quality at sources

Water quality analysis conducted by ENACAL covers only basic water quality parameters which ENACAL can analyze by itself in its in-house laboratory. Despite being required by the drinking water standards, heavy metals and pesticides are not examined by ENACAL. This means that ENACAL is not examining the safety of water it supplies to customers. It is recommended that ENACAL contract out the analysis work of all such parameters to local laboratories in Nicaragua (e.g. CIRA/UNAN and LAQUISA). With regard to a few parameters which can not be analyzed in Nicaragua (e.g. trihalomethanes), ENACAL is advised to contract out the analysis work to laboratories in the U.S.A.

It is recommended that ENACAL should carry out the testing of all existing water sources twice a year, once in the dry season and the other in the wet season, each time covering all the water quality parameters required by the drinking water standards. Further, ENACAL is recommended to carry out the arsenic testing four times a year (every three months) for those wells that have an arsenic concentration equal to or larger than 6.0 ppb but smaller than 8.0 ppb at present. ENACAL is also recommended to carry out regular water quality monitoring of existing wells that are located in between Lake Asososca and the nearby industrial area to observe how water quality of those wells changes with time.

(D) Establish control over construction and operation of fuel filling stations

Water sources must be protected against all forms of contamination and pollution through the legal system. There are many fuel filling stations in Managua, some of which are located immediately adjacent to ENACAL's wells. It is essential that the existing groundwater sources are protected against possible contamination by fuel filling stations, petrochemical industries and other chemical manufacturing and storage facilities. All relevant existing laws for the granting of licenses for construction and operation of such facilities should be reviewed and reformed as necessary.

(E) Strengthening of ENACAL's capability to analyze water quality

Monitoring and evaluation is the last line of defence against the possible pollution and contamination of existing water sources. Already it is known that some sources are at risk. Responsibility for monitoring and evaluation rests with the ENACAL Environmental Department which was recently upgraded with laboratory equipment, including an atomic absorption spectrometer and a gas chromatograph, financed by PAHO and UNICEF, to extend its analyses capability to carry out all of the testing required by the PAHO standards. Strengthening is required by further training of the personnel on this equipment particularly for the detection of heavy metals and pesticides. Further, an UPS (Uninterrupted Power Supply) device with an integrated voltage stabilizer will need to be procured and installed in the laboratory before ENACAL can actually start using the equipment.

II-3. Assessment of Water Sources

In conclusion, our assessment of existing water sources indicated that, with the implementation of the various measures described below, existing water sources including Lake Asososca would be able to sustain a total supply capacity of 402,950 m³/day in 2015.

(A) Restoration of design production capacity at Managua I and II Well Fields

Our review of ENACAL's operation records indicated that when the volume of abstraction from

Lake Asososca was in the order of 30,000 to 40,000 m³/day in the past, the water level of the lake remained being high and fairly stable. Given that the depletion of the water level in the lake increases the risk of contamination from nearby industrial areas, it is proposed that the abstraction from the lake should be reduced in the long run from the current 56,500 m³/day to 30,000 m³/day. In the meantime, in order to compensate for the reduction of abstraction from the lake, it is proposed that the current production capacity of the Managua I Well Field (53,000 m³/day) should be increased by 18,000 m³/day to its design production capacity of 71,000 m³/day and so should be increased the current production capacity of the Managua II Well Field (44,000 m³/day) by 12,000 m³/day to its design production capacity of 56,000 m³/day.

(B) Countermeasures against wells with high arsenic concentrations

Against each of the 15 wells that were classified into Category A or Category B, countermeasures were proposed as shown in **Table S-2**.

Table S-2 Countermeasures Against Wells with High Arsenic Concentrations

Category	Well No.	Name of Well	Proposed Countermeasures
A	27	Sabana Grande No.1	To be abandoned and a replacement well/s should be constructed in higher elevation areas
	28	Sabana Grande No.2	Same as above
	29	Sabana Grande No.3	Same as above
	46	Villa Libertad	Same as above
B	8	San Antonio	Same as above
	10	Mercado Oriental	Same as above
	11	Col. Tenderi	To be abandoned without any replacement
	30	Sabana Grande No.4	To be mixed with water from other source/s for dilution
	52	La Mascota	To be abandoned without any replacement
	57	Plaza de Sol	To be mixed with water from other source/s for dilution
	68	Villa Austria	Maintain the existing system which dilutes arsenic by mixing with water from other source/s
	77	Villa Fraternidad	Same as above
	78	Buenos Aires	Same as above
	91	Laureano Mairena	To be abandoned without any replacement
112	Anexo V. Libertad	To be mixed with water from other source/s for dilution	

(C) Stage-wise rehabilitation/renewal of old wells and well pumps

Ten existing wells that are not functioning at present or being barely operated at significantly low production rates are proposed to be subjected to urgent rehabilitation through cleaning of wells and replacement of well pumps. In order to sustain the current production rates of existing sources in the future, criteria for replacement of existing wells and well pumps were established as shown below and based on that criteria 16 wells and 40 well pumps were selected for replacement by 2015.

- Well pumps that have been in service for more than 20 years should be replaced,
- Wells that have been in service for more than 30 years should be replaced.

(D) Establish control over the use and development of groundwater sources

The water sector authorities must have full control of the use and development of water sources. Private water sources and supplies should not be allowed within the ENACAL's service area without the issuing of a license by the relevant authority in the water sector, after a proper review of each application. The laws should be reviewed and reformed as necessary to protect the interests of ENACAL. It is proposed that water meters should be installed at all existing

private wells and ENACAL should be allowed to collect both water supply and sewerage charges from the well users based on meter reading.

II-4. Leakage Surveys

Leakage surveys conducted in 10 selected micro sectors demonstrated that the measurement of minimum night flows with the use of a portable type ultrasonic flow meter and the implementation of leakage detection/reduction measures within micro sectors is a quite effective means to reduce leakage. The outcome of the surveys also indicated that:

- (i) leakage currently accounts for 35% of water distributed into the system;
- (ii) wastage currently accounts for 10% of water distributed into the system;
- (iii) leakage and wastage are high in Zona Baja, medium in Zona Alta, and low in Zona Alta Superior;
- (iv) leakage and wastage are particularly high in asentamientos where water is available on a continuous basis and with good pressures;
- (v) All the leaks detected during the surveys existed in service connection pipes;
- (vi) The current unconstrained per capita domestic water demand in Managua is 175 lpcd;
- (vii) At least 16% of existing water meters are defective; and
- (viii) Approximately 9% of existing connections are either unauthorized or illegal.

It is proposed in this Study that leakage and wastage be reduced to 23% and 2% respectively by 2015. The following problems will need to be addressed to achieve that goal.

- Distribution network is not divided into a number of micro sectors (small distribution districts) which can be hydraulically isolated
- Many of existing water meters have been in service for more than 10 years
- Lack of coordination on the reduction of leakage, illegal connections and meter related losses.
- No mechanism to deal effectively with the massive wastage of water and loss of revenue in its supply to low-income settlements
- Existing water tariff structure is not designed to provide consistent incentives for the efficient use of water or to provide social protection for the extremely poor.
- Location of the meter, meter installation and responsibility for maintenance
- Customers do not trust ENACAL's meter reading, billing and collection
- The public's low awareness on water conservation
- No mechanism to deal effectively with the media, civic groups and customers

II-5. Measurement of Flows and Pressures

Field measurement of flows and pressures was carried out at various strategic locations within the existing water supply system in order to assess the current water supply conditions. The outcome of this measurement suggested us the following.

- (i) Most of existing flow meters are functioning properly.
- (ii) At Asososca, the amount of gravity flow to Zona Baja varies significantly depending on the number of pumps used for distribution to Zona Alta.
- (iii) San Judas, Schick and Altamira tanks are not receiving as much water as have been envisaged by the detailed design of the Managua I Project.
- (iv) More than half of the water gravitated to Altamira from the Santo Domingo tank is pumped in reverse direction to high ground areas near the Santo Domingo tank.
- (v) The capacity of the transmission facilities constructed under the Managua I and II projects is not being fully utilized at present. This is mainly because the Managua I and II well fields are currently able to produce only 75 to 80% of their respective design production capacity.

- (vi) The volumes of water produced from existing wells in Zona Baja fluctuate significantly corresponding to the variation of the local water pressure in the distribution network. This is because those wells are connected directly to the distribution network.
- (vii) Water supply conditions are generally good in most areas of Managua city except in the following areas (see **Figure S-2** for their locations) where the level of water service is extremely poor and residents are suffering from severe water shortages.
 - a. Area supplied from the San Judas tank
 - b. Area supplied from the Schick tank
 - c. Area supplied from the Sabana Grande well field

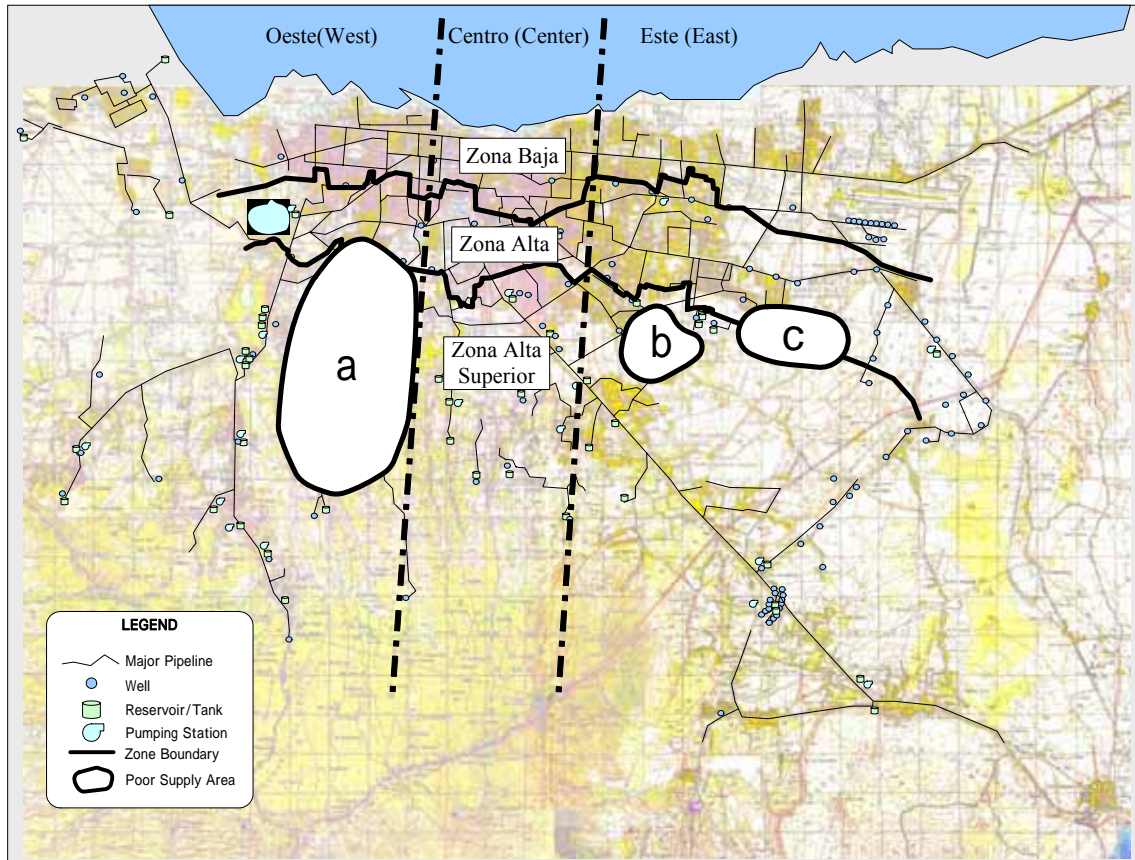


Figure S-2 Areas with Severe Water Shortages

II-6. Water Consumption and Awareness Surveys

Water consumption and awareness survey was carried out for randomly selected 450 domestic users and 150 non-domestic users (industrial, commercial and institutional users) in order to have a better understanding on the actual situation of water consumption by these users and to assess their views on the ENACAL's water services. The outcome of the surveys is summarized as follows:

(A) Water Consumption and Awareness Survey of Domestic Users

The results of the water consumption and awareness survey on domestic users are summarized in **Table S-3**.

Table S-3 Results of Water Consumption and Awareness Survey on Domestic Users

Item	Unit	Total	Tariff Category		
			Low-income	Middle-income	High-income
Registered Domestic Users of ENACAL	Household (HH)	168,313	56,702	99,523	12,088
Samples Taken in the Surveys	HH	449	91	324	34
Water Consumption Survey					
Size of Household	Person/HH	5.07	5.34	4.81	4.94
Water Supply Connection	%	96*	100	95*	100
Sewerage Connection	%	72	49	81	59
Meter Installation	%	70	2	87	94
Water Consumption Rate	m ³ /HH/Month	28.73	N/A	27.17	48.18
Same as above	pcd	189	N/A	188	325
Daily Water Supply	%	86	82	86	94
24-hr Water Supply	%	67	59	69	79
Adequate Water Pressure	%	69	63	73	38
Own Storage Facilities	%	47	57	44	53
Purchasing bottled water	%	21	11	23	26
Awareness Survey					
Satisfied with Water Service	%	45	48	43	65
Dissatisfied with Water Service	%	52	49	54	35
Dissatisfied with Meter Reading and Billing	%	24	11	28	15
Dissatisfied with Water Quality	%	3	2	3	3
Dissatisfied with Quantity	%	19	26	19	12
Tariffs are Expensive	%	41	11	50	35
Tariffs are Inexpensive	%	37	45	33	53
Average Willingness-to-Pay Amount	C\$/Month	121	91	122	250

* Lower than 100% as some households were being disconnected by ENACAL at the time of the surveys.

(B) Water Consumption Survey of Non-domestic Users

The results of water consumption survey on non-domestic users are summarized in **Table S-4**.

Table S-4 Results of Water Consumption Survey on Non-domestic Users

Item	Unit	Total	Industrial	Commercial & Institutional							
				Sub-total	Gov't	Education	Medical	Hotel	Shop	Office	Other
Registered Non-domestic Users of ENACAL	No.	6,179	285	5,894	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Samples Taken in the Survey	No.	149	49	100	3	10	1	5	23	19	39
Water Supply Connection	%	97	92	99	100	100	100	100	100	100	97
Sewerage Connection	%	87	84	89	67	70	100	80	96	100	87
Unit Consumption Rate	m ³ /Sample/Month	393	621	165	1005	159	47	180	72	82	129
Daily Water Supply	%	87	98	86	67	70	100	80	91	89	85
24-hr Water Supply	%	77	89	74	67	50	100	80	74	89	72
Adequate Water Pressure	%	78	87	77	67	70	100	80	74	79	79
Good Quality	%	66	78	64	0	70	100	60	48	74	72
Poor Quality	%	29	22	33	100	30	0	40	52	26	21
Odor	%	7	4	9	0	0	0	20	13	11	8
Unpleasant Appearance	%	6	6	6	33	10	0	0	4	0	5
Bad Taste	%	11	8	12	0	20	0	0	26	11	3
Other Quality Problems	%	14	16	14	0	20	0	0	17	16	5

II-7. Water Transmission and Distribution Systems

Our study identified the following critical problems in the existing water transmission and distribution systems. It is recommended that efficiency of the water transmission and distribution systems should be increased by implementing improvement measures to address such critical problems.

- (1) It is not possible to obtain accurate information on the state of water being distributed over the entire city area. It is not possible to delineate the extent of area supplied by each major water source.
- (2) O&M of the existing water transmission and distribution systems are highly complicated, making it difficult for ENACAL to deal with emergencies promptly.
- (3) Although water is generally abundant in most areas of Zona Baja, there are three distinct areas in Zona Alta and Zona Alta Superior (See **Figure S-2** for their locations) where the level of service is currently extremely poor and the residents are suffering from severe water shortages. This clearly demonstrates that water is not properly distributed over the entire service area.
- (4) Due to the lack of distribution zoning system, it is not possible to obtain accurate information on the geographic distribution of non-revenue water or to decide priority areas for the reduction of non-revenue water.
- (5) No provision has been made for the extension of service to newly developing areas such as Esquipulas and Las Jaguitas.
- (6) Many of existing water transmission pump stations have been deteriorated and require the renewal of existing pumps and electric panels.
- (7) There is a need to improve water supply conditions in Ticuantepe and Nindiri and in other high elevation areas along the Carretera Masaya.

Our assessment of these problems indicated that there is a clear need for better matching of supply sources with their supply areas. It is therefore essential that the existing distribution network is divided into a number of large, hydraulically isolated distribution zones (macro sectors) to ensure that intended matching is not hypothetical but is actually put in place on the ground.

II-8. ENACAL's Financial Capacity

Examination of the financial statements of ENACAL for recent years shows an extremely worrying trend as regards its short and long term financial positions. Over recent years, ENACAL has continuously been operating its services in deficit. With respect to the water supply service in Managua, the accumulated deficit totalled to C\$ 243 million (US\$ 15 million) in 2003, which is equivalent to 76% of the total annual income generated from the service in the same year. It is estimated that by the end of fiscal year 2005 this amount will further increase to C\$ 420 million (US\$ 25.8 million), which is approximately 120% of the projected total annual income in the same year. The overall picture is one of the water utilities falling into a deep financial crisis. In order to strengthen the ENACAL's financial capacity, there is a clear need for a substantial tariff increase. Tariffs should be able to recover a reasonable level of O&M and depreciation expenses by 2010. Further, they should also enable ENACAL to pay interests on long-term debts by 2015.

Although it is not possible to develop a full-scale financial model of ENACAL within the time and resources available for this Study, we have conducted a financial simulation analysis based on the following scenarios and assumptions.

- (i) Leakage and wastage will be reduced to 35% in 2010 and 25% in 2015
- (ii) The water supply system will be improved in accordance with the long-term development plan proposed by this Study

- (iii) External financing by donors will carry an annual interest rate of 2.0%, 10 years of grace period and 35 years of repayment period.
- (iv) A new set of domestic tariffs shown in **Table S-5** will be effectuated in 2007 and thereafter until 2015 domestic tariffs will be increased every year at the rate of 3.5% p.a. in real term. There will be no changes in the existing non-domestic tariffs.
- (v) Direct O&M costs (excluding energy cost which is already high at present) will be increased to 200% of the current level of expenditure in 2008 and onward
- (vi) Indirect O&M costs (sales and administration expenses) will be increased to 150% of the current level of expenditure in 2008 and onward
- (vii) The level of inventory will be maintained at 0.05% of the total book value of fixed assets at the end of each fiscal year
- (viii) The average turnover ratio of accounts receivable will be increased from 1.0 in 2003 to 4.0 in 2005 and 6.0 in 2015
- (ix) ENACAL's contribution to the Central Level will continue based on the unit volumetric charge of C\$ 0.56 per every cubic meter of water sold
- (x) Any shortage in working capital will be met by short-term borrowings from the central government at the interest rate of 5% p.a.

Table S-5 Existing and Proposed Water Tariffs

EXISTING TARIFFS IN MANAGUA IN 2004					PROPOSED TARIFFS				
User Category	Fixed Charge (C\$/Month)	Variable Charge			User Category	Fixed Charge (C\$/Month)	Variable Charge		
		Consumption (m ³ /Month)	Rate (C\$/m ³)				Consumption (m ³ /Month)	Rate (C\$/m ³)	
Domestic Users					Domestic Users				
1. High Income	8.56	Less than 20	5.88		1. Un-subsidized	9.18	Less than 10	5.28	
		Between 21-50	5.88				Between 11-30	7.54	
		More than 51	13.20				Between 31-50	9.84	
							More than 51	12.00	
2. Middle Income	4.24	Less than 20	3.54		2. Subsidized	0.00	Less than 10	0.00	
		Between 21-50	5.88				Between 11-30	3.50	
		More than 51	10.48				Between 31-50	5.25	
3. Low Income	1.06	Less than 20	1.99				More than 51	9.00	
		More than 21	2.50						
Non-domestic Users					Non-domestic Users				
	8.56	Less than 50	6.76			8.56	Less than 50	6.76	
		More than 51	14.49				More than 51	14.49	

Figure S-3 summarizes the results of our simulation analysis. It is envisaged from this analysis that, from 2010 onward, ENACAL's revenues would be able to recover the projected O&M and depreciation expenses. Further, ENACAL would also be able to generate a net profit after payment of interests on long-term debts, which can be used for the amortization of long-term debts or for the reduction of the accumulated deficit.

Our financial simulation of ENACAL's operations suggested that there is a distinct need for a substantial tariff increase. The domestic tariffs used in our analysis are quite compatible with that currently adopted in Matagalpa. Further, tariffs for the low-income category are designed to protect the "extremely poor" whose consumption is less than 10m³ monthly and to provide a stimulus to encourage people in low-income settlements to request for installation of water meters.

The above financial simulation analysis assumes that a new set of domestic tariffs shown in **Table S-5** will take effect in 2007, and thereafter until 2015 domestic tariffs will be increased every year by 3.5% in real term. It is anticipated in this case that although the accumulated deficit will increase to C\$862 millions in 2011, it will rapidly decrease afterwards to zero in 2018. **Figure S-4** shows the results of the simulation where the tariffs are increased only by 1.5% p.a. instead of 3.5% p.a. It is anticipated in this case that the accumulated deficit will balloon to more than C\$1,000 millions in 2012 and it will continue to remain at a significantly

high level for a long period of time afterwards.

Finally, it is essential that ENACAL separates the financial account of water services in Managua from that covering the rest of the country. The establishment of an independent financial account is necessary to obtain accurate information on the financial performance of water services in Managua, to evaluate the efficiency of the water service operations in Managua, and to decide and implement the measures to strengthen the financial capacity of water services in Managua.

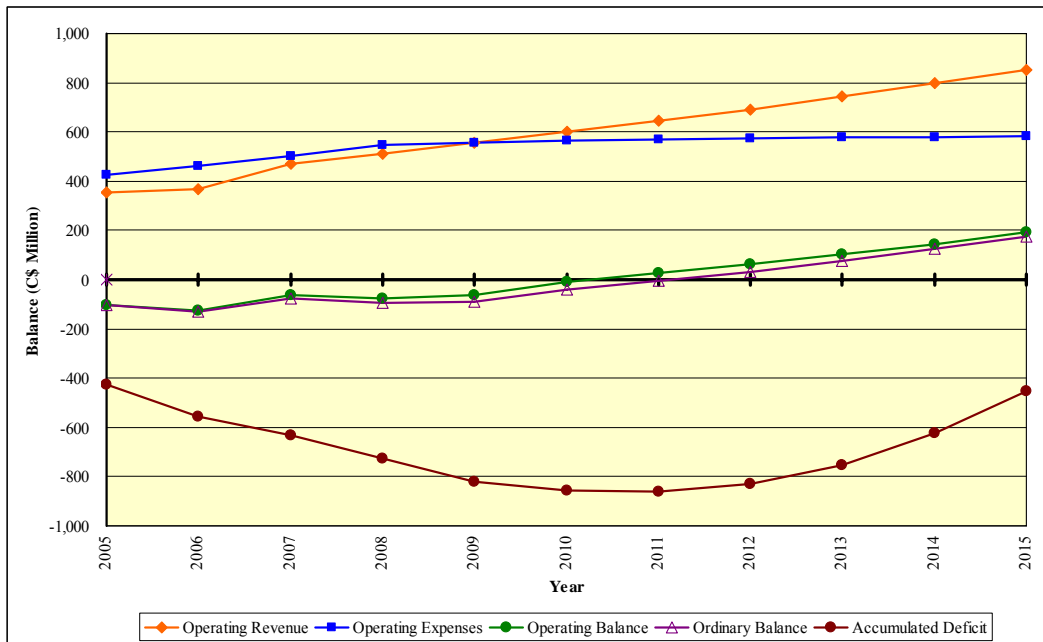


Figure S-3 Projection of Financial Balance and Accumulated Deficit

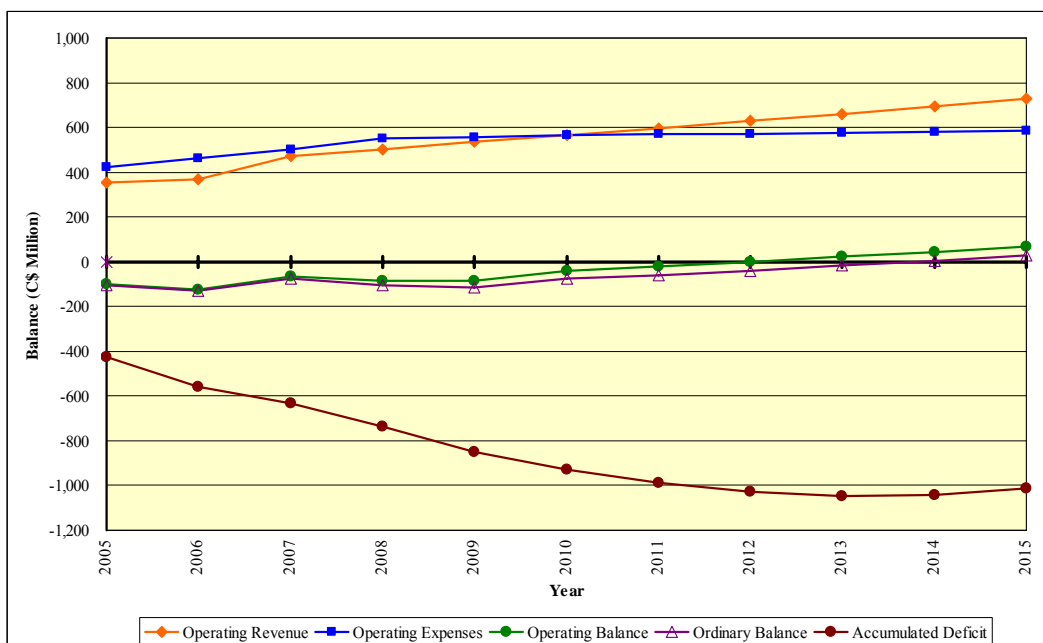


Figure S-4 Projection of Financial Balance and Accumulated Deficit (2)

III. LONG-TERM IMPROVEMENT PLAN (LIP)

III-1. Basic Strategies Adopted for Developing LIP

Chapter II discussed various problems of the existing water supply system in Managua. Although having an adequate supply capacity, the existing water supply system can not meet the current water demand satisfactorily. It is largely because of the inefficiency of the water transmission and distribution systems and the high levels of leakage and wastage which combined accounts for 45% of the volume of water distributed into the distribution system. As a result, there are three distinct areas, namely San Judas, Schick and Laureles Sur, in the study area, where the current extremely poor water supply condition is recognized as one of the most critical social problems in Managua. Further, ENACAL has not been able to deal effectively with the recent rapid increase in water demand in the Esquipulas, Jaguitas, Ticuantepe and Nindiri areas and in areas along the Carretera Masaya.

Our assessment of existing water sources indicated that the total water supply capacity in Managua would gradually decrease in years to come. Relatively high concentrations of arsenic and nitrate were detected at several wells used by ENACAL. In some wells, the concentrations already exceed the maximum allowable limits of the drinking water standards. Our study suggested that the volume of intake from Lake Asososca will need to be decreased to 30,000 m³/day in the future in order to protect the lake from possible contamination. Due to a backlog of repairs and maintenance, many wells and well pumps are not functioning at present or being barely operated at significantly low production rates. In the absence of regular replacement programs, many wells and well pumps have already been used beyond their normal useful life.

Taking all of these problems into account, a basic strategy for developing a long-term water supply improvement plan for Managua up to the year 2015 was established. **Figure S-5** shows the basic strategy adopted in this study for developing a long-term improvement plan (LIP). The strategy is based on the four basic policies shown below and to achieve the goals shown in **Table S-6** by implementing both physical and non-physical improvement measures. **Table S-7** indicates the relationship between (a) the problems of the existing water supply system in Managua and (b) the basic policies and goals of the long-term improvement plan (LIP).

Four Basic Policies of LIP

- (1) Rehabilitation and protection of existing water sources
- (2) Reduction of leakage/wastage
- (3) Increase in the efficiency of water transmission and distribution systems
- (4) Establishment of a basic financial framework for the management of water services in Managua

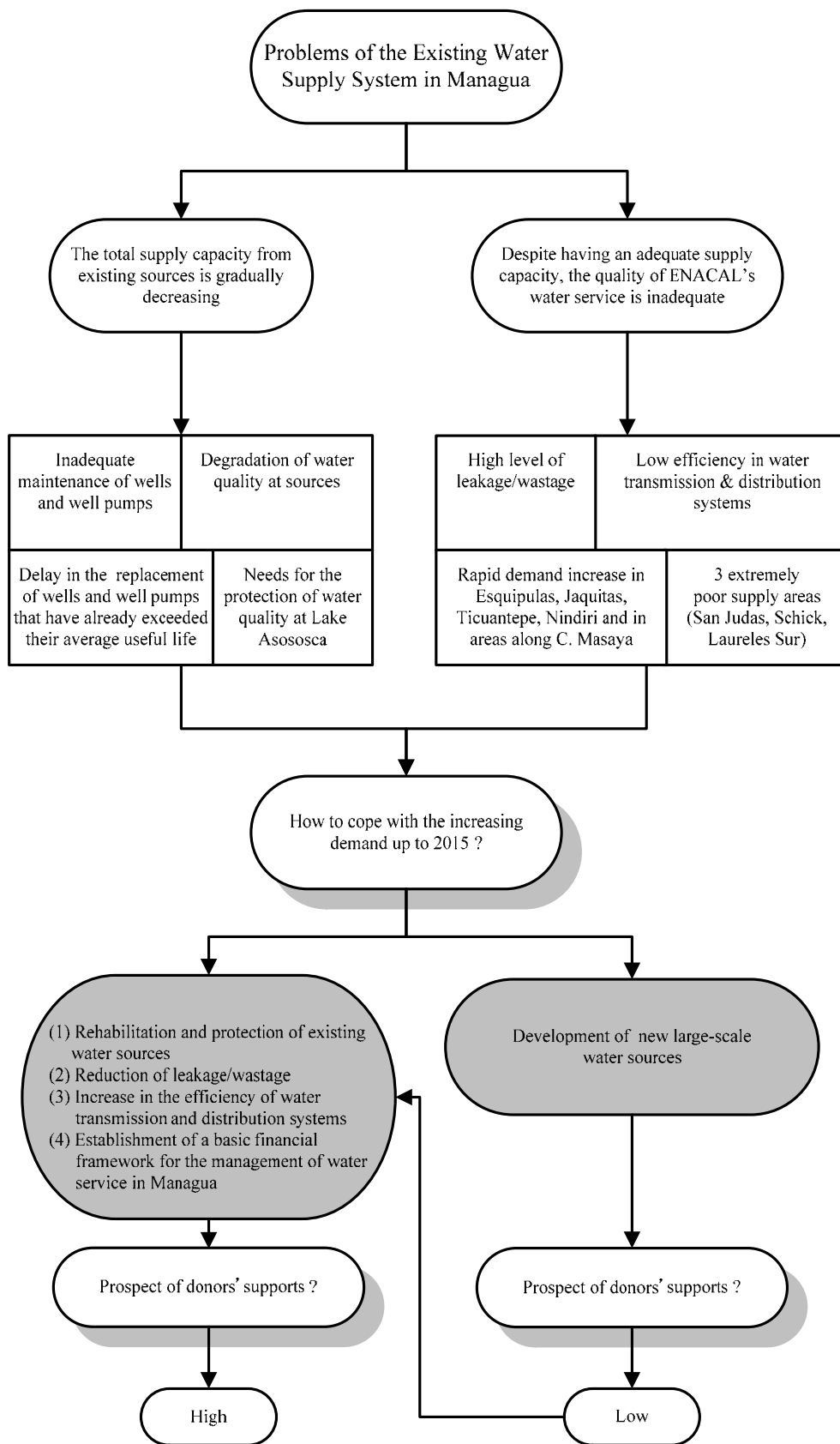


Figure S-5 Basic Strategies Adopted for Development of LIP

Table S-6 Policies and Goals of LIP

Policies		Goals	
1.	Rehabilitation and protection of existing water sources	(1)	The total production capacity of existing sources will be sustained.
		(2)	Water quality of existing sources will be protected.
		(3)	Safety of water supply will be assured.
2.	Reduction of leakage/wastage	(1)	Water resources will be conserved.
		(2)	The volume of water that can be delivered to customers will increase.
		(3)	Large-scale investments for the development of new water sources can be deferred.
		(4)	Revenues from water sale will increase.
		(5)	Public awareness on the efficient use (conservation) of water will increase.
3.	Increase in the efficiency of water transmission and distribution systems	(1)	The state of water being distributed over the entire city area can be assessed precisely.
		(2)	O&M of the water supply system will become easier and ENACAL will be able to deal with problems in a more prompt and appropriate manner.
		(3)	The equity of water service will be enhanced by strengthening supplies to areas where water supply conditions are currently extremely poor.
		(4)	The economic growth of the region will be sustained by strengthening supplies to areas where rapid developments have been taking place in recent years.
		(5)	Old water transmission pump stations will be rehabilitated.
		(6)	Secondary/tertiary distribution mains and service connections will be installed to cater for increased service populations in the future.
4.	Establishment of a basic financial framework for the management of water services in Managua	(1)	ENACAL will spend a sufficient level of expenses for the O&M of the existing water supply system in Managua.
		(2)	Depreciation expenses will be recovered through tariffs and used for the replacement/rehabilitation of deteriorated equipment and facilities.
		(3)	Financial evaluation of the water services in Managua will become possible.

III-2. Rehabilitation and Protection of Existing Water Sources

The following measures are proposed for the rehabilitation and protection of existing water sources. **Table S-8** provides the details of proposed measures and their priority for implementation.

- Restoration of the design production capacity of the Managua I well field
- Restoration of the design production capacity of the Managua II well field
- Stage-wise rehabilitation and renewal of aged wells and well pumps
- Taking measures against wells that have relatively high levels of nitrate concentrations
- Taking measures against wells that have relatively high levels of arsenic concentrations
- Reduction in the volume of abstraction from Lake Asososca
- Establish control over the use and development of groundwater by the private sector
- Establish control over the construction and operation of facilities which otherwise could contaminate groundwater
- Continuous monitoring and evaluation of water quality at sources by ENACAL
- Increase the analytical capacity of the ENACAL's laboratory

III-3. Reduction of Leakage/Wastage

The following measures are proposed for the reduction of leakage and wastage. **Table S-9** provides the details of proposed measures and their priority for implementation.

- Micro-sectoring of the distribution network and implementation of leakage/wastage reduction measures in the micro sectors
- Replacement of aged water meters
- Reorganization of the existing Commercial Department
- Review/revision of the existing water tariff structure
- Review/revision of the “Reglamento de Servicios al Usuario”
- Strengthening ENACAL’s capacity in meter reading, billing and collection
- Increasing public awareness
- Improvement of water supply and sanitation conditions in low-income settlements through community participatory approaches

III-4. Increase in the Efficiency of Water Transmission and Distribution Systems

The following measures are proposed for increasing in the efficiency of water transmission and distribution systems. **Table S-10** provides the details of proposed measures and their priority for implementation.

- Macro-sectoring of the distribution network
- Improvement of water supply conditions in the San Judas, Schick and Laureles Sur areas and extension of water supply to the Jaguitas and Esquipulas areas
- Strengthening of water supplies in Veracruz and areas along the Carretera Masaya
- Strengthening of water supplies in Ticuantepe and Nindiri
- Strengthening of water supply in Zona Baja
- Rehabilitation of water transmission pump stations
- Provision of secondary and tertiary distribution mains and service connections to cater for the increased service population in the future

III-5. Establishment of a Basic Financial Framework for the Management of Water Services in Managua

The following measures are proposed for the establishment of a basic financial framework for the management of the water services in Managua. **Table S-11** provides the details of proposed measures and their priority for implementation.

- Establishment of an independent financial account for the water services in Managua
- Tariff increase
- Minimizing headquarters’ expenses and establishing appropriate rules for the division of such expenses
- Training

Table S-8 Rehabilitation and Protection of Existing Water Sources (1/2)

Measures	Description	Priority
1A Restoration of the design production capacity of the Managua I Well Field.	- The current production capacity of the Managua I Well Field (53,000 m3/day) will be increased by 18,000 m3/day to its design production capacity (71,000m3/day). The work will include the renewal of 1 well (W7) and rehabilitation of 4 wells (E4, W3, W6 & W8) through cleaning of wells and replacement of well pumps.	High
1B Restoration of the design production capacity of the Managua II Well Field.	- The current production capacity of the Managua II Well Field (44,000 m3/day) will be increased by 12,000 m3/day to its design production capacity (56,000m3/day). The work will include the renewal of 1 electric transformer (P11) and 1 electric panel (P13); and rehabilitation of 4 wells (P6, P8, P1 & P16) through cleaning of wells and replacement of well pumps.	High
1C Stage-wise rehabilitation and renewal of aged wells and well pumps	(a) 10 wells that are currently malfunctioning or barely operated at significantly low production rates will be rehabilitated. The work will include the rehabilitation of 6 wells in Zona Baja (No.17, No.18, No.22, No.24, No.25 & No.80), 1 well in Zona Alta (No31) and 3 wells in Zona Alta Superior (No.71, No.75 & No.108) through cleaning of wells and replacement of well pumps.	High
	(b) 22 wells, of which well pumps will have been in service for more than 20 years in 2010 will be rehabilitated. The work will include the rehabilitation of 1 well in Zona Baja, 7 wells in Zona Alta and 14 wells in Zona Alta Superior through cleaning of wells and replacement of well pumps.	Medium
	(c) 18 wells, of which well pumps will have been in service for more than 20 years in 2015 will be rehabilitated. The work will include the rehabilitation of 8 wells in Zona Baja, 4 wells in Zona Alta and 6 wells in Zona Alta Superior through cleaning of wells and replacement of well pumps.	Low
	(d) 10 wells which will have been in service for more than 30 years in 2010 will be renewed. The work will include the renewal of 4 wells in Zona Baja, 1 well in Zona Alta and 5 wells in Zona Alta Superior.	Medium
	(e) 6 wells which will have been in service for more than 30 years in 2015 will be renewed. The work will include the renewal of 5 wells in Zona Baja and 1 well in Zona Alta Superior.	Low
1D Taking measures against wells that have relatively high levels of nitrate concentrations	(a) No.8 and No.10 wells in Zona Baja will be abandoned and substitute wells will be constructed in the San Judas area by 2010. The work will include the construction of 3 new wells and a raw water supply main (PVC150 : 1.0km).	High
	(b) No.9 well in Zona Baja will be abandoned and substitute wells will be constructed in the Esquipulas area by 2015. The work will include the construction of 2 new wells and a raw water supply main (PVC150 : 1.0km).	Low
1E Taking measures against wells that have relatively high levels of arsenic concentrations	(a) Four wells, namely No.27, No.28, No.29 and No.46 will be abandoned and substitute wells will be constructed in the Jaquitas area by 2010 to supply areas that are currently supplied by these four wells. The work will include the construction of 5 new wells, a water tank (4,000m3) and distribution mains (DIP300 to 450 :2.9km & PVC250 : 1.1km).	High
	(b) Direct distribution from Well No.57 will be discontinued. Water from this well will be first transported to the Altamira Tank for mixing with water from other sources and then distributed from the tank. Water from Well No.68 will continuously be sent to the Las Americas Tank (as is the case at present) for mixing with water from the Managua II well field. Direct distribution from Well No. 112 will be discontinued. Water from this well will be first sent to the Las Americas Tank for mixing with water from the Managua II well field and then distributed from the tank. Direct distribution from Well No.30 will be discontinued. Water from this well will be mixed with water from the neighboring Well No.31 before it is distributed to customers. Water from Wells No.77 and No.78 will continuously be injected directly into the 900 mm diameter distribution trunk main (as is the case at present) and thus it will be mixed with water from the Las Mercedes well field.	Low
	(c) Four existing wells, namely No.11, No.52, No.91 and No14 (Las Mercedes No.9) will be abandoned by 2015.	Low

Table S-8 Rehabilitation and Protection of Existing Water Sources (2/2)

1 F	Reduction in the volume of abstraction from Lake Asososca.	- The volume of abstraction from Lake Asososca will in the long run be reduced to approximately 30,000m ³ /day with a view to maintaining the water level of the lake high enough to prevent the intrusion of groundwater into the lake.	Low
1G	Establish control over the use and development of groundwater by the private sector	- Usage and development of groundwater by the private sector will be controlled strictly with a view to maintaining the sustainability of public water services. Private wells will be metered and both water and sewerage charges will be collected from users by ENACAL based on metered consumptions.	High
1H	Establish control over the construction and operation of facilities which otherwise could contaminate groundwater	- Construction and operation of gas stations and other chemical manufacturing/storage facilities will be controlled strictly with a view to preventing them from spilling gasoline and other hazardous chemicals into the ground.	High
1I	Continuous monitoring and evaluation of water quality at sources by ENACAL	- ENACAL will analyze water quality of all the existing water sources twice a year (once in the dry season and the other in the wet season), covering all the water quality parameters included in the National Drinking Water Quality Standards. Wells currently having an arsenic concentration between 6.0 µg/l and 8.0 µg/l will be tested for arsenic four times a year (every three months). The results of the analyses will be evaluated and countermeasures will be explored when problems are encountered.	High
1J	Increase the analytical capacity of ENACAL's laboratory	- ENACAL's staff in the laboratory will receive adequate training in analytical skills required for the measurement of the concentrations of heavy metals (using an atomic absorption spectroscopy) and pesticides (using a gas chromatograph). UPS (Uninterrupted Power Supply) devices will be installed in the laboratory to protect these analytical equipment from sudden electricity surges and power failures.	High

Table S-9 Reduction of Leakage/Wastage (1/2)

Measures	Description	Priority	
2A	Micro-sectoring of the distribution network and implementation of leakage and wastage reduction measures	(a) The existing distribution network in Zona Baja will be divided into 170 micro sectors and measures for reducing leakage and wastage will be implemented in each of the established micro sectors. The work will include the procurement of valves and valves, measurement of minimum night flows, and detection/repair of approximately 32,000 visible/invisible leaks.	High
		(b) The existing distribution network in Zona Alta will be divided into 100 micro sectors and measures for reducing leakage and wastage will be implemented in each of the established micro sectors. The work will include the procurement of valves, measurement of minimum night flows, and detection/repair of approximately 20,000 visible/invisible leaks.	Medium
		(c) The existing distribution network in Zona Alta Superior will be divided into 110 micor sectors and measures for reducing leakage and wastage will be implemented in each of the established micro sectors. The work will include the procurement of valves, measurement of minimum night flows, and detection/repair of approximately 28,000 visible/invisible leaks.	Low
2B	Replacement of aged water meters.	- Water meters that have already been in service for more than 10 years will be replaced. The work will include the replacement of 72,000 meters.	High
2C	Enabling the existing Commercial Department to play more integrated roles in reducing leakage, wastage and illegal connections and in increasing revenues from water sale	- Four units, namely LAU (Leakage Abatement Unit), ICCU (Illegal Connection Control Unit), AIPU (Asentamiento Improvement Program Unit), and CMBU (Customer Metering and Billing Unit) will be established within the existing Commercial Department, and each unit will be staffed by personnel who has experience in that particular field.	High

Table S-9 Reduction of Leakage/Wastage (2/2)

2D	Review/revision of the existing water tariff structure	- Existing water tariffs for domestic customers will be reviewed and revised with a view to providing more consistent incentives for the efficient use of water. The limit of essential (subsistence) consumption for an average household will be established and subsidized tariffs will only be applied to metered consumption below that limit. Subsidized tariffs will never be applied to un-metered connections. Relatively high levels of fixed charges will be applied to un-metered domestic customers to provide a stimulus to encourage such customers to request the installation of a meter.	High
2E	Review/revision of "Reglamento de Servicios al Usuario"	- "Reglamento de Servicios al Usuario" will set forth that (a) water meters will in principle be installed within the premises of customers and (b) customers will be held liable for any damages except normal wear and tear to water meters, including tampering. It will also set forth that (a) water meters will in principle be installed aboveground and (b) ENACAL has a right to decide the location and method of meter installation at its own discretion. Fines and penalties for illegal users will be increased.	High
2F	Strengthening ENACAL's capacity in meter reading, billing and collection	- Registry of customers will be reorganized and updated. Classification of customers by use category will be defined more clearly and applied without discrimination. Meter readers will be trained in social communication skills. Meter reading, billing and collection systems will be related to the geographic coverages of macro sectors. Information on meter reading, billing and collection will be managed exclusively by CMBU (Customer Metering and Billing Unit) of the Commercial Department but will be shared with other units and departments of ENACAL through a computer network.	High
2G	Increasing public awareness	- ENACAL will implement campaigns through the mass media (TV, radio and newspapers) to increase public awareness on issues such as water conservation, illegal connections and payment of water charges. Curriculums for primary and secondary schools will include tours of water supply facilities. Government will designate March 22nd as the "Nicaraguan Water Day" and ENACAL will organize exhibitions and arrange an inspection tour of water supply facilities on that particular day. In the dry season, ENACAL will send loudspeaker-mounted vehicles to areas where water is relatively abundant asking residents to stop watering roads/gardens or	High
2H	Improvement of water supply and sanitation conditions in low-income settlements through community participatory approaches	(a) Databases on approximately 166 low-income settlements in Managua will be developed. Information compiled in the databases will include ages of the settlement, total number of households, average household size, ownership of land titles, water supply conditions, sanitary environments, conditions of other infrastructure (roads, electricity, telephone, sewerage, solid wastes disposal), community organizations, and priority needs of residents.	High
		(b) Pilot projects will be implemented through community participatory approaches to improve water supply and sanitation conditions in 3 low-income settlements each selected from Type A, Type B and Type C settlements. The work will include the procurement of 2 vehicles and consultancy/NGO services, supply/installation of 750 water meters, provision of 750 new water service connections and 1,160 new sewerage service connections, and construction of internal water/sewerage reticulation systems.	High
		(c) Water supply and sanitation conditions in 81 Type A settlements will be improved through community participatory approaches. The work will include the procurement of 2 vehicles and consultancy/NGO services, supply/installation of 27,000 water meters, provision of 9,000 new sewerage connections, and construction of internal sewerage reticulation systems.	High
		(d) Water supply and sanitation conditions in 52 Type C settlements will be improved through community participatory approaches. The work will include the procurement of 2 vehicles and consultancy/NGO services, provision of 12,500 new water connections and 12,500 new sewerage service connections, and construction of internal water and sewerage reticulation systems.	High
		(e) Water supply and sanitation conditions in 30 Type B settlements will be improved through community participatory approaches. The work will include the procurement of 2 vehicles and consultancy/NGO services, supply/installation of 6,000 water meters, provision of 6,000 new water connections and 12,000 new sewerage service connections, and construction of internal sewerage reticulation systems.	Medium

Table S-10 Increase in the Efficiency of Water Transmission and Distribution Systems

Measures	Description	Priority
3A Macro-sectoring of the distribution system	- The existng distribution network will be divided into a number of hydraulically-isolated macro sectors with a view to ensuring appropriate matching of water sources with their supply areas. The work will include the installation of 101 valves (50 ~ 800mm) for the isolation of macro sectors and 31 bulk water meters (150 ~ 800mm) for the measurement of flows into macro sectors.	High
3B Improvement of water supply conditions in the San Judas, Schick and Laureles Sur areas and extension of water supply to the Jaguitas and Esquipulas areas	(a) Wate supply conditions in the San Judas area will be improved. The work will include the construction of a water tank (2,000m3), a transmission pump station (74kw), a transmission main (PVC150 : 1.5km) and distribution mains (DIP300 : 0.3km & PVC250 : 2.3km).	High
	(b) Water supply conditions in the Schick and Laureles Sur areas will be improved. Water supply will be extended to the Esquipulas and Jaquitas areas where many housing development schemes are being implemented. The work will include the construction of a water tank (5,000m3), a transmission main (DIP300 : 1.0km) and distribution mains (DIP300 ~ 500 : 6.6km & PVC150 ~ 200 : 5.6km).	High
3C Strengthening of water supplies in Veracruz and areas along the Carretera Masaya	- Water supply in Veracruz and areas along the Carretera Masaya will be strengthened. The work will include the construction of a transmission pump station (150kw), a transmission main (PVC250 : 4.1km), a distribution pump station (225kw) and a distribution main (DIP350 : 0.6km).	High
3D Strengthening of water supplies in Ticuantepe and Nindiri	(a) Water supply in Ticuantepe will be strengthened. The work will include the construction of a new well and a raw water supply main (PVC150 : 1.0km).	High
	(b) Water supply in Nindiri will be strengthened. The work will include the construction of a new well and a raw water supply main (PVC150 : 4.0km).	High
3E Strengthening of water supply in Zona Baja	- Water supply capacity in Zona Baja will be strengthened in the medium- and long-term future to compensate the reduction in the volume of abstraction from Lake Asososca and the relocation of 3 wells to higher elevation areas. The work will include the construction of a pump suction well (1,000m3), a transmission pump station (300kw) and a transmission main (DIP450 : 4.4km).	Low
3F Rehabilitation of water transmission pump stations	- Existing transmission pump stations including those located at Asososca and km8 will be rehabilitated. The work will include the replacement of pumps and electric panels at existng pump stations (Total pumping capacity:1,500kw).	Medium
3G Provision of small diameter distribution pipes and service connections to cator for the increased service population in the future	(a) Provision of secondary and tertiary distribution mains to cater for the increased service population during the 10 years from 2005 to 2015. The work will include the construction of small diameter distribution mains (PVC 50 ~ 250) to supply 49,500 new service connections.	Medium
	(b) Provision of service connections to cater for the increased service population during the 10 years from 2005 to 2015. The work will include the installation of 49,500 new metered service connections.	Medium

Table S-11 Establishment of a Basic Financial Framework for the Management of Water Services in Managua

Measures	Description	Priority
4A Establishment of an independent financial account for the water services in Managua	- ENACAL will establish an independent financial account for the water services in Managua. To this end, the ENACAL's current financial account will be divided into two, one covering the water services in Managua and the other covering the water services in the rest of the country.	High
4B Tariff increase	- Domestic tariffs in Managua will be increased at least to the level of the domestic tariffs currently applied in Matagalpa. At the same time, a special low tariff block (lifeline tariff block) for a subsistence monthly consumption will be provided in tariff structures to protect the extremely poor. The poor will be allowed to pay connection charges in installments over a long period of time.	High
4C Minimizing headquarters' expenses and establishing appropriate rules for the division of such expenses	- ENACAL will minimize its headquarters' expenses and establish appropriate rules for dividing such expenses between different financial accounts.	High
4D Training	- ENACAL's staff in the Financial Department will receive training on issues such as "Revenue Requirements", "Water Tariff Structures", "Cross-subsidization of Water Tariffs", "Depreciation" and "Cost Recovery".	High

III-6. Preliminary Cost Estimates of LIP

Table S-12 shows the estimated project costs of LIP. They are expressed in United States Dollars using the currency exchange rates of US\$1.0 = JPY106.0900 = EUR0.7583 = C\$16.2834 publicized by the Central Bank of Nicaragua on 10 December 2004. Base Costs are estimated based on the December-2004 price. Other assumptions used in the estimate are as follows:

- Engineering fees (D/D and C/S) : 7% of Base Cost
- Physical Contingency: 5% of (Base Cost + Engineering Fees)
- Price Contingency: 3.9%p.a. (starting from 2006)
- Project Administration Cost: 2.5% of (Base Cost + Engineering Fees + Physical Contingency + Price Contingency)

It is assumed that 70 % of the total project cost is Foreign Component Cost and the remaining 30% is Local Component Cost. Applying the annual price escalation rates of 3% for Foreign Component Cost and 6% for Local Component Cost, the average price escalation rate of 3.9% ($0.7 \times 0.03 + 0.3 \times 0.06 = 0.039$) was obtained. The project cost is provisionally divided into "Donor" and "ENACAL" components because their financing costs are different. This division is necessary for the financial evaluation of ENACAL's water services and for the economic/financial evaluation of the proposed LIP. In principle, those ranked "high" in priority are included in the "Donor" component.

Table S-12 Preliminary Cost Estimates of LIP (US\$ 1,000)

Measures/Items		First Stage (2006 to 2010)			Second Stage (2010 to 2015)			Total (2006 to 2015)		
		Donor	ENACAL	Total	Donor	ENACAL	Total	Donor	ENACAL	Total
1.	Rehabilitation and protection of existing water sources	8,217	6,850	15,068	0	6,058	6,058	8,217	12,908	21,125
2.	Reduction of leakage/wastage	22,197	325	22,522	9,354	14,057	23,411	31,551	14,383	45,933
3.	Increasing in the efficiency of water transmission and distribution systems	9,126	9,440	18,566	0	14,501	14,501	9,126	23,941	33,067
4.	Establishment of a basic financial framework for the management of water services in Managua	0	0	0	0	0	0	0	0	0
Total Base Cost		39,540	16,615	56,155	9,354	34,616	43,970	48,894	51,231	100,126
Engineering Fees (D/D & C/S)		2,768	1,163	3,931	655	2,423	3,078	3,423	3,586	7,009
Physical Contingency		2,115	889	3,004	500	1,852	2,352	2,616	2,741	5,357
Price Contingency		6,338	2,645	8,982	2,712	14,016	16,728	9,050	16,661	25,710
Project Administration Cost		0	1,802	1,802	0	1,653	1,653	0	3,455	3,455
Total Project Cost		50,761	23,113	73,875	13,221	54,561	67,782	63,982	77,674	141,656

III-7. Implementation and Disbursement Schedules of LIP

Table S-13 shows the proposed implementation and disbursement schedules of LIP.

Table S-13 Implementation & Disbursement Schedules of LIP (1/4)

1. Rehabilitation and protection of existing water sources

Measures	Base Cost (US\$ 1,000)	First Stage (2006 to 2010)																Second Stage (2011 to 2015)																		
		2006				2007				2008				2009				2010				2011			2012			2013			2014			2015		
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
1A Restoration of the design production capacity of the Managua I Well Field	-	1,080																																		
	0																																			
1B Restoration of the design production capacity of the Managua II Well Field	-	710																																		
	0																																			
1C Stage-wise rehabilitation and renewal of aged wells and well pumps	(a)	1,400																																		
	0																																			
	(b)	0																																		
	3,080																																			
	(c)	0																																		
	2,520																																			
	(d)	0																																		
	3,770																																			
(e)	0																																			
2,262																																				
1D Taking measures against wells that have relatively high levels of nitrate concentrations	(a)	1,185																																		
	0																																			
1E Taking measures against wells that have relatively high levels of arsenic concentrations	(a)	3,842																																		
	0																																			
1F Reduction in the volume of abstraction from Lake Asososca	(b)	0																																		
	808																																			
1G Establish control over the use and development of groundwater by the private sector	(c)	0																																		
	0																																			
1H Establish control over the construction and operation of facilities which otherwise could contaminate groundwater	(d)	0																																		
	0																																			
1I Continuous monitoring and evaluation of water quality at sources by ENACAL	(e)	0																																		
	0																																			
1J Increase the analytical capacity of ENACAL's laboratory	(f)	0																																		
	0																																			
Sub-Total		21,125	0	3,493	7,465	2,055	2,055				956	1,199	1,522	1,097	1,283																					
Donor		8,217	0	2,465	5,752	0	0				0	0	0	0	0																					
ENACAL		12,908	0	1,028	1,713	2,055	2,055				956	1,199	1,522	1,097	1,283																					

Table S-13 Implementation & Disbursement Schedules of LIP (4/4)

Item	Cost (US\$ 1,000)	First Stage (2006 to 2010)					Second Stage (2011 to 2015)				
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Base Cost											
Total	100,126	1,691	9,412	20,647	10,463	13,943	12,978	8,535	9,979	8,537	3,941
Donor	48,894	0	6,657	17,169	6,360	9,354	9,354	0	0	0	0
ENACAL	51,231	1,691	2,755	3,478	4,103	4,589	3,624	8,535	9,979	8,537	3,941
Engineering Fees (D/D & C/S)											
Total	7,009	118	659	1,445	732	976	908	597	699	598	276
Donor	3,423	0	466	1,202	445	655	655	0	0	0	0
ENACAL	3,586	118	193	243	287	321	254	597	699	598	276
Physical Contingency											
Total	5,357	90	504	1,105	560	746	694	457	534	457	211
Donor	2,616	0	356	919	340	500	500	0	0	0	0
ENACAL	2,741	90	147	186	219	246	194	457	534	457	211
Price Contingency											
Total	25,710	74	841	2,821	1,944	3,302	3,762	2,945	4,015	3,942	2,064
Donor	9,050	0	595	2,346	1,182	2,215	2,712	0	0	0	0
ENACAL	16,661	74	246	475	762	1,087	1,051	2,945	4,015	3,942	2,064
Project Administration Costs											
Total	3,455	49	285	650	342	474	459	313	381	338	162
Donor	0	0	0	0	0	0	0	0	0	0	0
ENACAL	3,455	49	285	650	342	474	459	313	381	338	162
Grand Total	141,656	2,023	11,700	26,668	14,041	19,442	18,802	12,847	15,607	13,872	6,653
Donor	63,982	0	8,074	21,635	8,327	12,725	13,221	0	0	0	0
ENACAL	77,674	2,023	3,626	5,033	5,714	6,717	5,581	12,847	15,607	13,872	6,653

IV. PRIORITY PROJECT (PPT)

IV-1. Selection of Priority Project

Of the various projects included in LIP, those ranked “high” in priority were selected to form the Priority Project (PPT). **Table S-14** presents a summary of the proposed PPT.

Table S-14 Priority Project (1/4)**1. Rehabilitation and protection of existing water sources**

Measures	Description
1A Restoration of the design production capacity of the Managua I Well Field.	- The current production capacity of the Managua I Well Field (53,000 m ³ /day) will be increased by 18,000 m ³ /day to its design production capacity (71,000m ³ /day). The work will include the renewal of 1 well (W7) and rehabilitation of 4 wells (E4, W3, W6 & W8) through cleaning of wells and replacement of well pumps.
1B Restoration of the design production capacity of the Managua II Well Field.	- The current production capacity of the Managua II Well Field (44,000 m ³ /day) will be increased by 12,000 m ³ /day to its design production capacity (56,000m ³ /day). The work will include the renewal of 1 electric transformer (P11) and 1 electric panel (P13); and rehabilitation of 4 wells (P6, P8, P1 & P16) through cleaning of wells and replacement of well pumps.
1C Stage-wise rehabilitation and renewal of aged wells and well pumps	(a) 10 wells that are currently malfunctioning or barely operated at significantly low production rates will be rehabilitated. The work will include the rehabilitation of 6 wells in Zona Baja (No.17, No.18, No.22, No.24, No.25 & No.80), 1 well in Zona Alta (No31) and 3 wells in Zona Alta Superior (No.71, No.75 & No.108) through cleaning of wells and replacement of well pumps.
1D Taking measures against wells that have relatively high levels of nitrate concentrations	(a) No.8 and No.10 wells in Zona Baja will be abandoned and substitute wells will be constructed in the San Judas area by 2010. The work will include the construction of 3 new wells and a raw water supply main (PVC150 : 1.0km).
1E Taking measures against wells that have relatively high levels of arsenic concentrations	(a) Four wells, namely No.27, No.28, No.29 and No.46 will be abandoned and substitute wells will be constructed in the Jaquitas area by 2010 to supply areas that are currently supplied by these four wells. The work will include the construction of 5 new wells, a water tank (4,000m ³) and distribution mains (DIP300 to 450 : 2.9km & PVC250 : 1.1km).
1G Establish control over the use and development of groundwater by the private sector	- Usage and development of groundwater by the private sector will be controlled strictly with a view to maintaining the sustainability of public water services. Private wells will be metered and both water and sewerage charges will be collected from users by ENACAL based on metered consumptions.
1H Establish control over the construction and operation of facilities which otherwise could contaminate groundwater	- Construction and operation of gas stations and other chemical manufacturing/storage facilities will be controlled strictly with a view to preventing them from spilling gasoline and other hazardous chemicals into the ground.
1I Continuous monitoring and evaluation of water quality at sources by ENACAL	- ENACAL will analyze water quality of all the existing water sources twice a year (once in the dry season and the other in the wet season), covering all the water quality parameters included in the National Drinking Water Quality Standards. Wells currently having an arsenic concentration between 6.0 µg/l and 8.0 µg/l will be tested for arsenic four times a year (every three months). The results of the analyses will be evaluated and countermeasures will be explored when problems are encountered.
1J Increase the analytical capacity of ENACAL's laboratory	- ENACAL's staff in the laboratory will receive adequate training in analytical skills required for the measurement of the concentrations of heavy metals (using an atomic absorption spectroscopy) and pesticides (using a gas chromatograph). UPS (Uninterrupted Power Supply) devices will be installed in the laboratory to protect these analytical equipment from sudden electricity surges and power failures.

Table S-14 Priority Project (2/4)

2. Reduction of leakage/wastage

Measures	Description
2A Micro-sectoring of the distribution network and implementation of leakage and wastage reduction measures	(a) The existing distribution network in Zona Baja will be divided into 170 micro sectors and measures for reducing leakage and wastage will be implemented in each of the established micro sectors. The work will include the procurement of vehicles and valves, measurement of minimum night flows, and detection/repair of approximately 32,000 visible/invisible leaks.
2B Replacement of aged water meters.	- Water meters that have already been in service for more than 10 years will be replaced. The work will include the replacement of 72,000 meters.
2C Enabling the existing Commercial Department to play more integrated roles in reducing leakage, wastage and illegal connections and in increasing revenues from water sale	- Four units, namely LAU (Leakage Abatement Unit), ICCU (Illegal Connection Control Unit), AIPU (Asentamiento Improvement Program Unit), and CMBU (Customer Metering and Billing Unit) will be established within the existing Commercial Department, and each unit will be staffed by personnel who has experience in that particular field.
2D Review/revision of the existing water tariff structure	- Existing water tariffs for domestic customers will be reviewed and revised with a view to providing more consistent incentives for the efficient use of water. The limit of essential (subsistence) consumption for an average household will be established and subsidized tariffs will only be applied to metered consumption below that limit. Subsidized tariffs will never be applied to un-metered connections. Relatively high levels of fixed charges will be applied to un-metered domestic customers to provide a stimulus to encourage such customers to request the installation of a meter.
2E Review/revision of "Reglamento de Servicios al Usuario"	- "Reglamento de Servicios al Usuario" will set forth that (a) water meters will in principle be installed within the premises of customers and (b) customers will be held liable for any damages except normal wear and tear to water meters, including tampering. It will also set forth that (a) water meters will in principle be installed aboveground and (b) ENACAL has a right to decide the location and method of meter installation at its own discretion. Fines and penalties for illegal users will be increased.
2F Strengthening ENACAL's capacity in meter reading, billing and collection	- Registry of customers will be reorganized and updated. Classification of customers by use category will be defined more clearly and applied without discrimination. Meter readers will be trained in social communication skills. Meter reading, billing and collection systems will be related to the geographic coverages of macro sectors. Information on meter reading, billing and collection will be managed exclusively by CMBU (Customer Metering and Billing Unit) of the Commercial Department but will be shared with other units and departments of ENACAL through a computer network.
2G Increasing public awareness	- ENACAL will implement campaigns through the mass media (TV, radio and newspapers) to increase public awareness on issues such as water conservation, illegal connections and payment of water charges. Curriculums for primary and secondary schools will include tours of water supply facilities. Government will designate March 22nd as the "Nicaraguan Water Day" and ENACAL will organize exhibitions and arrange an inspection tour of water supply facilities on that particular day. In the dry season, ENACAL will send loudspeaker-mounted vehicles to areas where water is relatively abundant asking residents to stop watering roads/gardens or using swimming pools.

<p>2H Improvement of water supply and sanitation conditions in low-income settlements through community participatory approaches</p>	<p>(a) Databases on approximately 166 low-income settlements in Managua will be developed. Information compiled in the databases will include ages of the settlement, total number of households, average household size, ownership of land titles, water supply conditions, sanitary environments, conditions of other infrastructure (roads, electricity, telephone, sewerage, solid wastes disposal) , community organizations, and priority needs of residents.</p>
	<p>(b) Pilot projects will be implemented through community participatory approaches to improve water supply and sanitation conditions in 3 low-income settlements each selected from Type A, Type B and Type C settlements . The work will include the procurement of 2 vehicles and consultancy/NGO services, supply/installation of 750 water meters, provision of 750 new water service connetions and 1,160 new sewerage service connections, and construction of internal water/sewerage reticulation systems.</p>
	<p>(c) Water supply and sanitation conditions in 81 Type A settlements will be improved through community participatory approaches. The work will include the procurement of 2 vehicles and consultancy/NGO services, supply/installation of 27,000 water meters, provision of 9,000 new sewerage connections, and construction of internal sewerage reticulation systems.</p>
	<p>(d) Water supply and sanitation conditions in 52 Type C settlements will be improved through community partipatory approaches. The work will include the procurement of 2 vehicles and consultancy/NGO services, provision of 12,500 new water connections and 12,500 new sewerage service connections, and construction of internal water and sewerage reticulation systems.</p>

Table S-14 Priority Project (3/4)**3. Increase in the efficiency of water transmission and distribution systems**

Measures	Description
3A Macro-sectoring of the distribution system	- The existng distribution network will be divided into a number of hydraulically-isolated macro sectors with a view to ensuring appropriate matching of water sources with their supply areas. The work will include the installation of 101 valves (50 ~ 800mm) for the isolation of macro sectors and 31 bulk water meters (150 ~ 800mm) for the measurement of flows into macro sectors.
3B Improvement of water supply conditions in the San Judas, Schick and Laureles Sur areas and extension of water supply to the Jaguitas and Esquipulas areas	<p>(a) Wate supply conditions in the San Judas area will be improved. The work will include the construction of a water tank (2,000m3), a transmission pump station (74kw), a transmission main (PVC150 : 1.5km) and distribution mains (DIP300 : 0.3km & PVC250 : 2.3km).</p> <p>(b) Water supply conditions in the Schick and Laureles Sur areas will be improved. Water supply will be extended to the Esquipulas and Jaquitas areas where many housing development schemes are being implemented. The work will include the construction of a water tank (5,000m3), a transmission main (DIP300 : 1.0km) and distribution mains (DIP300 ~ 500 : 6.6km & PVC150 ~ 200 : 5.6km).</p>
3C Strengthening of water supplies in Veracruz and areas along the Carretera Masaya	- Water supply in Veracruz and areas along the Carretera Masaya will be strengthened. The work will include the construction of a transmission pump station (150kw), a transmission main (PVC250 : 4.1km), a distribution pump station (225kw) and a distribution main (DIP350 : 0.6km).
3D Strengthening of water supplies in Ticuantepe and Nindiri	<p>(a) Water supply in Ticuantepe will be strengthened. The work will include the construction of a new well and a raw water supply main (PVC150 : 1.0km).</p> <p>(b) Water supply in Nindiri will be strengthened. The work will include the construction of a new well and a raw water supply main (PVC150 : 4.0km).</p>

Table S-14 Priority Project (4/4)**4. Establishment of a basic financial framework for the management of water services in Managua**

Measures	Description
4A Establishment of an independent financial account for the water services in Managua	- ENACAL will establish an independent financial account for the water services in Managua. To this end, the ENACAL's current financial account will be divided into two, one covering the water services in Managua and the other covering the water services in the rest of the country.
4B Tariff increase	- Domestic tariffs in Managua will be increased at least to the level of the domestic tariffs currently applied in Matagalpa. At the same time, a special low tariff block (lifeline tariff block) for a subsistence monthly consumption will be provided in tariff structures to protect the extremely poor. The poor will be allowed to pay connection charges in installments over a long period of time.
4C Minimizing headquarters' expenses and establishing appropriate rules for the division of such expenses	- ENACAL will minimize its headquarters' expenses and establish appropriate rules for dividing such expenses between different financial accounts.
4D Training	- ENACAL's staff in the Financial Department will receive training on issues such as "Revenue Requirements", "Water Tariff Structures", "Cross-subsidization of Water Tariffs", "Depreciation" and "Cost Recovery".

IV-2. Preliminary Cost Estimates of PPT

Table S-15 shows the preliminary cost estimates of PPT. Currency exchange rates and other assumptions used in the cost estimates are the same as that used in the case of LIP.

Table S-15 Preliminary Cost Estimates of PPT (US\$ 1,000)

Measures/Items	First Stage (2006 to 2010)			Second Stage (2010 to 2015)			Total (2006 to 2015)		
	Donor	ENACAL	Total	Donor	ENACAL	Total	Donor	ENACAL	Total
1. Rehabilitation and protection of existing water sources	8,217	0	8,217	0	0	0	8,217	0	8,217
2. Reduction of leakage/wastage	22,197	0	22,197	9,354	0	9,354	31,551	0	31,551
3. Increasing in the efficiency of water transmission and distribution systems	9,126	0	9,126	0	0	0	9,126	0	9,126
4. Establishment of a basic financial framework for the management of water services in Managua	0	0	0	0	0	0	0	0	0
Total Base Cost	39,540	0	39,540	9,354	0	9,354	48,894	0	48,894
Engineering Fees (D/D & C/S)	2,768	0	2,768	655	0	655	3,423	0	3,423
Physical Contingency	2,115	0	2,115	500	0	500	2,616	0	2,616
Price Contingency	6,338	0	6,338	2,712	0	2,712	9,050	0	2,616
Project Administration Cost	0	1,269	1,269	0	331	331	0	1,600	1,600
Total Project Cost	50,761	1,269	52,030	13,221	331	13,551	63,982	1,600	65,582

IV-3. Implementation and Disbursement Schedules of PPT

Table S-16 shows the proposed implementation and disbursement schedules of PPT.

Table S-16 Implementation & Disbursement Schedules of PPT (2/4)

2. Reduction of leakage/wastage

Measures	Base Cost (US\$ 1,000)	First Stage (2006 to 2010)																Second Stage (2011 to 2015)																							
		2006				2007				2008				2009				2010				2011				2012				2013				2014				2015			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4				
2A Micro-sectoring of the distribution network and implementation of leakage and wastage reduction measures	(a) 1,959	█																																							
						0.20				0.60				0.20																											
	0					392				1,176				392																											
2B Replacement of aged water meters	3,337	█																																							
						0.20				0.60				0.20																											
	0					667				2,002				667																											
2C Re-organization of the existing Commercial Department	0	█																																							
		█																																							
	0	█																																							
2D Review/revision of the existing water tariff structure	0	█																																							
		█																																							
	0	█																																							
2E Review/revision of "Reglamento de Servicios al Usuario"	0	█																																							
		█																																							
	0	█																																							
2F Strengthening ENACAL's capacity in meter reading, billing and collection	0	█																																							
		█																																							
	0	█																																							
2G Increasing public awareness	0	█																																							
		█																																							
	0	█																																							
2H Improvement of water supply and sanitation conditions in low-income settlements through community participatory approaches	(a) 790	█																																							
						0.50				0.50																															
	0					395				395																															
	(b) 2,080	█																																							
						0.70				0.30																															
	0					1,456				624																															
	(c) 9,192	█																																							
										0.20				0.40				0.40																							
	0									1,838				3,677				3,677																							
	(d) 14,193	█																																							
										0.20				0.40				0.40																							
	0									2,839				5,677				5,677																							
Sub- Total	31,551	0	0	0	0	1,454	1,454	1,454	1,454	5,028	5,028	5,028	5,028	6,360	6,360	6,360	6,360	9,354	9,354	9,354	9,354	9,354	9,354	9,354	9,354	0	0	0	0	0	0	0	0								
Donor	31,551	0	0	0	0	1,454	1,454	1,454	1,454	5,028	5,028	5,028	5,028	6,360	6,360	6,360	6,360	9,354	9,354	9,354	9,354	9,354	9,354	9,354	9,354	0	0	0	0	0	0	0	0								
ENACAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0								

Table S-16 Implementation & Disbursement Schedules of PPT (4/4)

Item	Cost (US\$ 1,000)	First Stage (2006 to 2010)					Second Stage (2011 to 2015)				
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Base Cost											
Total	48,894	0	6,657	17,169	6,360	9,354	9,354	0	0	0	0
Donor	48,894	0	6,657	17,169	6,360	9,354	9,354	0	0	0	0
ENACAL	0	0	0	0	0	0	0	0	0	0	0
Engineering Fees (D/D & C/S)											
Total	3,423	0	466	1,202	445	655	655	0	0	0	0
Donor	3,423	0	466	1,202	445	655	655	0	0	0	0
ENACAL	0	0	0	0	0	0	0	0	0	0	0
Physical Contingency											
Total	2,616	0	356	919	340	500	500	0	0	0	0
Donor	2,616	0	356	919	340	500	500	0	0	0	0
ENACAL	0	0	0	0	0	0	0	0	0	0	0
Price Contingency											
Total	9,050	0	595	2,346	1,182	2,215	2,712	0	0	0	0
Donor	9,050	0	595	2,346	1,182	2,215	2,712	0	0	0	0
ENACAL	0	0	0	0	0	0	0	0	0	0	0
Project Administration Costs											
Total	1,600	0	202	541	208	318	331	0	0	0	0
Donor	0	0	0	0	0	0	0	0	0	0	0
ENACAL	1,600	0	202	541	208	318	331	0	0	0	0
Grand Total	65,582	0	8,276	22,176	8,535	13,043	13,551	0	0	0	0
Donor	63,982	0	8,074	21,635	8,327	12,725	13,221	0	0	0	0
ENACAL	1,600	0	202	541	208	318	331	0	0	0	0

V. RECOMMENDATIONS

V-1. Reduction of Intake Amount from Lake Asososca

It is recommended in our Study that the amount of abstraction from Lake Asososca should be reduced to 30,000 m³/day in order to protect the water quality of the lake from contamination. Further, our study also recommends that three existing wells in Zona Baja should be relocated to higher elevation areas because of their water quality problems. These recommendations, however, do not necessarily mean that they should be implemented immediately. Instead, they should be implemented on a step-by-step basis corresponding to the development of substitute water sources which adequately make up for any deficit in the supply capacity in areas currently supplied from those sources.

V-2. Coordination with Other Donors

Our Study indicated that (a) increasing in efficiency of the water transmission and distribution system and (b) reducing leakage and wastage are the two major goals that are critical to the sustainability of the water service in Managua. Thus, the long-term improvement plan proposed by this Study has been developed with the objective of achieving these two crucial goals. It is recommended that all on-going and future improvement projects in Managua should, in principle, be implemented in accordance with the development strategies and priorities proposed in the long-term improvement plan. In particular, it is recommended that ENACAL coordinate the on-going projects financed by the Government of Spain and IDB to ensure that the scopes of those projects are consistent with the long-term improvement plan proposed by this Study. Such coordination is particularly important in the following areas.

- One of the major components included in the Spanish Government’s “Proyecto de Optimización del Sistema de Abastecimiento, Mejora de los Indices de Macro y Micomedición, Planificación y Mejoramiento Medioambiental” is the micro-sectoring (including the implementation of non-revenue water reduction activities in micro sectors) of a 800 km distribution network in Zona Baja, which is equivalent to two-thirds of the total length of existing distribution pipes in the zone. However, it has not been clear about in which specific area/s of Zona Baja these improvement works will be implemented. It is therefore recommended that ENACAL discuss and agree with the Government of Spain that the proposed improvement works will be implemented in the western two-thirds area of Zona Baja.
- The Spanish Government’s project also includes the procurement of 100,000 water meters. Nonetheless, it is still unknown where they will be installed. It is recommended that ENACAL use approximately three-quarters of them to replace existing aged water meters in Managua, which have been in service for more than 10 years.
- Approximately US\$ 3.6 millions have been earmarked for the reduction of non-revenue water under the IDB’s “Programa de Modernización del Sistema de Agua Potable”. However, how and where these funds will be used is still unknown to date. It is recommended that ENACAL discuss and agree with IDB/Service Contractor that the funds will be used for the micro-sectoring (including the implementation of non-revenue water reduction activities in micro sectors) of a 400 km distribution network in the eastern one-thirds area of Zona Baja.
- Micro-sectoring of the existing distribution network in Zona Baja under these on-going projects should be consistent with the macro-sectoring plan of Zona Baja proposed by the long-term improvement plan.

V-3. Methods of Micro-sectoring

The micro-sectoring plan envisaged by the Spanish Government project includes the installation of a bulk meter for each micro sector and the continuous monitoring of the flow at a remote station through a telemetry system. However, there seems to be no point in making such sophisticated and expensive arrangements. Continuous monitoring of the flow is unnecessary for the reduction of non-revenue water. Instead, minimum night flows should be measured manually and as and when necessary with the use of a portable type ultrasonic flow meter. This method has been tested in our Study and proved to be quite effective in reducing non-revenue water. It is recommended that ENACAL propose the revision of the method to the Spanish Government.

V-4. Reduction of Leakage and Wastage

Our leakage surveys demonstrated that the micro-sectoring of the distribution network, measurement of minimum night flows with the use of a portable type ultrasonic flow meter, and the implementation of leak detection and repair works within micro sectors can effectively reduce leakage. In contrast, however, the reduction of wastage may require a rather holistic approach given that it is not a straightforward engineering issue but is the issue involving many complex social and institutional elements. In effect, there seems to be no magic bullet that can drastically reduce wastage within a short timeframe. One of the elements making this issue extremely complicated is the existence of many low-income settlements in Managua. Either directly or indirectly, the following elements constitute the grounds for the massive wastage of water in the city. It is therefore recommended that ENACAL review these elements carefully and recommend revisions to INAA as necessary.

- Water tariff structure for domestic use (design concepts, cross-subsidy, fixed charges

- applied to non-metered customers)
- Existence of many non-metered connections
 - Existence of many illegal users and non-payment customers
 - Location of water meter and method of its installation
 - Customers' responsibility for maintenance of water meters

In reducing wastage, different approaches must be adopted for low-income settlements from the rest of the city. In order to reduce wastage in low-income settlements, we recommend that ENACAL take the following steps.

- (i) Carrying out continuous water awareness campaigns for economic use of water
- (ii) Establishing databases of all asentamientos in the city, including the year of establishment, total population and the number of households, socio-economic conditions, status of infrastructure development (water, sanitation, electricity, telephone, solid wastes disposal, schools, roads, etc.), land titles, community based organizations, priority needs of communities, availability of water service, and conditions of existing internal reticulation systems for water and sewerage services.
- (iii) Classifying asentamientos according to the current availability of water service
- (iv) Implementing pilot projects using community participatory approaches
- (v) Evaluating the outcome of the pilot projects
- (vi) Implementing improvement works using community participatory approaches

It is also recommended that ENACAL have NGOs and Civil Society Groups actively involved in taking these approaches. Their involvement throughout the entire process is essential for the participation of communities. The ultimate objective of the proposed pilot projects is to provide a stimulus to encourage the residents of low-income settlements to relate their water consumption to their water bills. This can only be achieved by installing water meters and charging them based on meter reading. In doing so, however, it is necessary to mitigate any unacceptable impacts that might fall on the extremely poor.

V-5. Population in the Study Area

In this Study, future population and water demand have been projected based on the population estimates produced by INEC in July 2004 as they are the latest and only available "official" estimates in the country at the time of this Study. INEC periodically reviews the 1995 census results and produces its estimates. On-going projects financed by other donors (for example, Lake Managua and City of Managua Environmental Improvement Program) have also adopted one of those INEC's estimates as a baseline for projecting future population. A census is undertaken by the Nicaraguan Government at intervals of 10 years and the next one is scheduled for 2005. It is recommended that ENACAL review the results of the next census carefully and notify JICA and other donors accordingly if there is any substantial divergence between the census results and the INEC's existing estimates.