I. SARA, ILOILO

I. SARA, ILOILO

I. STUDY AREA AND HYDROGEOLOGICAL ANALYSIS

1. Description of the Study Area

1.1 Physical Description

1.1.1 Geographical Location and Area

The municipality of Sara is located on the northern part of Iloilo at the southeastern border of the province of Capiz. It is bounded on the east by the municipality of San Dionisio, on the south by the municipality of Ajuy, on the west by the municipality of Lemery, and on the north by the province of Capiz. About 102 km from Iloilo City, it has a total land area of 18,300 ha covering 42 barangays. Location map is shown in FIGURE I-1.

1.1.2 Climate

The municipality of Sara has no very pronounced maximum rain period with dry season from January to March. Maximum temperature is 34^{o}C while minimum temperature is 22.3^{o}C.

1.1.3 Terrain/Topography

With about one-half of its land area belonging to the 0-8% slope category, Sara has a generally flat terrain. Mountainous areas (15.1-35+% slope) comprised 36% while hilly areas (8.1-15% slope) accounted for 14% of the total land area.

1.1.4 Soil

The predominant soil types in Sara are Sara sandy loam and Buotec loam in the plain and San Rafael loam in the hills.

1.1.5 Administrative Composition and Land Use

The municipality is headed by the Mayor and Vice Mayor with eight (8) members of the Sangguniang Bayan as the local legislative body. Under the municipality are the barangays, the smallest political subdivision, which are headed by Barangay Captains/Chairmen with the Sangguniang Barangay as the lawmaking body. All these local officials are selected by the people through popular election.

Municipalities are classified according to the annual revenues from taxes. This classification serves as a major indication of the socio-economic situation of the population in the municipalities. The municipality of Sara belongs to

FIGURE I-1

LOCATION MAP
SARA , ILOILO

the 3rd class.

Listed below are the 42 barangays comprising the municipality of Sara:

1.	Aguirre	22.	Gildore
2.	Aldeguer	23.	Improgo
3.	Alibayog	24.	Juaneza
4.	Anoring	25.	Labigan
5.	Apelo	26.	Lanciola
6.	Apologista	27.	Latawan
7.	Aposaga	28.	Malapaya
8.	Arante	29.	Muyco
9.	Ardemil	30.	Padios
10.	Aspera	31.	Pasig
11.	Aswe-Pabriaga	32.	Ilawod (Poblacion)
12.	Bagaygay	33.	Ilaya (Poblacion)
13.	Bakabak	34.	Market (Poblacion)
14.	Batitao	35.	Posadas
15.	Bato	36.	Preciosa
16.	Castillo	37.	Salcedo
17.	Castor	38.	San Luis
18.	Crespo	39.	Tady
19.	Devera	40.	Tentay
20.	Domingo	41.	Villa Hermosa
21.	Ferraris	42.	Zerrudo

1.1.6 Transportation

Land transportation is the primary means of commutation. Prevalent mode of transportation include public utility vehicles (buses, jeepneys and tricycles) and private vehicles.

1.1.7 Infrastructure

Of the 53.75 km of road network in Sara, 83.7% were barangay roads and only 16.3% comprised of municipal roads. The overall road inventory indicates an underdeveloped system with 97.5% of all roads of gravel and sand structure and only 2.5% concreted and asphalted.

Only 33% of the 42 barangys of Sara are currently energized by ILECO-II. Number of connections totalled to 680, 30.49% of the potential consumers.

1.2 Population and Living Conditions

1.2.1 Population Trend from the Past

Sara has a relatively high growth rate compared to the other municipalities in Iloilo. From 1975 to 1980, Sara's population increased from 24,809 to 28,838 indicating a 3.06% growth rate. Male-female ratio is almost 1:1.

Number of households totalled 5,120 in 1980 indicating an average household size 6. Popolation density is only 158 persons per square kilometer. Majority of the population (87.62%) live in the rural areas.

TABLE I-1 Population and Number of Households by Barangay, Sara, Iloilo 1980

Barangay	Population	No. of Households
Aguirre	298	54
Aldeguer	602	121
Alibayog	603	103
Anoring	1,322	251
Apelo	551	107
Apologista	972	182
Aposaga	429	80
Arante	501	91
Ardemil	938	166
Aspera	803	131
Aswe-Pabriaga	361	61
Bagaygay	767	147
Bakabak	889	163
Batitao	220	39
Bato	597	107
Castillo	1,254	201
Castor	111	19
Crespo	603	117
Devera	1,271	225
Domingo	652	113
Ferraris	616	105
Gildore	297	52
Improgo	396	86
Juaneza	512	81
Labigan	688	136
Lanciola	549	102
Latawan	339	59
Malapaya	610	111
Muyco	686	115
Padios	805	144
Pasig	789	148
Ilawod (Poblacion)	1,803	296
Ilaya (Poblacion)	1,235	214
Market (Poblacion)	533	90
Posadas	599	98
Preciosa	515	86
Salcedo	482	82
San Luis	882	144
Tady	576	101
Tentay	659	117
Villa Hermosa	516	94
Zerrudo	1,007	182
TOTAL	28,838	5,120

1.2.2 Age Distribution

Sara's population has a young age structure with 54% belonging to the 0-24 years old bracket.

The dependent population (0-14 years old) accounted for 43.10% of the total population while the productive or working age groups represented 56.9%.

1.2.3 Morbidity/Mortality

The leading causes of morbidity and mortality in the area are bronchitis, gastro-enteritis-diarrhea and dysentery.

1.2.4 Sanitation

The municipality is beset with lack of sanitary disposal facilities. Majority of the households used closed pit (47.6%), open pit (31.1%), water sealed toilet (8.6%) while 11.2% of the total households have no toilet facilities.

1.2.5 Public Services

There are a total of 8 health centers and health stations operating in Sara with a total manpower of 12 consisting of 8 midwives, 1 rural health physician, 1 dentist, 1 nurse and 1 rural sanitary inspector.

Telecommunication services are provided by the post office and one telegraph station.

1.3 Economy and Industry

1.3.1 Agriculture

Sara is a predominantly agricultural municipality with rice as the major crop. As of 1980, 7,206 ha were cultivated to rice production, 84% of which were rainfed areas. Production totalled to 370,882 sacks with an average production of 75.8 sacks per hectare for rainfed areas. Coconut and corn, the other crops planted in Sara, had an area of 473 ha and 200 ha planted respectively with an average production of 25 per tree for coconut and 19 sacks per hectare for corn.

Total number of farms was 2,232 in 1980 covering an aggregate of 6,908 ha. Average farm size was 3.09 ha.

As of 1983, livestock and poultry population totalled to 76,637 heads; chicken and ducks accounting for 77.41% and 14.57%, respectively.

1.3.2 Other Industries

There were a total of 256 business establishments operating in Sara as of 1980. Major industries include manufacturing accounting for 34.4%, wholesale and retail trade - 23.8%, community, social and personal services, 21.9% and transportation, storage and communication, 17.2%.

1.3.3 Municipality Income

From 1978 to 1981, Sara generated an income of ₱668,661 mostly from real property and business taxes.

2. Analysis of Potential Water Source

2.1 Topography and Geology

The poblacion area of Sara is about 10 km inland from the coastal line and is situated on the well cultivated plain with about 22 m in ground elevation. The mountain area surrounds the plain from three directions, north, west and south.

The basement rock of the study area consists of diorite distributed in 600 sq.km area. The alluvial deposits are found in the plain between mountains. Geology map is shown in FIGURE I-2.

Sara Diorite (Paleocene, Tertiary)

Sara diorite occupies the wide area belonging to the northeastern part of Iloilo Province. This diorite is reported to have intruded into the Sibala Formation at the early period of Tertiary.

The character of this rock is usually white gray in color, hard and holocrystaline but sometime is brownish and loose by deep weathering.

There is no topsoil at the mountain slope, so the vegetation is poor.

Alluvial Deposits (Quaternary)

This unit is found in the flood plain and consists of sand, clay and pebble formed as a result of erosion and weathering from diorite mass.

The thickness of this unit is variable from 5 m to 20 m.

2.2 Existing Water Source

Surface Water

The present water sources of Sara Waterworks are two intake dams collecting water from the creeks originating from the cracks of diorite. This water supply system was established in 1930.

One of the creeks, which is located in Cobotongan, is 3.8 km north of the Poblacion. Another one, which is in Agbayatin, is located 5.2 km northwest of the Poblacion.

The residents in the Poblacion and the area along the transmission pipeline depend on this water supply system. Those in the Poblacion, however, utilize water drawn from their own private shallow/dug wells due to insufficient water supply of the distribution pipeline network.

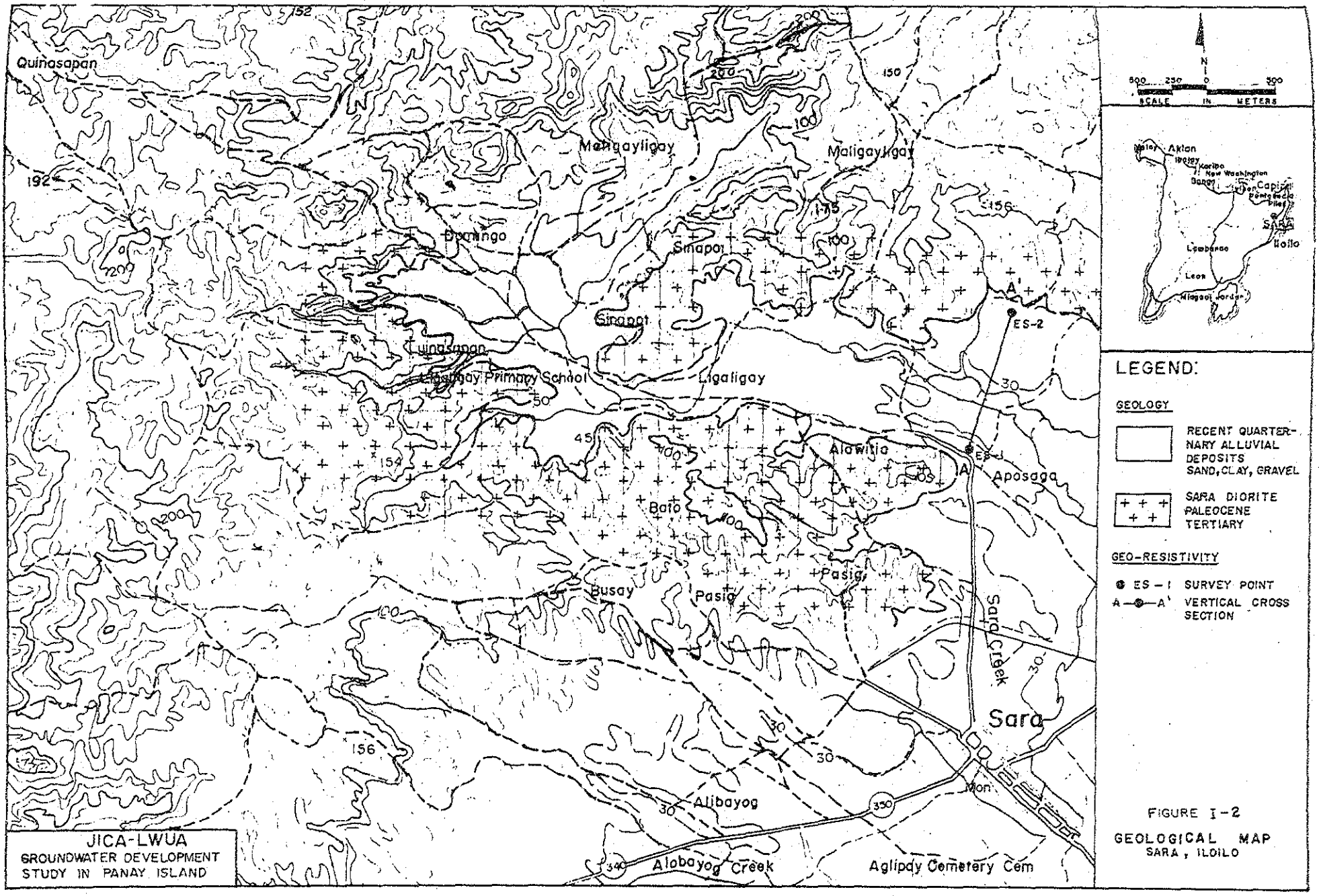


FIGURE I-2
GEOLOGICAL MAP
SARA, ILOILO

In addition, there is a small stream, called Alibayog creek south of the Agbayatin creek at the other side of the bridge. Although the water flowing in this creek is sufficient for the water supply needs in th area, said water is being utilized for the irrigation of rice field at present.

The flow rate of these creeks were measured as shown in TABLE I-2.

TABLE I-2 **Surface Water Flow Rate**

Location	Flow Rate Dry Season (May 14)	Rainy Season (September 22)
Cobotongan Creek (No. 1 Intake Dam)	177 cu.m/day	259 cu.m/day
Agbayatin Creek (No. 2 Intake Dam)	197 cu.m/day	2,205 cu.m/day
Sub-total	374 cu.m/day	2,464 cu.m/day
Alibayog Creek	430 cu.m/day	3,800 cu.m/day
Total	804 cu.m/day	6,264 cu.m/day

The flow rate of the Cobotongan Creek was measured at 177 cu.m/day in dry season and 259 cu.m.day in rainy season at the upstream of the Intake Dam No. 1.

On the other hand, the flow rate of the Agbayatin Creek flowing into the Intake Dam No. 2 was measured at 2.28 liter/sec or 197 cu.m/day in dry season. In rainy season, two (2) creeks, including Agbayatin Creek, were flowing into the Dam No. 2 with a total flow amount of 2,205 cu.m/day.

The flow rate of the Alibayog Creek was measured at 4.92 liter/sec or 430 cu.m/day in dry season and 380 cu.m/day in rainy season.

The present total intake amount during the dry season was calculated at 380 cu.m/day, with a possible additional 430 cu.m/day to be drawn from the Alibayog Creek near the existing Intake Dam No. 2.

Wells

A well inventory survey involving the measurement of total depth of the well and static water level was carried out in four (4) wells located in the Poblacion. Data collected is presented in TABLE I-3 and FIGURE I-3.

Survey results are summarized below:

i) Groundwater table is situated at about 18 m above mean sea water level which is almost the same level as the paddy field surrounding the Poblacion,

ii) The static water levels are high comparing to the total depth of well. This substantiates a theory that the specific capacity of the wells are low. The existence of pressured aquifer may be conjectured. However, considering the geological condition of the area, this possibility remains very small.

TABLE I-3 Well Data Summary

JICA-LWUA Source Number	Well Depth (M)	Ground Level (MAMSL)	Static Water Level			
			Dry Season (May 19)		Rainy Season (September 22)	
			(MBGL)	(MAMSL)*	(MBGL)	(MAMSL)
I-3 Shallow Well, Poblacion	15.48	22.5	-4.74	17.8	-3.20	19.3
I-4 Deep Well, DEO,DPWH	21.0	22.9	-4.95	17.9	-3.35	19.5
I-5 Deep Well, Public Market	16.51	21.5	-6.98 (PWL)**	14.5 (PWL)	-1.29	20.2
I-6 Public Well, Malapaya Elem. Sch.	24.81	41.1	-4.65	36.4	-3.50	37.6
I-7 Shallow Well, Poblacion	24.79	22.5	-	-	-2.99	19.5

* Estimated based on the topographic map with a scale of 1/4,000.

** Pumping water level

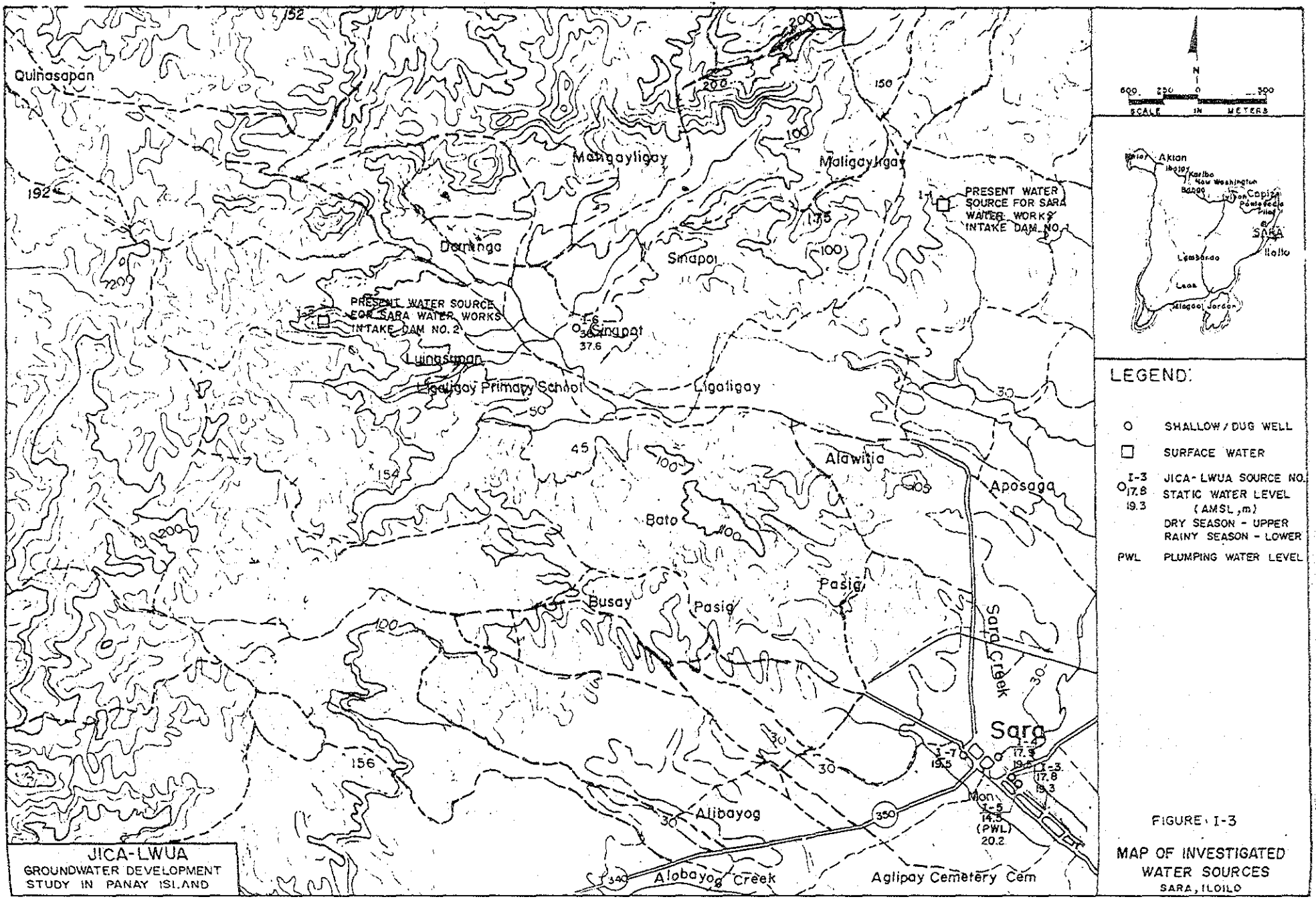


FIGURE I-3

MAP OF INVESTIGATED WATER SOURCES
SARA, ILOILO

2.3 Survey for Potential Water Source

2.3.1 Evaluation of Georesistivity Survey

In this study area, the flood plain is observed to possess diolite as its basement. The georesistivity survey was intended to determine the depth distribution of diolite and the presence of aquifer in it; sandy to gravely facies in the alluvial deposit form the said flood plain. Survey points are indicated in FIGURE I-2.

Survey activities are summarized as follows:

Date	:	May 17, 1988
No. of Survey Points	:	two (2) points
Type of Survey	:	Vertical Sounding
Configuration	:	Wenner Method
Sounding depth	:	100 meters

The results of the ρ-a curve analysis are shown in TABLE I-4 and the georesistivity section is shown in FIGURE I-4.

Following interpretations and assessments have been obtained at the present:

1) The geology in the study area shows two layers of structures excluding the surface layer.

2) Diolite is present at depths deeper than 4 to 10 mbgl.

3) Resistivity of alluvial deposit overlying the diolite is low enough to be considered clay-like to silty facies.

4) As a whole, the aquifer in alluvial deposit is considered to have poor potential of groundwater.

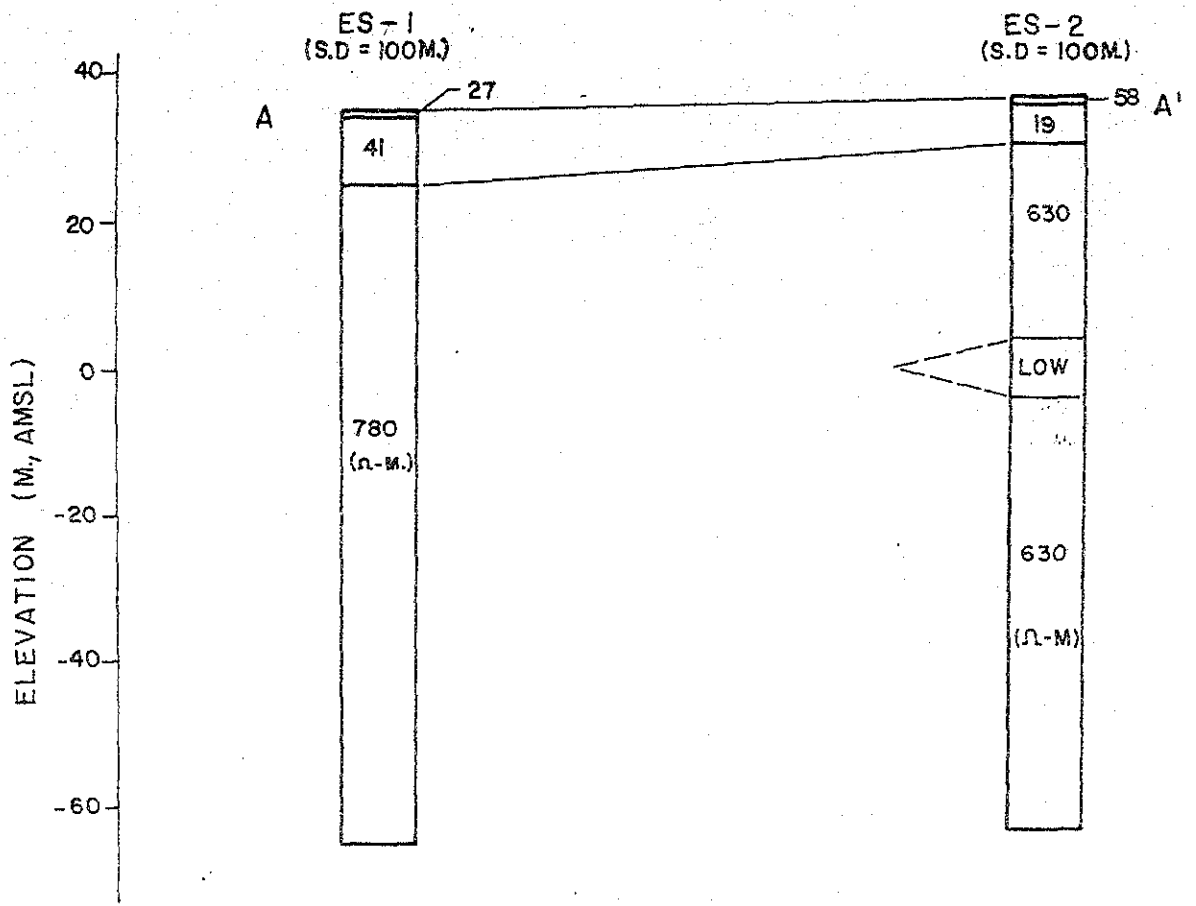
5) Survey point ES-2 detected low resistivity later at depth from 32 to 40 mbgl, which is assumed to be weathered layer of diolite as possible aquifer.

TABLE I-4 DEDUCTED VALUES OF GEORESISTIVITY

READING INTERPRETATION

SARA, ILOILO

SURVEY POINT	ELEVATION (M,AMSL)	TOPOGRAPHY	RESISTIVITY LAYER 1		2		3	
			ohm.m	m	ohm.m	m	ohm.m	m
ES-1	35	flood plain	27	0.8	41	10	780	
ES-2	38	flood plain	58	0.6	19	4	630	



SCALE H = 1: 10,000
V = 1: 1,000

FIGURE I - 4

GEORESISTIVITY SECTION A-A'
SARA, ILOILO, PANAY ISLAND

JICA - LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND

2.4 Water Quality Analysis

Water quality of eight (8) existing water sources was examined during the field survey and four (4) water samples were collected from two existing water sources of Sara municipal water supply system for laboratory analysis at LWUA. Survey points are indicated on FIGURE I-4 and field analysis results are presented in TABLE I-5.

TABLE I-5 Water Quality Analysis Results

Sample	WT (°C)	pH (-)	EC (μS/cm)	T-Fe (ppm)	Mn (ppm)	NH_4-N (ppm)
Dry Season						
I-1 Cobotongan Creek	-	8.3	240	nil	nil	<0.4
I-2 Agbayatin Creek	27.5	8.0	220	nil	-	nil
I-3 Shallow Well, Poblacion	30.5	6.7	250	<1.0	nil	-
I-4 Deep Well, DEO, DPWH	33.0	6.6	190	nil	nil	nil
I-5 Deep Well, Level III, Market	29.5	6.6	800	nil	-	-
I-6 Public Well, Malapaya Elem. School	30.0	6.8	240	nil	-	-
I-7 Deep Well, Poblacion	29.3	6.2	480	1.5	nil	nil

TABLE I-5 Water Quality Analysis Results (Cont'd)

Sample	WT (°C)	pH (-)	EC (uS/cm)	T-Fe (ppm)	Mn (ppm)	NH_4-N (ppm)
Rainy Season						
I-1 Cobotongan Creek	28.2	7.4	205	nil	-	nil
I-2 Agbayatin Creek	27.0	8.1	175	nil	-	nil
I-3 Shallow Well, Poblacion	29.4	6.9	132	-	-	-
I-4 Deep Well, DEO, DPWH	30.5	6.7	184	-	-	-
I-5 Deep Well, Level III, Market	28.9	6.6	620	nil	-	nil
I-6 Public Well, Malapaya Elem. School	28.8	6.9	328	0.2	-	nil
I-7 Deep Well, Poblacion	28.6	6.3	472	1.0	-	nil
- Creek, No. 3	28.2	8.0	170	Tr.	-	nil

Water sources of the Sara municipal water supply system (I-1 and I-2) and a creek neighboring with Agbayatin Creek show high pH values as alkaline condition, while other water sources are comparatively low in pH as acidic condition. Likewise, the origin of these water sources may be categorized into two groups.

Deep wells manifest a higher electric conductivity than shallow wells demonstrating that deep groundwater is rich in dissolved chemical constituents.

Following are the results of laboratory analysis performed for water samples collected from water sources of the Sara municipal water supply system.

Sample	Cobotongan Creek (I-1)		Agbayatin Creek (I-2)	
Date of Sampling	5.17.88	9.24.88	5.17.88	9.24.88
Turbidity (FTU)	2	2.2	0.9	2
Color (UNIT)	nil	8	nil	10
TDS (mg/l)	192	165	288	155
pH (-)	6.8	7.6	7.0	7.7
EC (μS/cm)	300	290	450	280
Alkalinity as $CaCO_3$ (mg/l)	95	115	114	108
Hardness as $CaCO_3$ (mg/l)	98	116	98	112
Major Cations (meq/l)				
Sodium	0.48	0.6	0.57	0.6
Potassium	0.05	0.05	0.05	0.02
Calcium	1.20	1.4	1.20	1.3
Magnesium	0.74	0.9	0.76	0.9
Total	2.47	2.95	2.58	2.82
Major Anions (meq/l)				
Carbonate	0	0	0	1.8
Bicarbonate	1.9	2.3	2.28	0.4
Chloride	0.38	0.6	0.38	0.6
Sulfate	0.22	nil	0.12	nil
Total	2.50	2.9	2.78	2.8

These analysis results indicate that both water sources have the Carbonate-Hardness Type of geochemical characteristics and favorable water quality for drinking purpose, provided however appropriate measure shall be taken up to remove color and turbidity. Although locations of these two water sources are not neighboring with each other, geochemical features of their catchment area are considered to be same.

3. Conclusion and Recommendation

The groundwater bearing in diorite is fissure water, and it is very hard to develop the fissure water by drilling.

The groundwater in alluvial deposits and upper weathered diorite is possible and can be utilized for drinking through shallow or dug wells. The quality of the groundwater in this area is good. However the quantity is not sufficient as the source of water supply

for the Poblacion and its surrounding area.

Also, it is not advisable to utilize the river bed water because the river is narrow and water is polluted upward the Poblacion.

Considering the above-mentioned hydrogeological condition, the practical way to increase the water amount in the area is the repair of existing deteriorated transmission pipelines and intake facilities. Though the development of the Alibayog Creek is the most effective means to increase the water supply capacity, the problem of water right against the irrigation users will first have to be resolved.

II. CONCEPTUAL WATER SUPPLY SYSTEM

1. Existing Water Supply Conditions

1.1 Water Use Condition

The major piped water supply system was established in 1930. This system has a total of 670 registered service connections as of April 1988, of which 549 are active connections, the remainder of which has been disconnected. Water meters are installed in 300 connections.

The water rate structure for metered connections is shown below.

	First 20 cu.m	In Excess of 20 cu.m
Domestic	₱10.0	₱1.00/cu.m
Commercial	₱12.0	₱1.50/cu.m
Industrial	₱15.0	₱2.00/cu.m

Non-metered connections are charged a flat rate as the minimum consumption of 20 cu.m.

Water intake amount was measured to be 380 cu.m/day, but the total distributed amount was not available due to absence of flow meter.

One small scale Level III water supply system is currently in working condition to serve tenants of the public market in the poblacion.

As a whole, approximately 3,000 people are estimated to be benefited by the existing water supply systems. Unserved people are, on the other hand, using private shallow wells.

Population coverage of the present water supply service seems considerably high, but the quality of services is considered poor, i.e., low water pressure at service connections, no disinfection of raw water, suspected leakage from pipelines due to aging of major facilities, etc.

To achieve the desirable level of water supply service and prepare for the expansion of water supply to unserved barangays, the improvement of existing water supply system is indeed indispensable.

1.2 Existing Water Supply System and Problems Encountered

The existing major water supply system established in 1930 has the following system configuration:

- Water source is Cabotongan Creek about 3.8 km north of the Poblacion and Agbayatin Creek at 5.2 km northwest of the Poblacion. All stream water is utilized for water supply and drawn

by the intake dams where flow rates are measured (Cabotongan Creek, 180 cu.m/day; Agbayatin Creek, 200 cu.m/day).

- Groundwater reservoir (RC, 300 cu.m) equipped with grit chamber is installed near each water intake facility.

- A chlorination facility is installed at grit chamber of Cabotongan water source, but it is not currently in use.

- The transmission line has a total length of about 8.2 km; ø150 mm cast iron pipeline from the Cabotongan reservoir to the poblacion area and ø100 mm asbestos cement pipeline from Agbayatin reservoir to the junction of the former pipeline.

- The distribution line has a total length of about 5.1 km in poblacion area.

The transmission line (AC, ø100 mm) originally laid in the irrigation canal was partly replaced by PVC pipes due to destruction/damage caused by the passage of carabaos. As a whole, thorough renovation of aged facilities will be required in the near future.

2. Water Demand Projection

2.1 Criteria

The existing water supply system is presently producing 380 cu.m/day of raw water. This water production is equivalent to about 115 lpcd of unit water consumption (380 cu.m/day consumed by 549 connections with 6 persons per household). As discussed earlier, when the consumption by commercial and institutional connections is taken into account, the domestic consumption shall be considered to be about 80% to 90% of the total distributed amount. Likewise, the present per capita unit water consumption is assumed to be 100 lpcd and this assumption is within the range of commonly adopted figure as described in the LWUA Methodology Manual.

Design unit water consumption by consumer type is estimated in accordance with the said Manual, as follows:

- Domestic per capita unit water consumption is estimated at 112 lpcd in the year 1995 with an annual increase ratio of 2% from 1988 to 1990 and 1.5% from 1990 to 1995 against 100 lpcd in 1988.

- Commercial unit water consumption in 1995 is esti mated at 1.4 cu.m/connection/day with its connec tion density ratio of 1.2 per 100 inhabitants.

- Institutional unit water consumption in 1995 is estimated at 5.2 cu.m/connection/day with its connection density ratio of 1.0 per 2,000 inhabitants in the service area.

The existing water supply system was constructed in late 1930's and expansion/improvement took place in accordance with the increase of water demand and aging of the facilities. In this regard, thorough improvement of the major facilities is a prerequisite. Taking into account these conditions, the unaccounted-for water is assumed to be 40% of the total distributed amount which is the LWUA standard ratio of old and new combined pipe lines.

2.2 Areas to be Served

The target year for water supply planning is set for the year 1995 for the purpose of intermediate water supply development/improvement.

With regard to the planned service area in the said target year, priority shall be given to the densely populated area for improvement of water supply conditions being rendered by superannuated existing water supply facilities. The present service area, which is in the poblacion, is likewise designated as the planned service area. Inclusion of unserved barangay to the water supply service area shall be considered upon accomplishment of the intermediate improvement.

2.3 Population Projection

The National Economic and Development Authority (NEDA) has projected the municipal population in each year from 1981 to 2000 based on population census it conducted in 1980. The municipal government, on the other hand, does not have any referrable population data for water supply planning.

Owing to the above-mentioned limitation on population data, the NEDA population projection is adopted in principle. Percentage share of barangay population to the municipal population in 1995 is assumed to be the same as that of the 1980 census result. The result of population projection is shown in TABLE I-6.

TABLE I-6 Population Projection of Service Area

Year	Municipality	Service Area (Poblacion)			
		Ilawad	Ilaya	Market	Total
1980	28,838	1,803	1,235	533	3,571
1985	32,110	2,010	1,380	590	3,980
1990	35,160	2,200	1,510	650	4,360
1995	37,740	2,360	1,620	700	4,680

With regard to the water supply service ratio, the municipal government is presently serving a total of 549 service connections, which is equivalent to about 75% of the service area population.

When the presence of commercial and institutional connections are taken into account, the actual service ratio to residents will be about 65% to 70%. Considering these background situations, the planned water supply service ratio for the target area is assumed to be 80%.

Average number of persons per household is estimated at 5.00 in 1995 based on the standard figure adopted by NEDA.

2.4 Water Demand Projection

The future water consumption in 1995 is estimated based on the aforementioned planned service population and design unit water consumption by consumer type.

The estimated number of connection and future water consumption are shown in TABLE I-7.

TABLE I-7 Water Consumption in 1995

Service Area	Poblacion			
	Ilawod	Ilaya	Market	Total
Served Population	1,890	1,300	560	3,750
No. of Connection				
Domestic	378	260	112	750
Commercial	23	16	7	46
Institutional*	1	1	0	2
Total	503	277	119	798
Water Consumption (cu.m/day)				
Domestic	212	146	63	421
Commercial	32	22	10	64
Institutional	5	5	0	10
Total	249	173	73	495
Unaccounted-for Water	166	115	49	330
TOTAL	415	288	122	825

* At least one connection is considered for each barangay as the elementary school

The ratio of the daily maximum water demand to the daily average water demand is determined in relation to the planned service population based on the LWUA Method ology Manual as shown in TABLE I-8.

TABLE I-8 Demand Variation Factor for Daily Maximum Water Demand

Service Population	Ratio (Daily Max./Daily Ave.)
Less than 30,000	1.30 : 1
30,000 to 200,000	1.25 : 1
Over 20,000	1.20 : 1

The estimated daily maximum water demand is shown in TABLE I-9.

TABLE I-9 Daily Maximum Water Demand

Service Area	Water Demand (cu.m/day)
Ilawod	540
Ilaya	370
Market	160
Total	1,070

The peak hour water demand is estimated in propor tion to the daily maximum water demand and service popu lation in accordance with the LWUA Methodology Manual as shown below:

$$C = (\text{Peak Hour Demand} \times 24)/(\text{Daily Maximum Demand})$$

$$= 2.2 - 0.3 \times \log (\text{Service Population}/1{,}000)$$

The ratio of peak hour demand in the year 1995 is calculated at 2.03 and the peak hour water demand is estimated at 2,170 cu.m/day.

3. Proposed Water Supply Facilities

3.1 Basic Approach for Water Supply Improvement

3.1.1 Conditions and Constraints

The conceptual plan for water supply improvement is focused on major water supply facilities, such as water source, main transmission and distribution pipelines, and reservoir. Branch lines, service connections and fire hydrants are likewise excluded from conceptual planning. However, following conditions are taken into account as much as possible:

(1) Low cost in construction, operation and maintenance,
(2) Seasonal fluctuation of source capacity will not seriously affect stable water supply,
(3) Water source will be located within the administrative boundary of respective municipality.

3.1.2 Water Source Development

The existing two water sources with the productions of 177 cu.m/day and 197 cu.m/day from intake dams in dry season are located 3.8km north and 5.2km northwest from the poblacion respectively, and the total production of 374 cu.m/day is a quite shorter than the planned daily maximum water demand in 1995.

As the result of the evaluation and analysis of hydrogeological investigation and surface water study, it is realized that the availability of ground water from deep well seems very few and only surface water from Alibayog Creek located at South of No.2 Intake Dam yield clear water suited for potable water. Thus, Alibayog Creek shall be utilized as an additional water source as well as the existing water sources.

3.1.3 Transmission and Distribution Facilities

Since the existing transmission and distribution facilities have been heavily deteriorated and are judged not to be durable any longer, they shall be replaced totally by new facilities together with rehabilitation of intake and reservoir facilities. The rate of leakage will be expected 25% after replacement of these facilities and it requires daily maximum water production which is almost equal to daily maximums water demand of 858 cu.m/day in dry season.

3.2 Plan for Improvement of Water Supply Facilities

3.2.1 Water Source Facility

New intake pipes (No.1 - ø300 mm x 30 m, No.2 - ø400 mm x 30 m) at the existing two intake dams, will be reconstructed to be embedded under the sand layer to avoid inflow of turbid water, especially during rainy season.

For new water source, an intake dam (15m W x 2.0m H) with intake pipe (ø400 mm x 30 m) embedded under the sand layer will be constructed.

3.2.2 Transmission Facility

The existing transmission line from No.1 Intake Dam to the existing reservoir will be completely renewed with ø100mm pipe x 400m length to meet with maximum available intake quantity of 259 cu.m/day. The existing transmission line from No.2 will be also renewed.

The existing chlorination tanks nearby No.1 and No.2 intake dams will be utilized at present conditions.

The existing reservoirs have enough capacity at storage and kept in good conditions so that only partial repair and cleaning of inside and water proof treatment of internal surface will be required.

New transmission line, a chlorination tank and a reservoir connected to new water intake dam in Alibayog Creek shall be constructed.

The capacity of new reservoir is planned to have a volume equivalent to 10% of the daily maximum water production in dry season.

Transmission line from No.1 Intake Dam Reservoir to a junction point of main transmission will be replaced by pipeline with a capacity of maximum water production in rainy season. Transmission line from No.2 Intake Dam Reservoir to a junction point with the line from new intake dam will be replaced. Furthermore new transmission line from new intake dam in Aliboyag Creek will be installed and remaining part of transmission line which is from a junction point of transmission line of No.2 and new intake, to poblacion will be replaced. Thus, all transmission line will be replaced or replaced.

3.2.3 Distribution Facility

New distribution main will be installed to form a loop in poblacion area. This pipe line will have flow capacity to meet

with the hourly maximum water demand.

3.2.4 Required Water Supply Facilities

Layout of major water supply facilities is shown in FIGURE I-5 and flow diagram of facilities in FIGURE I-6 and detail of distribution pipeline in proposed service area in FIGURE I-7.

Size and quantity of required facilities are listed below:

(1) Water Source Facility

Intake pipe for No.1 Intake Dam:
ϕ 300mm pipe, 30m

Intake pipe for No.2 Intake Dam:
ϕ 400mm pipe, 30m

New intake dam in Alibayog Creek:
RC, 15mW x 2.0mH, EL + 70.0m

Intake pipe for new intake dam:
ϕ 400mm pipe, 30m

(2) Transmission Line

Pipe line from intake to the existing reservoirs at No.1 and No.2 Intake Dam:
No.1 -- ϕ 100mm Pipe, 400m
No.2 -- ϕ 150mm Pipe, 70m

Pipe line from new intake dam at Alibayog Creek to a new chlorination tank:
ϕ 150mm Pipe, 100m

Repair of the existing reservoirs at No.1 and No.2 Intake Dam:
No.1 -- RC, 300 cu.m, 1 unit
No.2 -- RC, 300 cu.m, 1 unit

Chlorination tank RC,

Reservoirs at new intake dam at Alibayog Creek:
RC, 5.0mW x 5.0mL x 2.5mH, 62 cu.m

Transmission main:
from No.1 Intake -- ϕ 100mm pipe, 2,000m
from No.2 Intake -- ϕ 150mm pipe, 1,500m
from No.3 Intake -- ϕ 150mm pipe, 1,500m
from junction of No.2 and No.3 -- ϕ 200mm pipe, 6700m

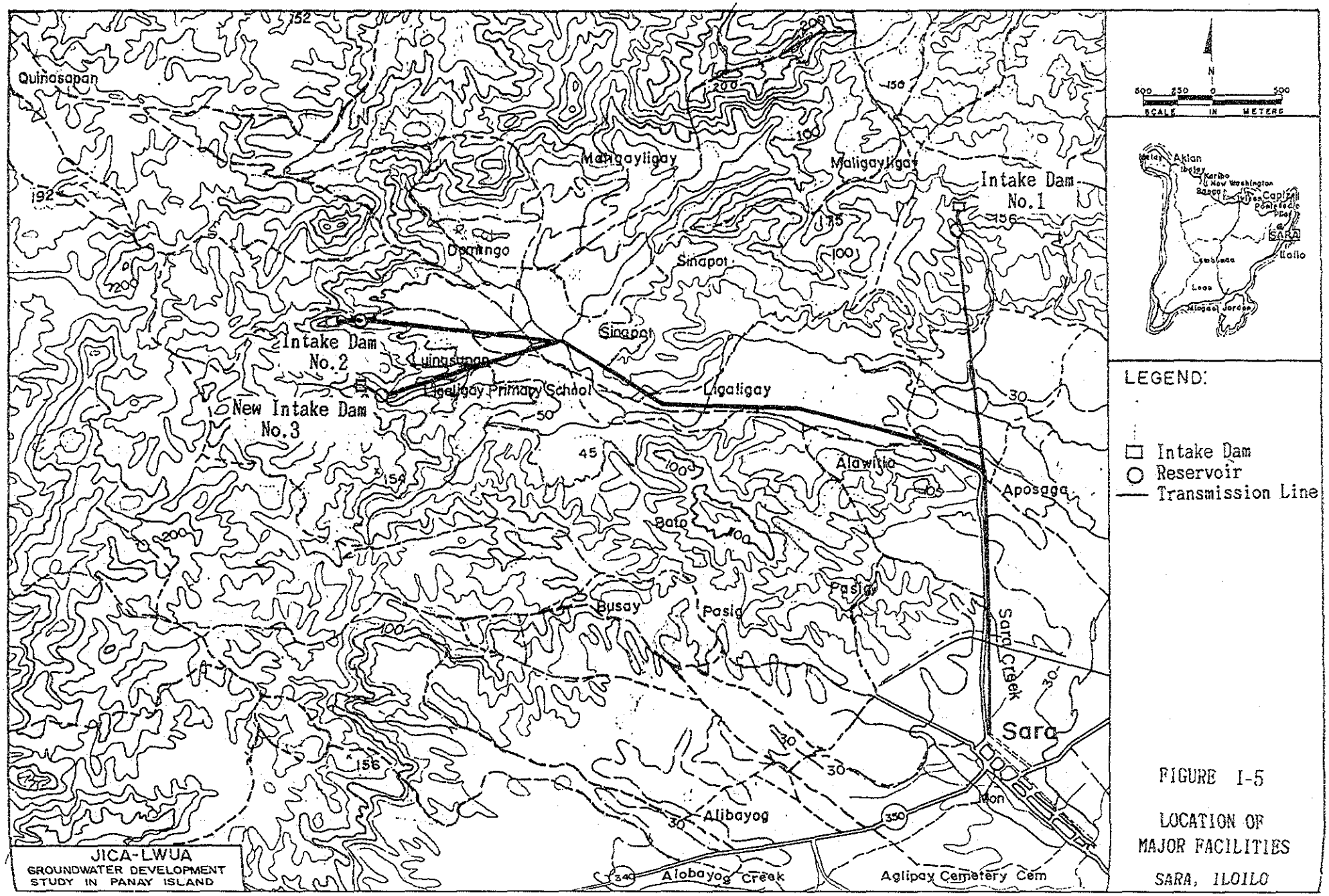


FIGURE I-5

LOCATION OF MAJOR FACILITIES

SARA, ILOILO

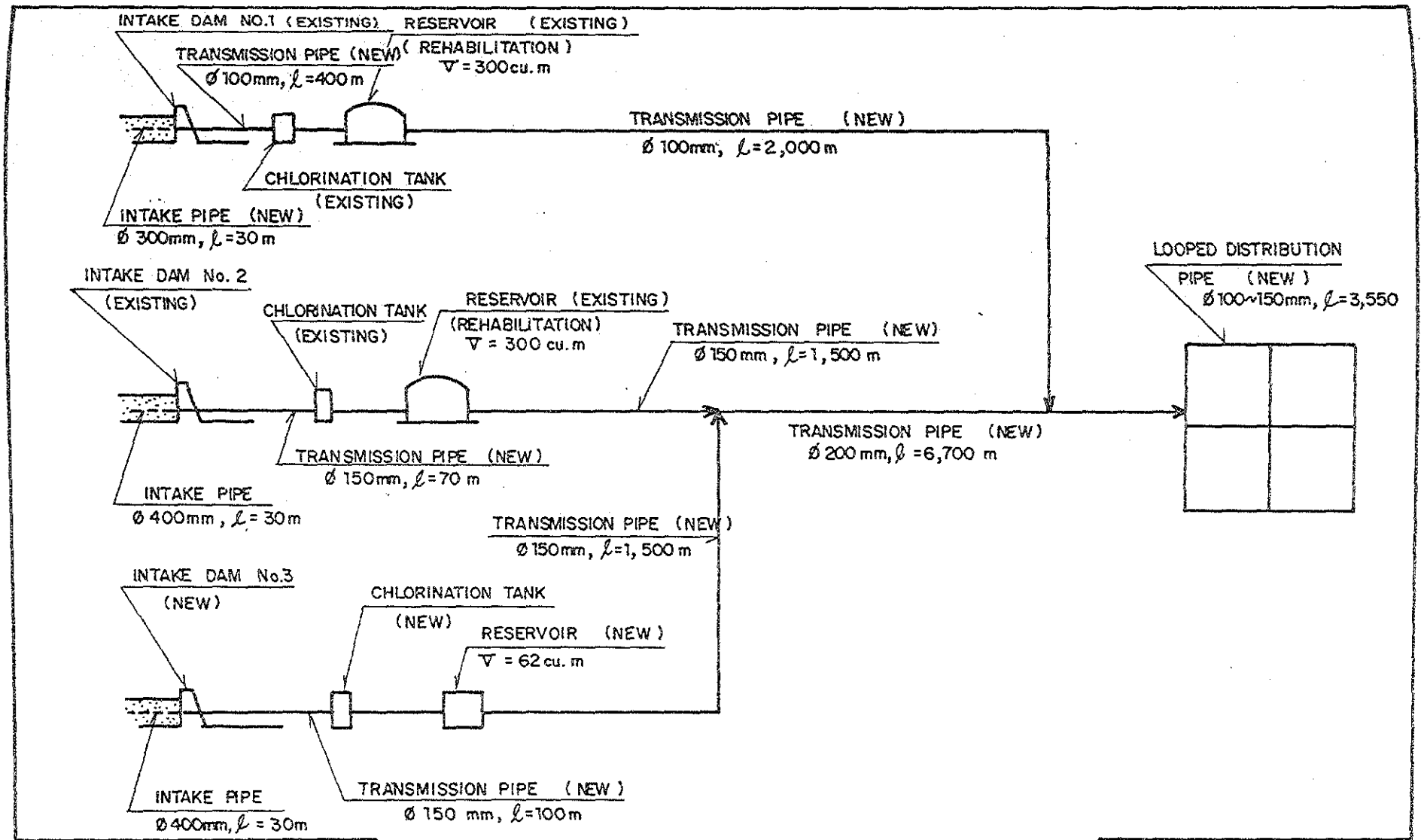


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FIGURE I-6
FLOW DIAGRAM
SARA, ILOILO

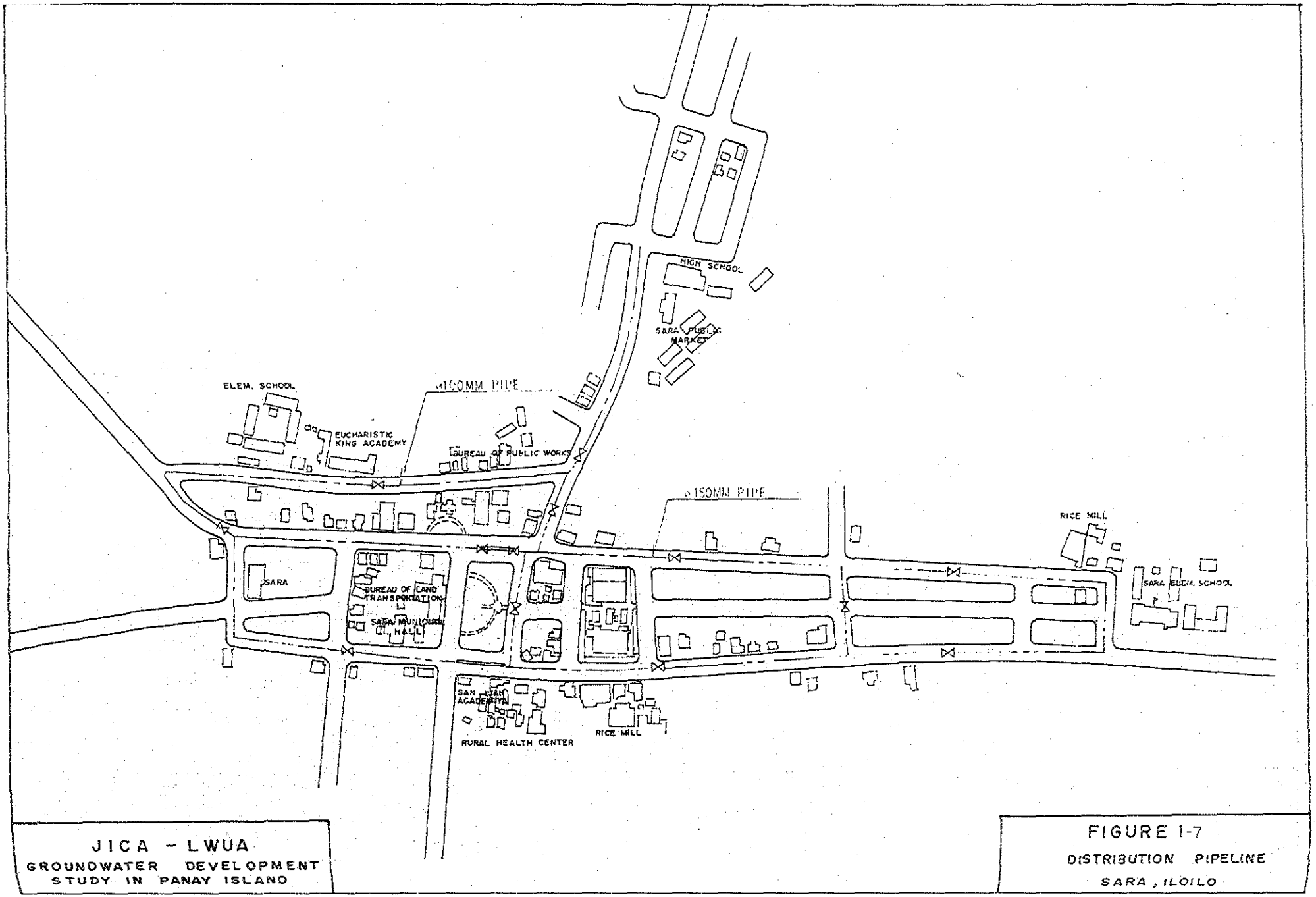

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FIGURE 1-7
DISTRIBUTION PIPELINE
SARA, ILOILO

(3) Distribution Line

Construction of looped distribution main in poblacion area:

ø 100mm pipe - 1,050m
ø 150mm pipe - 2,500m

3.3 Rough Cost Estimate of Major Water Supply Facilities

3.3.1 Unit Construction Cost

Unit construction cost of required facilities is based on the "In-Place Cost of Waterworks Materials" (as of January 1989) of LWUA. Any unit cost not shown in this list is referred to "Unit Price Manual - Water Supply Feasibility Studies" (July 1983) upon consideration of price escalation that 15% per annum up to 1987 and 7% per annum from 1987 as adopted by LWUA.

All construction costs are estimated in Philippine Pesos and the total cost is only converted into U.S. Dollars and Japanese Yen based on the following exchange rate as of September 1989.

U.S. $1.00 = Yen 145.70 = Peso 20.78

Unit costs used in rough cost estimate are attached in Appendix-5.

3.3.2 Rough Cost Estimate

Facility	Cost (Thousand Peso)
Water Source	
Infiltration pipes	
(ø 300 mm pipe, 30 m)	33.6
(ø 400 mm pipe, 30 m + 30 m)	122.4
Intake Dam	
(15 mW x 2.0 mH)	101.4
Transmission Line	
From dams to reservoirs	
(ø 150 mm pipe, 70m + 100m)	107.1
(ø 100 mm pipe, 400 m)	200.0
Rehabilitation of reservoirs	
(300 cu.m x 0.1 x 2 units)	115.8
New chlorination tank	
(7.5 cu.m)	14.5
New installation of reservoir	
(62 cu.m)	119.7
From reservoirs to poblacion	
(ø 100 mm pipe, 2,000 m)	540.0
(ø 150 mm pipe, 3,000 m)	1,620.0
(ø 200 mm pipe, 6,700 m)	5,025.0
Distribution Line	
(ø 100 mm pipe, 1,050 m)	283.5
(ø 150 mm pipe, 2,500 m)	1,350.0
(ø 100 mm value, 4 pcs.)	18.0
(ø 150 mm value, 9 pcs.)	51.3
Total	9,702.3

Total construction cost for improvement of major water supply facilities is estimated at approximately 9.70 million Pesos (68.0 million Yen or 0.47 million U.S. Dollar).

J. LAMBUNAO, ILOILO

J. LAMBUNAO, ILOILO

I. STUDY AREA AND HYDROGEOLOGICAL ANALYSIS

1. Description of the Study Area

1.1 Physical Description

1.1.1 Geographical Location and Area

Lambunao is located on a plateau of about 160-170 meters above sea level, 50 km. from the City of Iloilo. It has a total land area of 24,692 ha. covering 73 barangays. Location map is shown in FIGURE J-1.

1.1.2 Climate

The municipality has pronounced maximum rain period with no distinct dry and wet season. Heavy rains occur in July and August while very dry period takes place from January to May. Average temperature is 27.74^{o}C and average humidity stands at 82.75%.

1.1.3 Terrain/Topography

Lambunao is generally mountainous with 40% of its land area being forest areas, 35% rolling hills and only 25% plain areas.

Terrain falls down to 70 m. to the north and northwest, 100 m. to the south and east.

1.1.4 Soil

The more common soil types within the municipality are Alimodian clay loam (hills), Alimodian soil, undifferentiated (hilly) and Umingan fine sandy loam (hills).

1.1.5 Administrative Composition and Land Use

The municipality is headed by the mayor and Vice Mayor with eight (8) members of the Sangguniang Bayan as the local legislative body. Under the municipality are the barangays, the smallest political subdivision, which are headed by Barangay Captains/Chairmen with the Sanggunian Barangay as the lawmaking body. All these local officials are selected by the people through popular election.

Municipalities are classified according to the annual revenues from taxes. This classification serves as a major indication of the socio-economic situation of the population in

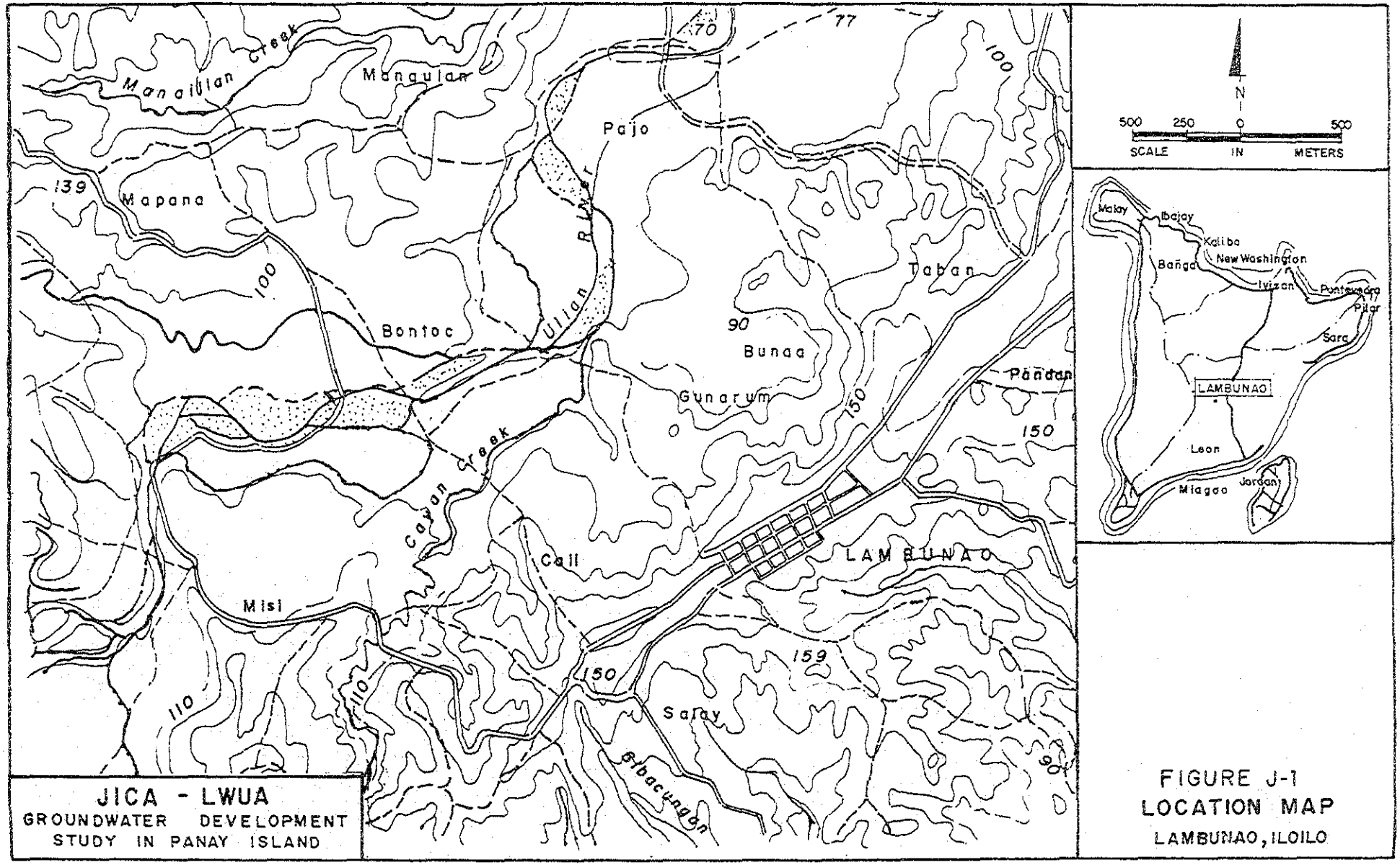

FIGURE J-1
LOCATION MAP
LAMBUNAO, ILOILO

the municipalities. The municipality of Lambunao belongs to the 3rd class. Listed below are the 73 barangays Composing the municipality:

1. Agsurab
2. Agtuman
3. Alugmawa
4. Badiangan
5. Bagongbong
6. Balagiao
7. Banban
8. Bansag
9. Bayoco
10. Binaba-an Armada
11. Binaba-an Labayno
12. Binaba-an Limoso
13. Binaba-an Portigo
14. Binaba-an Tirador
15. Bonbon
16. Bontoc
17. Buri
18. Burirao
19. Buwang
50. Cabatangan
21. Cabugao
22. Cabunlawan
23. Caguisanan
24. Caloy-ahan
25. Caninguan
26. Capangyan
27. Cayan Este
28. Cayan Oeste
29. Corot-on
30. Coto
31. Cubay
32. Cunarum
33. Daanbanwa
34. Gines
35. Hipgos
36. Jayobo
37. Jorog
38. Lanot Grande
39. Lanot Pequeno
40. Legayada
41. Lumanay
42. Madarag
43. Magbato
44. Maite Grande
45. Maite Pequeno
46. Malag-it
47. Manaulan
48. Maribong
49. Marong
50. Misi
51. Natividad
52. Pajo
53. Pandan
54. Panuran
55. Pasig
56. Patag
57. Poblacion Ilawod
58. Poblacion ilaya
59. Poong
60. Pughanan
61. Pungsod
62. Quiling
63. Sagcup
64. San Gregorio
65. Sibacungan
66. Sibaguan
67. Simsiman
68. Supoc
69. Tampucao
70. Tranghawan
71. Tribungan
72. Tuburan
73. Walang

1.1.6 Transportation

Land transportation is the primary means of commutation in the municipality. Prevalent modes of transportation include public utility vehicles (buses, jeeps and tricycles) and private vehicles.

1.1.7 Infrastructure

Of the total 4.403 km. of municipal roads, 63% were asphalted, 32% of gravel surfacing and only 5% were concrete

structure. Barangay roads, on the other hand which total to 59.3 km. were mostly unpaved, of gravel and earth surfacing.

Regarding electrification, only 9.94% of the 7,083 potential consumers covering 9 barangays were energized by ILECO II.

1.2 Population and Living Conditions

1.2.1 Population Trend from the Past

From 1975 to 1980, population grew by 1.40% annually, from 142,385 in 1975 to 45,435 in 1980. The proportion of male to female population is almost similar 1:1.

Total number of households was 7,808 with a population density of 184 per square kilometer and average household size of six. Majority of the population (92.36%) live in the rural areas.

TABLE J-1 Population and Number of Households by Barangay, Lambunao, Iloilo 1980

Barangay	Population	No. of Households
Agsurab	854	139
Agtuman	422	86
Alugmawa	607	105
Badiangan	244	44
Bagongbong	495	82
Balagiao	582	105
Banban	586	109
Bansag	484	69
Bayoco	289	53
Binaba-an Armada	288	51
Binaba-an Labayao	504	89
Binaba-an Limoso	245	44
Binaba-an Portigo	353	63
Binaba-an Tirador	562	97
Bonbon	811	141
Bontoc	365	57
Buri	1,006	161
Burirao	277	46
Buwang	361	67
Cabatangan	775	142
Cabugao	934	158
Cabunlawan	360	63
Caguisanan	945	154
Caloy-ahan	555	93
Caninguan	910	159
Capangyan	407	64
Cayan Este	533	92
Cayan Oeste	673	115

TABLE J-1 Population and Number of Households by Barangay, Lambunao, Iloilo 1980 (Cont'd)

Barangay	Population	No. of Households
Corot-on	170	30
Coto	331	65
Cubay	454	83
Cunarum	555	93
Daanbanwa	598	99
Gines	484	91
Hipgos	550	91
Jayobo	2,135	364
Jorog	344	57
Lanot Grande	344	364
Lanot Pequero	227	57
Legayada	421	65
Lumanay	455	36
Madarag	461	75
Magbato	534	83
Maite Grande	542	94
Maite Pequero	776	90
Malag-it	442	74
Manaulan	522	87
Maribong	2,571	456
Marong	441	81
Misi	622	94
Natividad	308	50
Pajo	868	145
Pandas	542	96
Panuran	1,065	185
Pasig	899	159
Patag	216	41
Poblacion Ilawod	1,782	303
Poblacion Ilaya	1,691	281
Poong	451	75
Pughanan	1,221	214
Pungsod	259	38
Quiling	110	19
Sagcup	392	69
San Gregorio	595	98
Sibacungan	691	119
Sibaguan	352	62
Simsiman	439	87
Supoc	215	33
Tampucao	915	162
Tranghawan	606	111
Tribungan	468	80
Tuburan	565	99
Walang	1,343	223
TOTAL	45,435	7,808

1.2.2 Morbidity/Mortality

The leading causes of morbidity and mortality in the area are parasitism, diarrhea, gastro-entiritis, dysentery and colitis.

Malnutrition is also prevalent in the area. Based on the Operation Timbang conducted in 1983 covering 8,147 preschool children, about 52.23% were suffering from varying degrees of malnutrition; 35.1% from first degree malnutrition, 17.05%, second degree and only .09%, third degree.

1.2.3 Sanitation

Majority of the households in Lambunao (59.73%) used closed pit type of toilet facility followed by open pits (31.77%). Water sealed toilet users accounted for only 6%.

1.2.4 Public Services

There were 8 health centers and stations manned by 2 rural health nurses, 1 dentist, 1 dental aide, 8 midwives, and 3 rural sanitary inspectors. Telecommunication facilities include the postal office and the telegraph service station.

1.3 Economy and Industry

1.3.1 Agriculture

Agriculture is the predominant activity in Lumbanao with rice as the major crop produced. Area planted to rice totaled 6,785 ha., 96% of which are rainfed while production reached 302,289 cavans. Average yield for irrigated areas was 82 cavans per hectare while for rainfed areas, 43 cavans per hectare.

Other crops grown include corn, covering 300 ha. with 30 cavans per hectare average production, coffee, 800 ha. with an average production of 2.22 tons per hectare, and coconut covering 122.46 ha. with an average production of 26 kg. per tree. Total number of farms was 4,624 covering an aggregate area of 12,058 ha.. Average farm size was 2.61 ha..

Livestock and poultry production reached 131,085 heads with chicken comprising 83.75% of total production, hogs (4.81%), carabao (4.12%), goats (3.11%) and cattle (.1%).

1.3.2 Other Industries

There were a total of 342 business establishments operating in Lambunao in 1980. Predominant activities include manufacturing (accounting for 45.91% of total firms), wholesale and

retail trade (36.26%) and community, social and personal services (12.86%).

1.3.3 Municipal Revenue

The municipal revenue generated by the municipality mostly from real property and business taxes amounted to ₱1.809 M in 1986. to ₱1.809 M in 1986.

2. Analysis of Potential Water Source

2.1 Topography and Geology

The municipality of Lambunao is situated on the plateau at about 160 to 170 m above sea level. The Ulian River in the study area flows from southwest to northeast and forms the terraces in several stages on both sides of the river.

The geology of the study area, comprises Ulian Formation, which belongs to late Pliocene, Tertiary and terrace deposits of diluvium and alluvial deposits. Geological map is shown in FIGURE J-2.

Ulian Formation (Pliocene, Tertiary)

This unit covers the west and northeast margins of Panay Central Plain forming low rolling hills. Its type locality is along Ulian River.

Ulian Formation, the basement of the study area, consists of considerably thick siltstone with occasional brownish finegrained sandy layers. Due to its softness and massiveness, the strike and the dip of Ulian Formation cannot be easily measured. Generally, its strike is N10 - 20 E and the dip is approximately horizontal.

Terrace Deposits (Diluvium, Quaternary)

These units formed in several stages are developed on both sides of the Ulian River and cover the base Ulian Formation. The thickness of the terrace deposits is approximately 5 m, and the major part consists of gravels of chart, limestone, graywacke, andesite, diorite and etc. These rocks are main components of Antique Range.

Alluvial Deposits (Quaternary)

This unit is distributed along the Ulian River. It comprises sand, clay and gravel of said rocks.

2.2 Existing Water Source

Surface Water

Although the Ulian River with a drainage area of about 115 sq.km flows about 1.3 km far from the town proper, only the people living adjacent to the river utilize the river water because of a great variance in the elevation which is approximately 90 m.

Flow quantity of Ulian River near the Poblacion is fairly enough even during the dry season.

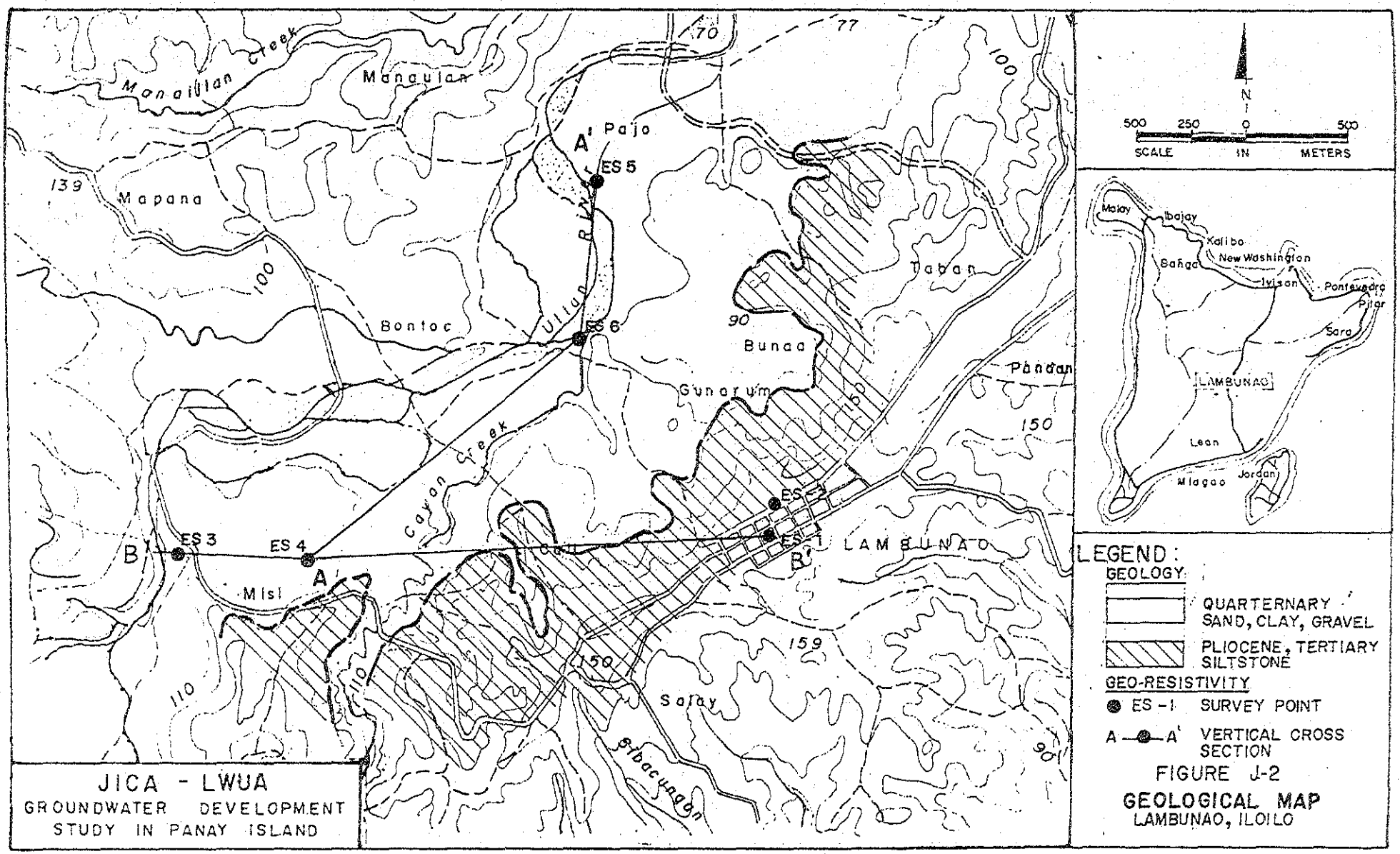

FIGURE J-2

GEOLOGICAL MAP
LAMBUNAO, ILOILO

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STUDY IN PANAY ISLAND

The flow rate measurement was conducted at the Ulian River using a current meter. Based on the result, the total amount of river flow was calculated at 65,000 cu.m/day.

Assuming that the annual run-off is 1272 mm which is adopted in the report by the National Water Resource Council, the annual run-off of the Ulian River is estimated at 146 million cu.m.

The measured flow amount is therefore equivalent to about 1/6 of estimated average daily discharge of 400,000 cu.m/day.

On the other hand, the flow amount in rainy season was measured at 430,000 cu.m/day last October 1, 1988.

Wells

The residents of the Poblacion of Lambunao depend on shallow/dug wells for their drinking water needs. Below the terrace, there are shallow wells with pitcher pump, while most of the wells on the highest terrace, where the town proper is located, are dug wells obtaining water from the terrace deposits.

Well inventory survey was conducted on 4 wells within the Poblacion and at the paddy field on the way to the river about 3 km away from the Poblacion, as shown in FIGURE J-3.

Surveyed data are presented in TABLE J-2.

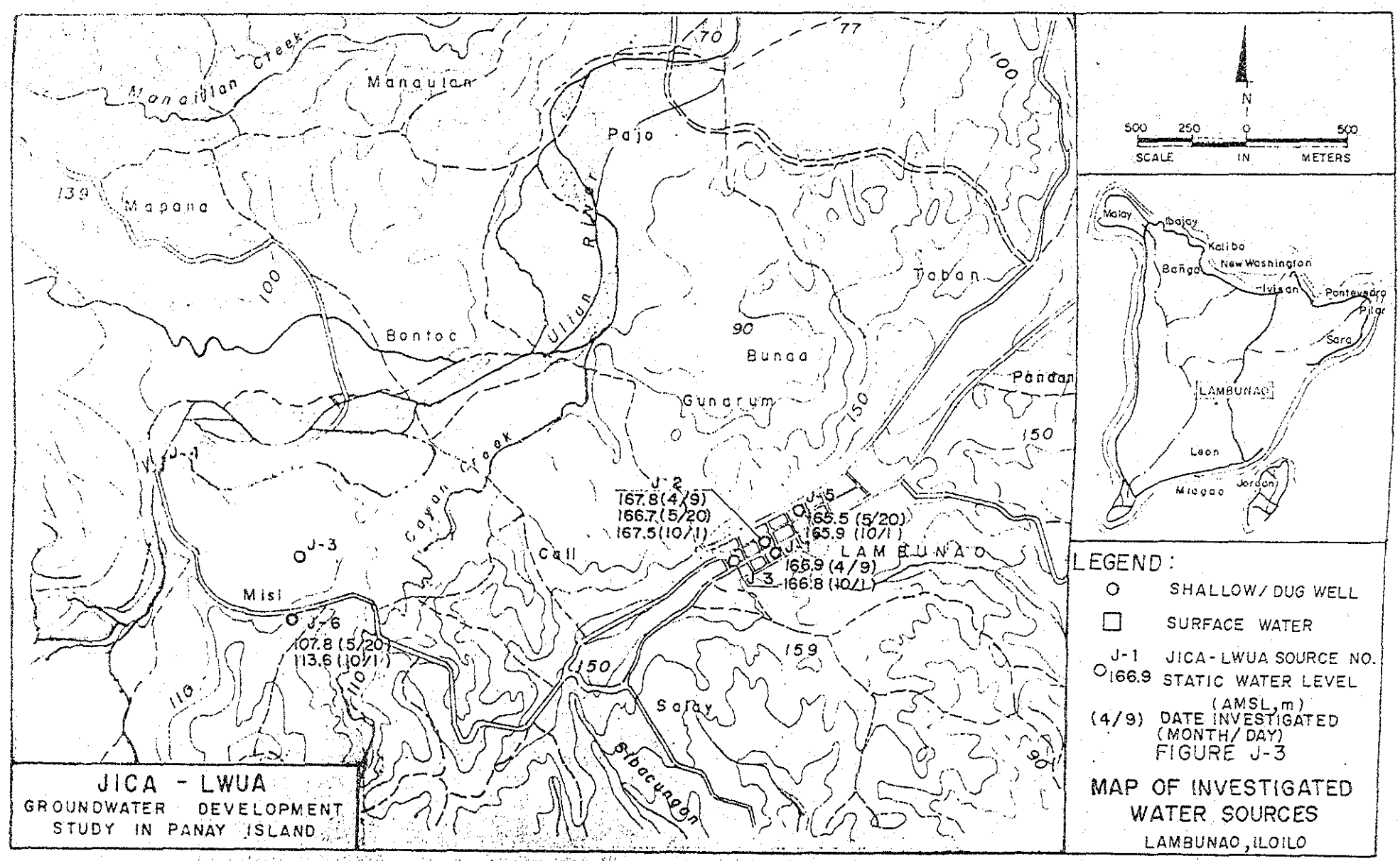

Manaulan Creek
Manaulan
Pajo
Mapana
Ulian River
Tabon
Bontoc
Bunga
Gunarum
Pandan
Cayon Creek
Call
LAMBUNAO
Misi
Saray
Gibacungan
J-1
J-2
167.8(4/9)
166.7(5/20)
167.5(10/1)
J-3
J-4
165.9 (4/9)
166.8 (10/1)
J-5
165.5 (5/20)
165.9 (10/1)
J-6
107.8 (5/20)
113.6 (10/1)
N
500 250 0 500
SCALE IN METERS
Malay
Bajay
Kalibo
New Washington
Banga
Ivisan
Pontevedra
Pilar
Sara
LAMBUNAO
Leon
Miagao
Jordan
LEGEND :
SHALLOW/ DUG WELL
SURFACE WATER
J-1 JICA-LWUA SOURCE NO.
166.9 STATIC WATER LEVEL (AMSL, m)
(4/9) DATE INVESTIGATED (MONTH/ DAY)
FIGURE J-3
MAP OF INVESTIGATED WATER SOURCES
LAMBUNAO, ILOILO
JICA - LWUA
GROUNDWATER DEVELOPMENT STUDY IN PANAY ISLAND

TABLE J-2 Well Data Summary

JICA-LWUA Source Number	Well Depth (M)	Ground Level (MAMSL)	Static Water Level: Dry Season (April 9, May 20) (MBGL)	Dry Season (MAMSL)*	Rainy Season (October 1) (MBGL)	Rainy Season (MAMSL)
J-1 Dug well at Mun. Hall	10.98	169.3	-2.39 (April 9)	166.9	-2.45	166.8
J-2 Dug well at the Plaza	4.53	168.8	-1.00 (April 9)	167.8	-1.32	167.5
J-2	4.53	168.8 (May 20)	-2.08	166.7	-	-
J-5 Dug well at ES-2	7.15	167.0	-1.45 (May 20)	165.5	-1.05	165.9
J-6 Dug well at S-4	7.54	114.0	-6.18 (May 20)	107.8	-0.36	113.6

* Estimated based on the 1/50,000 scale topograpical map and the supplemental topographic survey.

Survey results are summarized as follows:

i) Shallow/dug wells are found only in the town proper and their specific capacity appears to be very low. This conjecture was arrived at due to the large drawdown found at the Well J-1 everytime the small pump is operated.

ii) The groundwater table in the town proper, which is situated on the highest terrace of the Ulian River, is about 168 m above mean sea level and 1 to 2 m below the ground level.

iii) At the lower terrace, the groundwater table is low compared to the one on the higher terrace. However, it is still higher than the elevation of the river.

iv) Groundwater level in the town proper is almost stable both in dry and rainy season, in spite of much rising up in the lower terrace.

2.3 Survey for Potential Water Source

2.3.1 Evaluation of Georesistivity Survey

The geology of Lambunao consists of terrace deposits and flood plain with the Ulian Formation as basement. In this regard, the georesistivity survey was focused on the exploration of the possible presence of aquifer in the Ulian Formation and the alluvial deposit. A total of six (6) survey points; namely ES-1 to ES-6, are indicated in FIGURE J-2.

Field activities are summarized below:

Date	:	April 7 to 9, 1988
No. of Survey Points	:	Six (6) points
Type of Survey	:	Vertical Sounding
Configuration	:	Wenner Method
Sounding Depth	:	100 to 150 meters

The results of the ρ-a curve analysis is shown in TABLE J-3 and was processed to develop the georesistivity section as shown in FIGUREs J-4 and J-5.

As of the present, the following interpretations and assessments have been performed:

1) The survey area was divided into 3 to 5 resistivity layers with values ranging from 1 to 180 ohm.m.

2) The thickness of the terrace is about 1 to 4 meters with resistivity of 5 to 60 ohm.m which classified it as a poor aquifer.

3) The flood plain of the Ulian River (ES-5) shows 48 to 180 ohm.m of resistivity and is expected to have an underflow water with the thickness of about 3 to 4 m with the depth of 4 to 5 mbgl.

4) The Ulian Formation shows low resistivity ranging from 1 to 15 ohm.m as clayey to silty facies disproving the presence of an aquifer.

2.3.2 Other Water Source

Although the urban area of Lambunao, for the time being, has no other source than the infiltrated water seeping from the Ulian River for its water supply system, but Lake Tinagon Dagat (Hidden Lake) will be a future water source for water supply together with a communal irrigation project to cover a total potential area of more than 1,200 ha within at least 16 barangays of Lambunao.

TABLE J-3 DEDUCTED VALUES OF GEORESISTIVITY READING INTERPRETATION

LAMBUNAO, ILOILO

SURVEY POINT	ELEVATION (M)	TOPOGRAPHY	RESISTIVITY LAYER 1		2		3		4		5	
			ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m
ES-1	170	higher terrace	12	0.7	60	2.2	7	30	3	56	8	
ES-2	168	higher terrace	60	0.5	15	3.8	4	34	2			
ES-3	105	flood plain	19	0.9	48	5.4	1	21	15			
ES-4	108	lower terrace	5	1.0	11	20	4					
ES-5	75	flood plain	45	1.0	180	4.2	<2					
ES-6	80	flood plain	7	1.0	29	11	3					

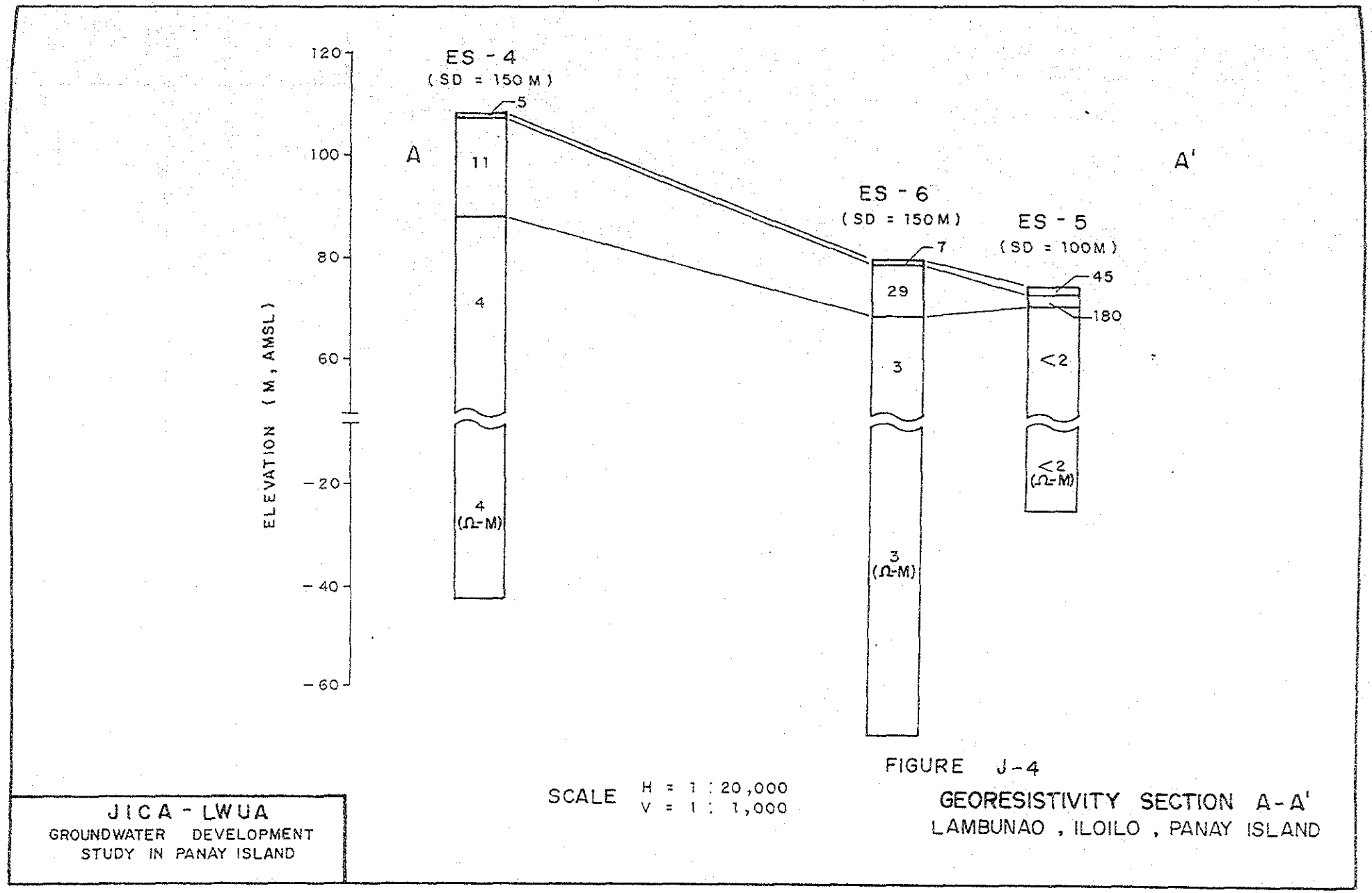


FIGURE J-4

GEORESISTIVITY SECTION A-A'
LAMBUNAO , ILOILO , PANAY ISLAND

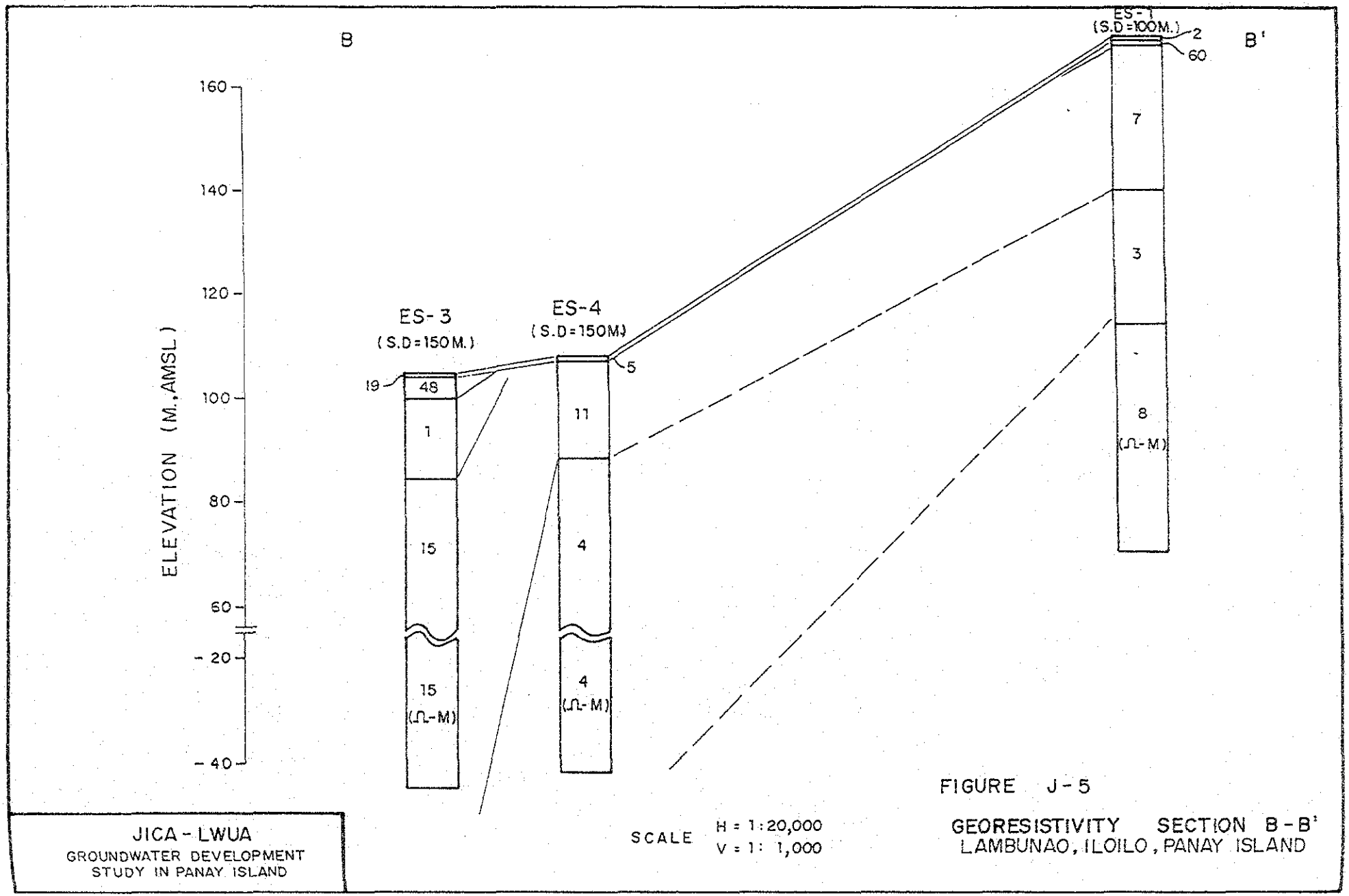


FIGURE J - 5

SCALE H = 1:20,000
V = 1: 1,000

GEORESISTIVITY SECTION B - B'
LAMBUNAO, ILOILO, PANAY ISLAND

JICA - LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND

Lake Tinagong Dagat is located in Cabatangan, the western most barangay of Lambunao, Iloilo, near the Iloilo-Antique provincial boundary. The lake is accessible from Lambunao poblacion through a 16 km provincial road going to barangay Jayubo where the Western Visayas State University College of Agriculture is located. The lake is situated on a crater plateau surrounded by cordillera ranges near the boundary of the provinces of Iloilo and Antique with an elevation of about 730 meters above sea level. The water of the lake has surface area of not less than 50,000 m^2. The outlet of the lake is oriented towards the northeast where its overflow water plunges off to a wall of rock approximately 250 m in height and flows toward Ulian River. The trail route from barangay Cabatangan proper to the lake leads towards a clearing devoid of perennial grasses and trees at the northern portion of the lake vicinity. At least three house are situated within this portion.

The following information were already obtained regarding the lake's characteristics:

1) The water level of the lake does not significantly subside even during summer and long drought periods. It maintains its level while the pressurized springs located along the lake's edge remains flowing.

2) Occasional change in color of water from normal to reddish which usually occur within the months of June and July.

3) The water that discharges from the lake sometimes reach about 0.6 m in depth most especially during typhoons. The water of the lake in those instances, however, remain relatively clear.

4) Alleged sounding by an American visitor to determine the depth of the lake whereby about 120 m chordline was utilized. The chord was broken before it reached the bottom.

On June 19, 1987, the Municipal Council of Lambunao, Iloilo passed Resolution petitioning for assistance from government agencies concerned for the development of a domestic water system and an irrigation system within the municipality. The said resolution proposed for the utilization of Ulian River as primary source of water.

Finally the proposal was referred to the NIA, Iloilo Provincial Irrigation office for pre-feasibility study, survey and investigation under the project name of Ulian Communal Irrigation Project (Ulian CIP). The domestic water system requested by the municipality was correspondingly referred to the Local Water Utilities Administration (LWUA).

NIA's concerns basically focused on the proposed project's water source-Ulian River. Because the Ulian River is a major tributary of Jalaur River, main water source of an existing national irrigation system-Jalaur River Irrigation System (JBIS).

The Jalaur River Multipurpose Project (JRMP) is a scheme, aiming at a year-round water supply for irrigation, power generation and municipal and industrial use by utilizing the water of the Jalaur river. At present, four irrigation systems with a total irrigation area of 30,200 ha are being operated in the project area by NIA with a financial assistance of the World Bank. This existing scheme is a run-of-river irrigation. The irrigation water is taken by the existing four diversion dams. This scheme directed toward a wet-season irrigation is referred to as the Stage I of JRMP. The service area is shown in the FIGURE J-6.

The Stage II of JRMP envisions to provide a year-round irrigation to an area of 36,000 ha including Stage I area of 30,200 ha, annual energy generation (installed capacity: 20,000 kW) and water supply for domestic and industrial use by a construction of a 145m-arch dam having an effective storage capacity of 337 million cu.m.

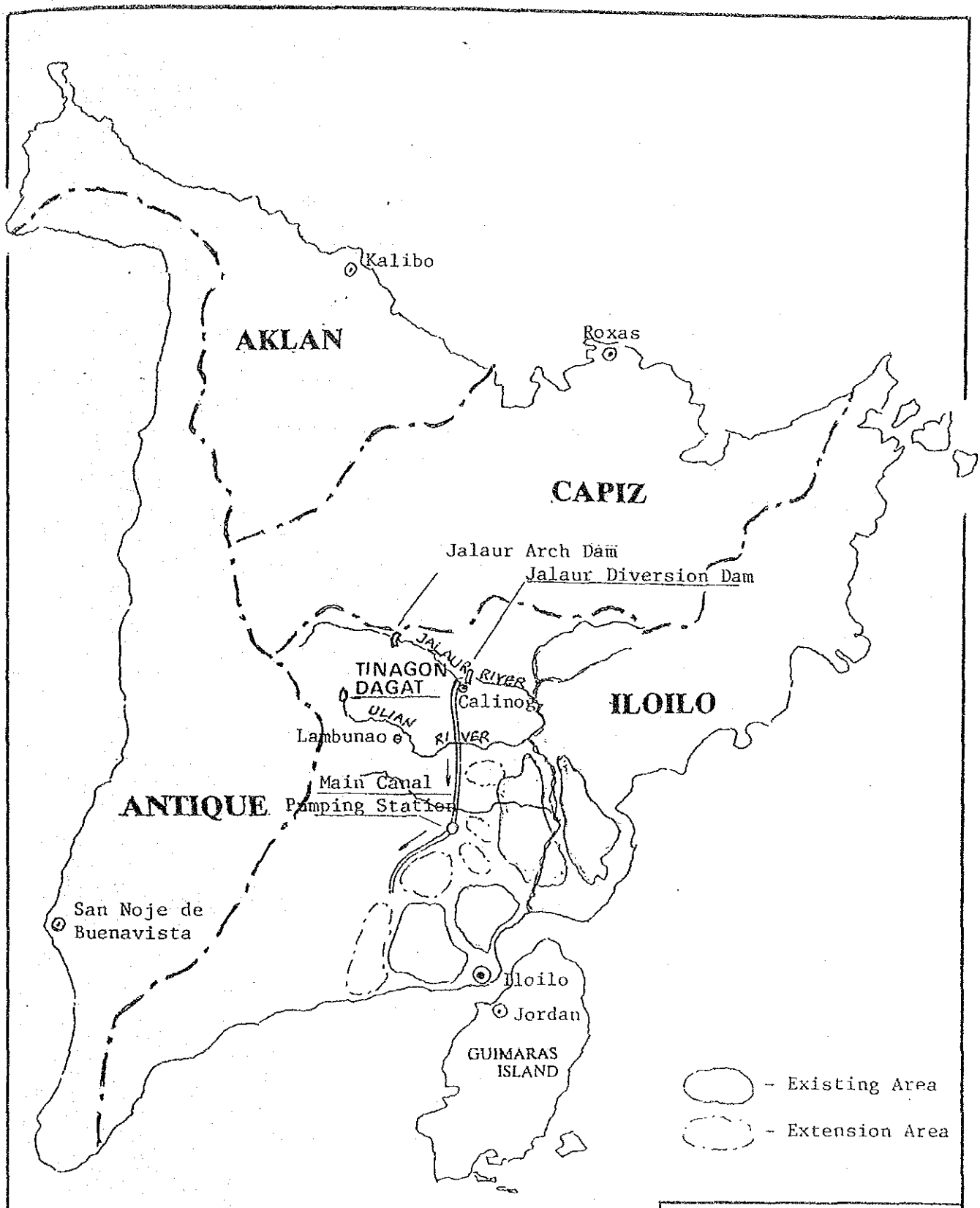
Considering that Ulian River is a major tributary of Jalaur River, the construction of Ulian CTP would significantly reduce the water supply for JRIS which has a vast service area down stream. These circumstance posed a dilemma in development priorities, that on one hand the agency wishes to realize Ulian CIP, and on the other hand is obliged to protect the existing beneficiaries of JRIS.

After through deliberations on the matter, the NIA Regional Office presented a position of compromise which suggested the following options:

1) Deferment of Ulian CIP until realization of the Jalaur River Multi-Purpose Project, Stage II. This said project would stabilize the water supply for JRIS even with the construction of Ulian CIP. The project, however, is still pending final approval and funding allocation at the top-government level.

2) Push through with construction of Ulian CIP but with the identification and utilization of additional supplementary water sources sufficient enough not to jeopardize the existing service area or JRIS.

An Geotechnical Investigation of Lake Tinagong Dagat conducted on December 2 to 4, 1987 was jointly undertaken by the Municipality of Lambunao, Iloilo, through the Municipal Agriculture and Fisheries Council (MAFC) and the National



JICA - LWUA
GROUNDWATER DEVELOPMENT STUDY IN PANAY ISLAND

FIGURE J - 6
TINAGON DAGAT AND JALAUR RIVER MULTIPURPOSE PROJECT

Irrigation Administration, Region VI and the Iloilo Provincial Irrigation Office.

Anyhow, various issues and problems have to be studied and resolved, for instance, the construction of a road link to Tinagon Dagat to accommodate delivery of construction materials to the jobsite, if ever found that such a development is feasible prior to make a plan to top Tinagon Dagat Lake as a potential water source for the municipal water supply of Lambunao.

2.4 Water Quality Analysis

Five (5) existing/potential water sources were examined during the field survey and the data of one existing public well was collected. Three (3) water samples were also collected for laboratory analysis at LWUA. Survey points are shown in FIGURE J-3 and results of field analysis are presented in TABLE J-4.

TABLE J-4 Water Quality Analysis Results

Sample	WT (°C)	pH (-)	EC (μS/cm)	T-Fe (ppm)	Mn (ppm)	NH_4-N (ppm)
Dry Season						
J-1 Dug Well, Mun. Hall	28.2	7.0	550	nil	nil	nil
J-2 Dug Well, Plaza	28.2	6.8	820	nil	nil	nil
J-3 Public Well, (Const'd on Jan.26/87)	28.7	6.8	290	0.1	nil	nil
J-4 Ulian River	32.1	8.6	3,680	nil	nil	nil
Rainy Season						
J-1 Dug Well, Mun. Hall	28.3	7.0	337	nil	-	nil
J-2 Dug Well, Plaza	29.7	6.9	540	Tr.	-	0.4
J-4 Ulian River	26.5	8.4	344	nil	-	nil
J-5 Dug Well, ES-2	27.2	7.4	700	-	-	-
J-6 Dug Well, ES-4	28.4	6.8	427	Tr.	-	nil

Existing wells show normal groundwater characteristics, while surface water in the Ulian River shows high pH values as alkaline conditions.

Following are the results of laboratory analysis.

Sample	Ulian River		Dug Well (J-1)	
Date of Sampling	10.01.88		5.20.88	10.01.88
Turbidity (FTU)	7		2	0.7
Color (UNIT)	15	(Apparent)	nil	nil
TDS (mg/l)	255		371	340
pH (-)	7.2		7.5	7.0
EC (µS/cm)	435		580	550
Alkalinity as $CaCO_3$ (mg/l)	162		180	190
Hardness as $CaCO_3$ (mg/l)	160		262	226
Major Cations (meq/l)				
Sodium	1.1		0.7	0.9
Potassium	0.05		0.05	0.05
Calcium	1.9		2.80	2.4
Magnesium	1.3		2.4	2.2
Total	4.35		5.95	5.55
Major Anions (meq/l)				
Carbonate	0		0	0
Bicarbonate	3.2		3.6	3.4
Chloride	0.5		1.5	1.3
Sulfate	0.6		0.8	0.7
Total	4.3		5.9	5.4

Based on the laboratory analysis, the surface water of Ulian River does not show high pH. The reason of difference on pH value among field analysis and laboratory analysis may be assumed that the gaseous constituents was lost during transportation/preservation of collected water sample and/or the error of analytical instrument.

Both the groundwater at Dug Well (J-1) and the surface water in Ulian River show the Carbonate-hardness type of geochemical characteristics and each chemical constituent of water is within the normal range.

3. Conclusion and Recommendation

Because of the thickness of impermeable silty layers in Ulian Formation in basement of the study area, the presence of water-bearing stratum is presumably very low. Therefore, it is very difficult to develop groundwater by deep wells.

Abstracting the riverbed water of Ulian River is the most practical and reliable way to secure a source of water supply. Besides, the construction cost of water supply facilities and pumping cost should be examined carefully because of large pump head requirement.

II. CONCEPTUAL WATER SUPPLY SYSTEM

1. Existing Water Supply Conditions

1.1 Water Use Condition

There exists no water supply system in this town, although the Water District of Lambunao was legally formed and filed with the LWUA in May 1982. Several years have passed, yet no improvement was made to make the Water District operational. In April 1988, the LWUA dis patched a water district formation officer to Lambunao to promote the reconstitution of members of the Board of Directors.

Two sets of deep wells and elevated tanks were constructed to facilitate the Level II system. One is located in the premises of the municipal hall and supplies the municipal hall, and the Philippine Constabulary building adjacent to the municipal hall. The one is located in the market area, however, was non-operational due to the breakdown of its pumping facilities. Thus, the residents in the Poblacion depend mainly on dug wells publicly or privately-owned for their water needs. Some also make use of stored rainwater during dry season.

As a whole, the present water supply condition is far from the desirable level and urgent development of potable water supply system is indispensable.

1.2 Existing Water Supply System and Problems Encountered

The deep well, which is located on the premises of the municipal hall is 15 m deep. Likewise, most of the privately-owned shallow wells have nearly the same depth (15 m). The elevated tank is square-shaped, made of concrete, with an elevation of 6 m above ground level and has a capacity of approximately 8 cu.m. Another tank, which is located on the market area has the same dimensions. The latter used to supply water to the market area through communal faucets formerly, but most of these communal faucets and pipelines had been broken down or removed, making it hard to rehabilitate or reuse them at once.

2. Water Demand Projection

2.1 Criteria

The absence of an operational piped water supply system and poor water supply condition make it difficult to assess the per capita unit water demand. Per capita unit water consumption is, therefore, assumed to be 90 lpcd in 1988 based on the LWUA Methodology Manual and the experience in similar water supply feasibility study, "Municipal Water Supply Project," conducted by JICA in 1987.

Design unit water consumption by consumer type is estimated in accordance with the said Manual, as follows:

- Domestic per capita unit water consumption is estimated at 100 lpcd in the year 1995 with an annual increase ratio of 2% from 1988 to 1990 and 1.5% from 1990 to 1995 against 90 lpcd in 1988.

- Commercial unit water consumption is estimated at 1.4 cu.m/connection/day with its connection density ratio of 1.2 per 100 inhabitants.

- Institutional unit water consumption in 1995 is estimated at 5.2 cu.m/connection/day with its connection density ratio of 1.0 per 2,000 inhabitants in the service area.

The ratio of unaccounted-for water is considered to be 25% of the total distributed amount, which is the standard ratio for new pipelines as adopted by LWUA Methodlogy Manual.

2.2 Areas to be Served

The target year for water supply planning is set for the year 1995 for the purpose of intermediate water supply development/improvement.

With regard to the planned water supply service area of the said target year, priority shall be given to the densely populated area which is the poblacion area. Barangays Ilawod and Ilaya are likewise designated as target area and inclusion of other barangays shall be considered upon accomplishment of the intermediate water supply development.

2.3 Population Projection

The National Economic and Development Authority (NEDA) has projected the municipal population in each year from 1981 to 2000 based on population census it conducted in 1980. The municipal government, on the other hand, does not have any population data, except the result of the said census. Therefore, the NEDA population census is adopted as principal data for population projection in the planned service area.

Percentage share of barangay population to the municipal population in 1995 is to be the same as that of the 1980 census result.

Result of population projection is shown in TABLE J-5.

TABLE J-5 Population Projection of Service Area

Year	Municipality	Service Area (Poblacion)		
		Ilawod	Ilaya	Total
1980	45,435	1,782	1,691	3,473
1985	49,770	2,040	1,940	3,980
1990	53,690	2,200	2,090	4,290
1995	56,830	2,330	2,210	4,540

The water supply service ratio is assumed to be 80% considering habitation pattern in the subject area. Average number of persons per household is assumed to be 5.00 based on the standard figure adopted by NEDA.

2.4 Water Demand Projection

The future water consumption in 1995 is estimated based on the aforementioned planned service population and design unit water consumption by consumer type.

The estimated number of connection and future water consumption are shown in TABLE J-6.

TABLE J-6 Water Consumption in 1995

Service Area	Poblacion		
	Ilawod	Ilaya	Total
Served Population	1,860	1,770	3,630
No. of Connection			
Domestic	372	354	726
Commercial	22	21	43
Institutional	1	1	2
Total	395	376	771
Water Consumption (cu.m/day)			
Domestic	186	177	363
Commercial	31	29	60
Institutional	5	5	10
Total	222	211	433
Unaccounted-for Water	74	70	144
TOTAL	296	281	577

The ratio of the daily maximum water demand to the daily average water demand is determined in relation to the planned service population based on the LWUA Methodology Manual as shown in TABLE J-7.

TABLE J-7 Demand Variation Factor for Daily Maximum Water Demand

Service Population	Ratio (Daily Max./Daily Ave.)
Less than 30,000	1.30 : 1
30,000 to 200,000	1.25 : 1
Over 20,000	1.20 : 1

The estimated daily maximum water demand is shown in TABLE J-8.

TABLE J-8 Daily Maximum Water Demand

Service Area	Water Demand (cu.m/day)
Ilawod	385
Ilaya	365
Total	750

The peak hour water demand is estimated in pro- portion to the daily maximum water demand and service population in accordance with the LWUA Methodology Manual as shown below:

$$C = (\text{Peak Hour Demand} \times 24)/(\text{Daily Maximum Demand})$$

$$= 2.2 - 0.3 \times \log (\text{Service Population}/1{,}000)$$

The ratio of peak hour demand in the year 1995 is calculated at 2.03 and the peak hour water demand is estimated at 1,520 cu.m/day.

3. Proposed Water Supply Facilities

3.1 Basic Approach for Water Supply Improvement

3.1.1 Conditions and Constraints

The conceptual plan for water supply improvement is focused on major water supply facilities, such as water source, main transmission and distribution pipelines, and reservoir. Branch lines, service connections and fire hydrants are likewise excluded from conceptual planning. However, following conditions are taken into account as much as possible:

(1) Low cost in construction, operation and maintenance,
(2)Seasonal fluctuation of source capacity will not seriously affect stable water supply,
(3)Water source will be located within the administrative boundary of respective municipality.

3.1.2 Water Source Development

Based on the evaluation and analysis of field survey results including georesistivity survey, it is concluded that groundwater resource in the poblacion area and its vicinity is quite scarce and not favorable for the use in water supply development. Due to this hydrogeological constraint, the utilization of river bed water in Ulian River is considered most appropriate in view of quality and quantity as well as reasonable distance from the poblacion area.

3.1.3 Transmission and Distribution Facilities

Due to absence of water supply system in the poblacion area, all the required facilities for water transmission and distribution shall be newly constructed.

The water will be transmitted from intake pump station to poblacion area. However, due to difference of ground elevation of about 85 m, direct pumping will require a total pumping head of about 110 m with a special type high tensile pipe material. In this regard, an intermediate reservoir and booster pump station will be planned at the middle of transmission line. Pumped water will be distributed through the elevated water tank since there is no favorable place for ground reservoir to distribute water by gravity flow.

3.2 Plan for Improvement of Water Supply Facilities

3.2.1 Water Source Facility

Infiltration gallery with intake pump station will be constructed at the right bank of Ulian River which is approximately 1.0 km northwest of the poblacion area. This water

source facility will have a capacity to meet with the planed daily maximum water demand in 1995 (750 cu.m/day).

3.2.2 Transmission Facility

Transmission main will be installed from intake pump station to elevated water tank in poblacion area via intermediate reservoir and booster pump station.

3.2.3 Distribution Facility

An intermediate ground reservoir with an effective storage volume of 108 cu.m will be constructed on the uphill at an elevation of GL+123 m. Chlorination facility will be installed at this reservoir.

An elevated water tank with an effective storage volume of 85 cu.m will be constructed in the plaza of poblacion at en elevation of GL+165 m. The Low water level will be GL+175 m and the total height will be approximately 14 m.

The total storage volume of these reservoirs is equivalent to 4 hours of the planned daily maximum water demand.

Distribution main will be installed to form a looped line in the poblacion area and have a flow capacity to meet with the planned hourly maximum water demand.

3.2.4 Required Water Supply Facilities

Location of major water supply facilities is shown in FIGURE J-7, flow diagram of facilities in FIGURE J-8 and detail of distribution pipeline in proposed service area in FIGURE J-9.

Size and quantity of required facilities are listed below:

(1) Water Source Facility

Infiltration gallery:
RC, ø 600 mm, 200 m, EL+80.0 m

Intake pumping station: RC,
Pump-ø 100 mm x 0.8 cu.m/min x 55 mH x 15 kW, 2 units

Chlorination Tank:
RC, 1.5 mW x 2.5 m x 2.0 mH, 1 unit

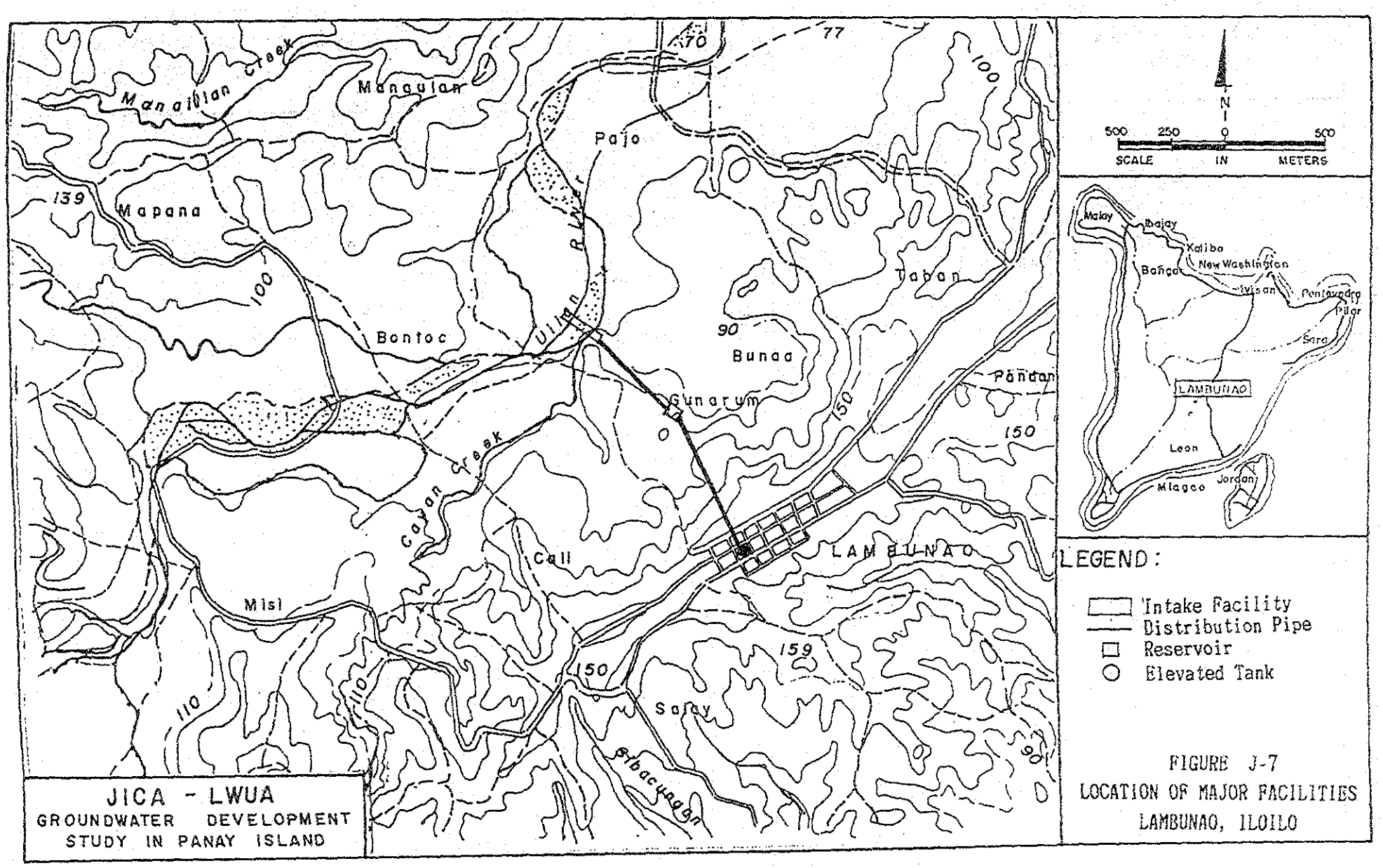


FIGURE J-7
LOCATION OF MAJOR FACILITIES
LAMBUNAO, ILOILO

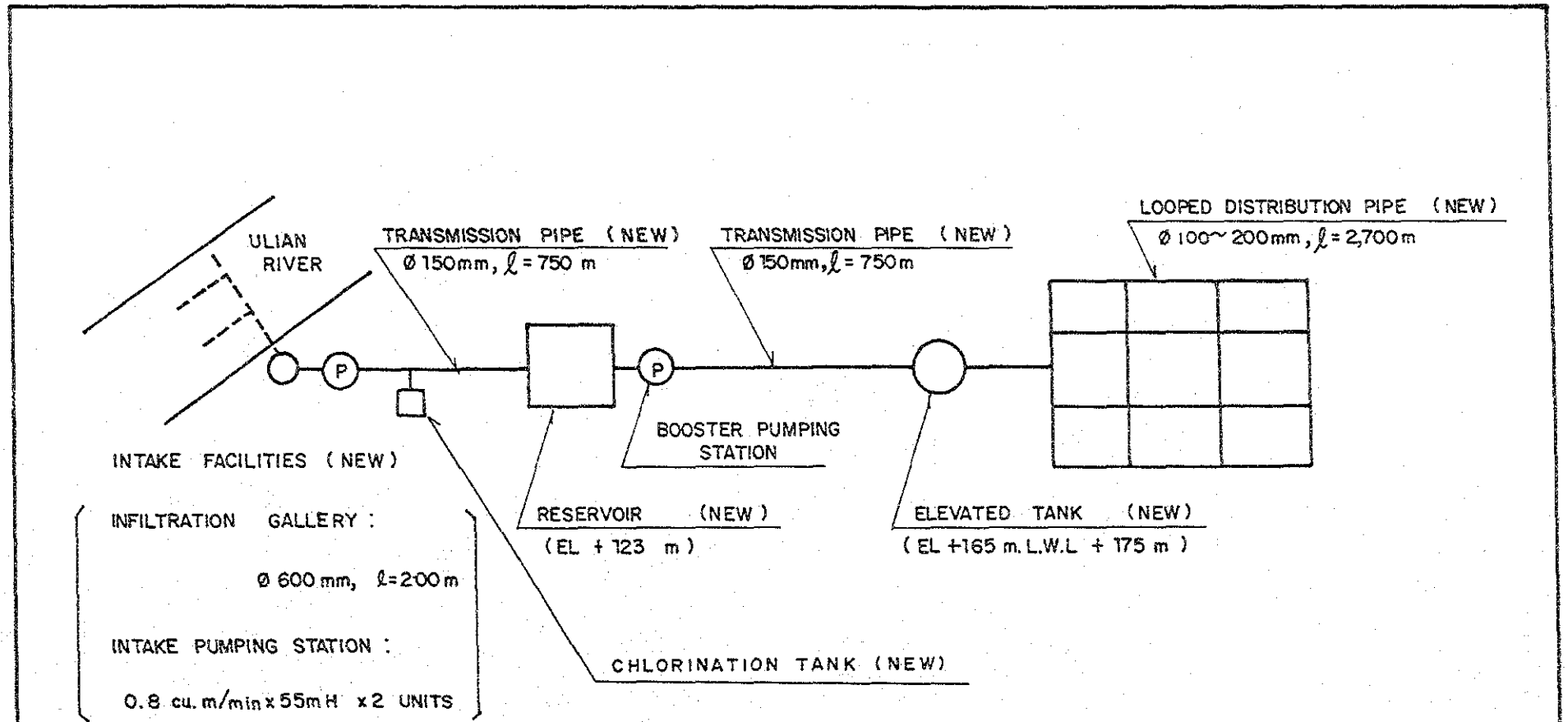


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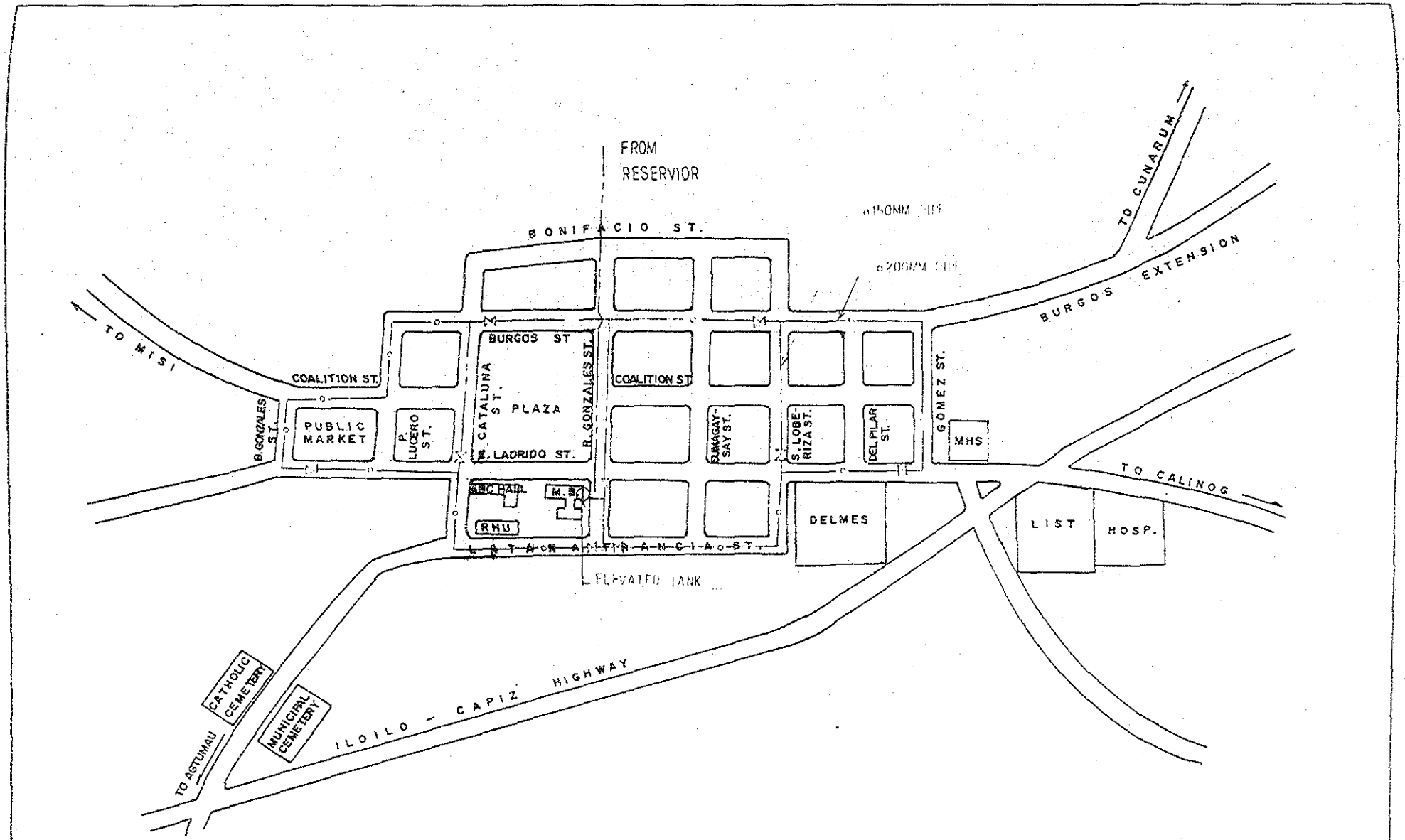
FIGURE J-8
FLOW DIAGRAM
LAMBUNAO, ILOILO



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GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND

FIGURE J-9
DISTRIBUTION PIPELINE
LAMBUNAO , ILOILO

(2) Transmission Facility

Transmission main:
ø 150 mm GI pipe, 1,500 m

Intermediate Reservoir:
RC, 6.0 mW x 6.0 mL x 3.0 mH x 108 cu.m,
EL+123 m, 1 unit

Booster pumping station: RC
Pump-ø100 mm x 0.8 cu.m/min x 55 mH x 15 kW, 2 units

(3) Distribution Facility

Elevated tank:
RC, ø 6.0 m x 3.0 m, 13 mH, 85 cu.m, 1 unit

Distribution main:
ø 150 mm pipe, 400 m
ø 200 mm pipe, 2,300 m

3.3 Rough Cost Estimate of Major Water Supply Facilities

3.3.1 Unit Construction Cost

Unit construction cost of required facilities is based on the "In-Place Cost of Waterworks Materials" (as of January 1989) of LWUA. Any unit cost not shown in this list is referred to "Unit Price Manual - Water Supply Feasibility Studies" (July 1983) upon consideration of price escalation that 15% per annum upto 1987 and 7% per annum from 1987 as adopted by LWUA.

All construction costs are estimated in Philippine Pesos and the total cost is only converted into U.S. Dollars and Japanese Yen based on the following exchange rate as of September 1989.

U.S. $1.00 = Yen 145.70 = Peso 20.78

Unit costs used in rough cost estimate are attached in Appendix-5.

3.3.2 Rough Cost Estimate

Facility	Cost (Thousand Peso)
Water Source Facility	
Infiltration gallery	
(RC, ø 600 mm, 200 m)	400.0
Intake pump station	
(RC, 0.8 cu.m/min, 55 mH, 15 kW, 2 units)	1,057.0
Chlorination tank	
(RC, 7.5 cu.m, 1 unit)	14.5
Transmission Facility	
Transmission main	
(ø 150 mm, 1,500 m)	945.0
Reservoir	
(RC, 108 cu.m, 1 unit)	208.4
Booster pump station	
(RC, 0.8 cu.m/min, 55 mH, 15 kW, 2 units)	1,057.0
Distribution Facility	
Elevated tank	
(RC, ø 6.0 m, 13 mH, 85 cu.m)	493.0
Distribution main	
(ø 150 mm pipe, 400 m)	216.0
(ø 200 mm pipe, 2,300 m)	1,449.0
(ø 150 mm valve, 3 pcs)	17.1
(ø 200 mm valve, 6 pcs)	51.0
Total	5,908.0

Total construction cost for improvement of major water supply facilities is estimated at approximately 5.91 million Pesos (41.4 million Yen or 0.28 million U.S. Dollar).

K. LEON, ILOILO

K. LEON, ILOILO

I. STUDY AREA AND HYDROGEOLOGICAL ANALYSIS

1. Description of the Study Area

1.1 Physical Description

1.1.1 Geographical Location and Area

Leon, is located on the central-western portion of Iloilo, is bounded on the north by Alimodian, on the east by San Miguel, on the south by Tigbauan and on the west of by Tubungan. It lies between 126°4'30" longitude and 10°46'48 latitude and is about 28.2 kms. from Iloilo City. It has a total land area of 17,902.26 ha. covering 85 barangays. Location map is shown FIGURE K-1.

1.1.2 Climate

Leon has two pronounced seasons, dry from November to April and wet during the rest of the year. The dry season is caused by dry northwest wind while the wet season is brought about by the southeast monsoon.

1.1.3 Terrain/Topography

The terrain of Leon ranges from plain, rolling hills to mountainous. However, majority of its land area have rolling to hilly terrain. Of the 85 barangays, only Omambong lies on the plain. The eastern portions are rolling and hilly and the areas to the borders of Antique are mountainous. Forty-one percent (41%) of the land area have slopes from 15.1% to 35% and above while forty percent (40%) have 8.1-15% slope.

1.1.4 Soil

Sandy loam is the predominant soil type with almost 50% of the total area belonging to this category. Other soil types include Alimodian soil (20%), and clay loam soil (30%).

1.1.5 Administrative Composition and Land Use

The municipality is headed by the mayor and Vice Mayor with eight (8) members of the Sangguniang Bayan as the local legislative body. Under the municipality are the barangays, the smallest political subdivision, which are headed by the Barangay Captains/Chairmen with the Sanggunian Barangay as the lawmaking body. All these local officials are selected by the people through popular election.

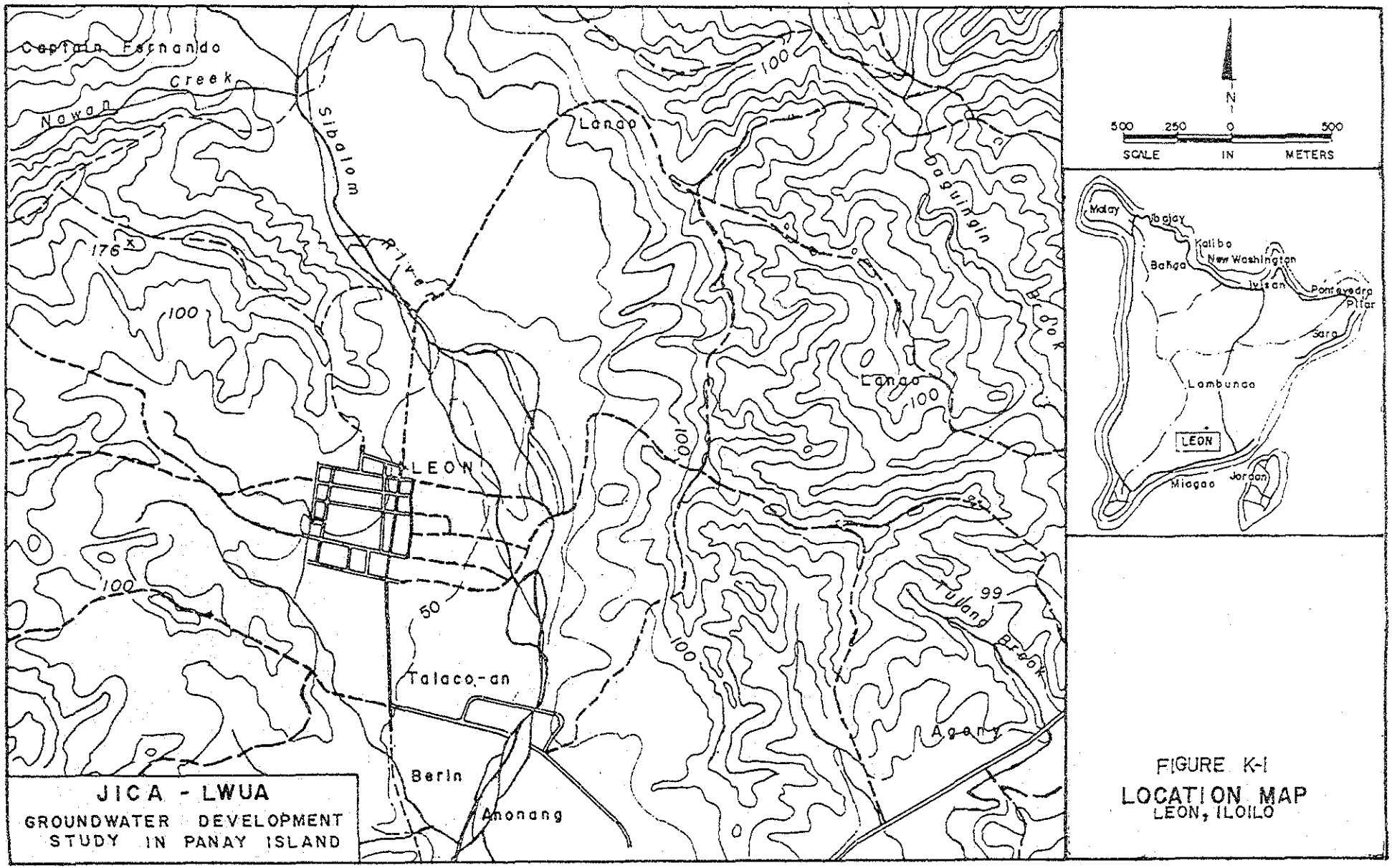

FIGURE K-1
LOCATION MAP
LEON, ILOILO

Municipalities are classified according to the annual revenues from taxes. This classification serves as a major indication of the socio-economic situation in the municipalities. The municipality of Leon belongs to the 3rd class.

Leon is composed of the following 85 barangays:

1. Agboy Norte
2. Agboy Sur
3. Agta
4. Ambulong
5. Anonang
6. Apian
7. Avanzada
8. Awis
9. Ayabang
10. Ayubo
11. Bacolod
12. Baje
13. Banagan
14. Barangbang
15. Barasan
16. Bayag Norte
17. Bayag Sur
18. Binolbog
19. Biri Norte
20. Biri Sur
21. Bobon
22. Bucari
23. Buenavista
24. Buga
25. Bulad
26. Bulwang
27. Cabulo-an
28. Cabunga-an
29. Cabutungan
30. Cagay
31. Camandag
32. Camando
33. Cananaman
34. Capt. Fernando
35. Carara-an
36. Carolina
37. Cawilihan
38. Coyugan Norte
39. Coyugan Sur
40. Danao
41. Dorog
42. Dusacan
43. Gines
44. Gumboc
45. Igcadios
46. Ingay
47. Isian Norte
48. Isian Victoria
49. Jamog Gines
50. Lanag
51. Lang-og
52. Ligtos
53. Lonoc
54. Lampaya
55. Magcapay
56. Maliao-Pongco
57. Malublub
58. Manampunay
59. Marirong
60. Mina
61. Mocol
62. Nagbang I
63. Nalbang
64. Odong-odong
65. Oluangan
66. Omangbong
67. Pa-oy
68. Pandan
69. Panginman
70 Pepe
71. Poblacion
72. Paga
73. Salngan
74. Samlague
75. Siol Norte
76. Siol Sur
77. Tacuyong Norte
78. Tacuyong Sur
79. Tagsing
80. Talacu-an
81. Ticuan
82. Tina-an Norte
83. Tina-an Sur
84. Tungjan
85. Tu-og

Of the total land area of 17,902.26 ha., 89% are classified as agricultural and forestry areas with only about 2.7% devoted to urban uses, industrial, commercial, residential and institutional.

1.1.6 Transportation

Land transportation is the primary means of commutation. To date, there are 46 public utility vehicles servicing the populace.

1.1.7 Infrastructure

As of 1980, municipal road length totalled to 8.635 km., 82.40% of which were of concrete structure while 17.6%, unpaved. Barangay roads length reached 62.5 km., most of which are of gravel and sand surface type. Bridges, on the other hand, were mostly of the bailey type.

Regarding electrification, only 30% of the 5,031 potential consumers are being served by ILECO I. Total number of barangays energized was 25.

1.2 Population and Living Conditions

1.2.1 Population Trend from the Past

From 1975 to 1980, population increased from 30,095 to 31,552 showing a .95% annual growth rate.

Number of households totalled to 5,587 with an average household size of six in 1980. Majority of the population (88.15%) live in the rural areas.

Male-female ratio was almost 1:1 while population density was 225 square kilometer.

TABLE K-1 Population and Number of Households by Barangay, Leon, Iloilo 1980

Barangay	Population	No. of Households
Agboy Norte	579	108
Agboy Sur	458	75
Agta	292	60
Ambulong	172	40
Anonang	503	87
Apian	134	21
Avanzada	137	33
Awis	277	49
Ayabang	284	56
Ayubo	71	17

TABLE K-1 Population and Number of Households by Barangay, Leon, Iloilo 1980 (Cont'd)

Barangay	Population	No. of Households
Bacolod	143	21
Baje	279	49
Banagan	301	49
Barangbang	145	24
Barasan	391	69
Bayag Norte	304	65
Bayag Sur	207	40
Binolbog	150	30
Biri Norte	276	44
Biri Sur	202	45
Bobon	245	41
Bucari	888	128
Buenavista	165	36
Buga	1985	362
Bulad	123	23
Bulwang	194	33
Cabulo-an	56	9
Cabunga-an	269	41
Cabutungan	198	37
Cagay	219	36
Camandag	367	63
Camando	314	61
Cananaman	298	63
Capt. Fernando	470	79
Carara-an	553	97
Carolina	321	60
Cawilihan	213	36
Coyugan Norte	99	18
Coyugan Sur	215	32
Danao	199	31
Dorog	477	83
Dusacan	239	45
Gines	280	54
Gumboc	170	25
Igcadios	188	32
Ingay	318	48
Isian Norte	757	137
Isian Victoria	412	74
Jamog Gines	226	41
Lanag	741	128
Lang-og	336	59
Ligtos	319	53
Lonoc	176	32
Lampaya	179	27
Magcapay	211	40
Maliao-Pongco	378	65
Malublub	929	151
Manampunay	382	66

TABLE K-1 Population and Number of Households by Barangay, Leon, Iloilo 1980 (Cont'd)

Barangay	Population	No. of Households
Marirong	258	45
Mina	97	21
Mocol	185	31
Nagbang I	359	65
Nalbang	207	38
Odong-odong	159	27
Oluangan	550	100
Omambong	932	175
Pa-oy	143	25
Pandan	349	63
Panginman	313	55
Pepe	109	20
Poblacion	3,740	651
Paga	215	41
Salngan	209	36
Samlague	275	49
Siol Norte	199	32
Siol Sur	116	20
Tacuyong Norte	311	59
Tacuyong Sur	260	50
Tagsing	486	81
Talacu-an	942	185
Ticuan	395	68
Tina-an Norte	649	103
Tina-an Sur	215	41
Tungjan	111	19
Tu-og	354	59
TOTAL	31,552	5,587

1.2.2 Age Distribution

Majority of Leon's population, accounting for 55.12% of total population belong to the productive or working age group (15-64 years old). Dependent population, belonging to the 0-14 years old and 65 years old and above comprised 38.98% and 5.90%, respectively of the total population.

1.2.3 Morbidity/Mortality

To date, crude death rate, infant death rate and natural death rate stood at 5.3, 25.1 and 1.5 per 1,000 population, respectively.

Malnutrition is prevalent in the area. Results of the Operation Timbang conducted in the poblacion showed that 44% of

the 4,677 preschool children weighed were suffering from first degree malnutrition, 31%, second degree and 2%, third degree malnutrition.

1.2.4 Sanitation

Sewerage and drainage facilities in the locality were inadequate. Majority of the households dispose their garbage by burning, dumping or composting.

The more common types of toilet facilities used in Leon were closed pit (used by 49% of the population and open pit (30.6%).

1.2.5 Public Services

To date, health services in Leon are being delivered through one Rural Health Unit (RHU) and 8 barangay health stations. These are manned by one physician, 2 nurses, 1 nursing aide, 1 dentist, 1 dental aide, 7 midwives and 2 rural sanitary inspectors. Augmenting the medical manpower of these centers are 283 volunteer health workers, 62 barangay health workers and 2 PUSH workers.

Communication facilities include a post office and a telegraph service station.

There are a total of 13 barangay schools in District I and 15 secondary and elementary schools in District II. Furthermore, there are two other secondary schools operating in Leon, one private, the Saint Catherine Academy being owned by the parish but under the supervision of the Dominican Sisters and an agricultural college, the Leon National College of Agriculture.

1.3 Economy and Industry

1.3.1 Agriculture

Leon is basically an agricultural municipality. Of its 17,902 ha. land area, 58.7% are devoted to agricultural production. Rice and corn are the major crops accounting for 28.3% and 18.25% of total cultivated areas, respectively.

Irrigated areas totalled to 459 ha. while rainfed areas, 4,319 ha. Average production was registered at 80.8 cavans/hectare for irrigated and 47.4 cavans/hectare for rainfed areas. Total areas devoted to corn production was 500 ha. with an average yield of 35 cavans per hectare.

Other crops grown include coconut, vegetables and mango accounting for 11.67%, 8.7% and .97% of total cultivated area,

respectively. Average production per hectare was 2 tons for coconut, 52.8 tons for mango and 5 tons for vegetables.

Total number of farms was 4,106 in 1980 covering an aggregate area of 6,987 ha.. Average farm size was 1.70 ha.

Livestock and poultry production which were mostly on a backyard scale in 1983 totalled to 131,298 heads with chicken accounting for 85.5% of total production; hog, 4.2%, carabao, 3.1%; cattle, 2.9%; ducks, 2.7%; and goats, 1.6%.

1.3.2 Other Industries

As of 1980, a total of 205 establishments were operating in Leon. Prevalent economic activities include wholesale and retail trade (accounting for 45.85%) and manufacturing (34%). Other firms include community, social and personal services, transportation, storage and communication.

1.3.3 Municipal Revenue

The average revenue generated by the municipality from 1978-1981 amounted to ₱690,049.00.

2. Analysis on Potential Water Source

2.1 Topography and Geology

The topography of Leon ranges from plain, rolling hills to mountainous. The eastern areas to the borders of Antique are mountainous. Sibalom River flows southward to the east side of Pobla- cion and forms the terraces in several stages on both sides of the river. The poblacion of Leon lies on the terrace about 60 m above sea level.

The study area comprises three geological portion: Tarao Formation of Tertiary, Terrace deposits and Alluvial deposits. Geological map is shown in FIGURE K-2.

Tarao Formation (Pliocene to Miocene, Tertiary)

This unit is the basement of the study area and comprises mainly of dark gray silstone, occasionally appears rhythmical alternations with thin layer of sandstones. The strike and the dip are much varied, but generally, N50 E and 20 SE, respectively.

Terrace Deposits (Diluvium, Quaternary)

These units are distributed on both sides of Sibalom River. Their thickness is approximated between 5 m to 10 m, and comprises chart, greywacke, diorite and other gravels which are the main components of Antique Range.

Alluvial Deposits (Quaternary)

This unit extends along the Sibalom River, and comprises sand, clay and gravel. The thickness is believed to be less than 10 m.

2.2 Existing Water Source

Surface Water

The Sibalom River, which flows 0.5 km east of the Poblacion with a drainage area of about 107 sq.km, is the most possible water source that can be developed. Thus, a field survey in this area was conducted to check the result of ocular inspection. Likewise, measurement of flow quantity of the river was conducted beside the town proper using a current meter.

Results of the measurement are summarized as follows:

i) The total amount of river flow was calculated to be 12 approximately 21,800 cu.m/day in dry season (April 12) and 883,700 cu.m/day in rainy season (October 8).

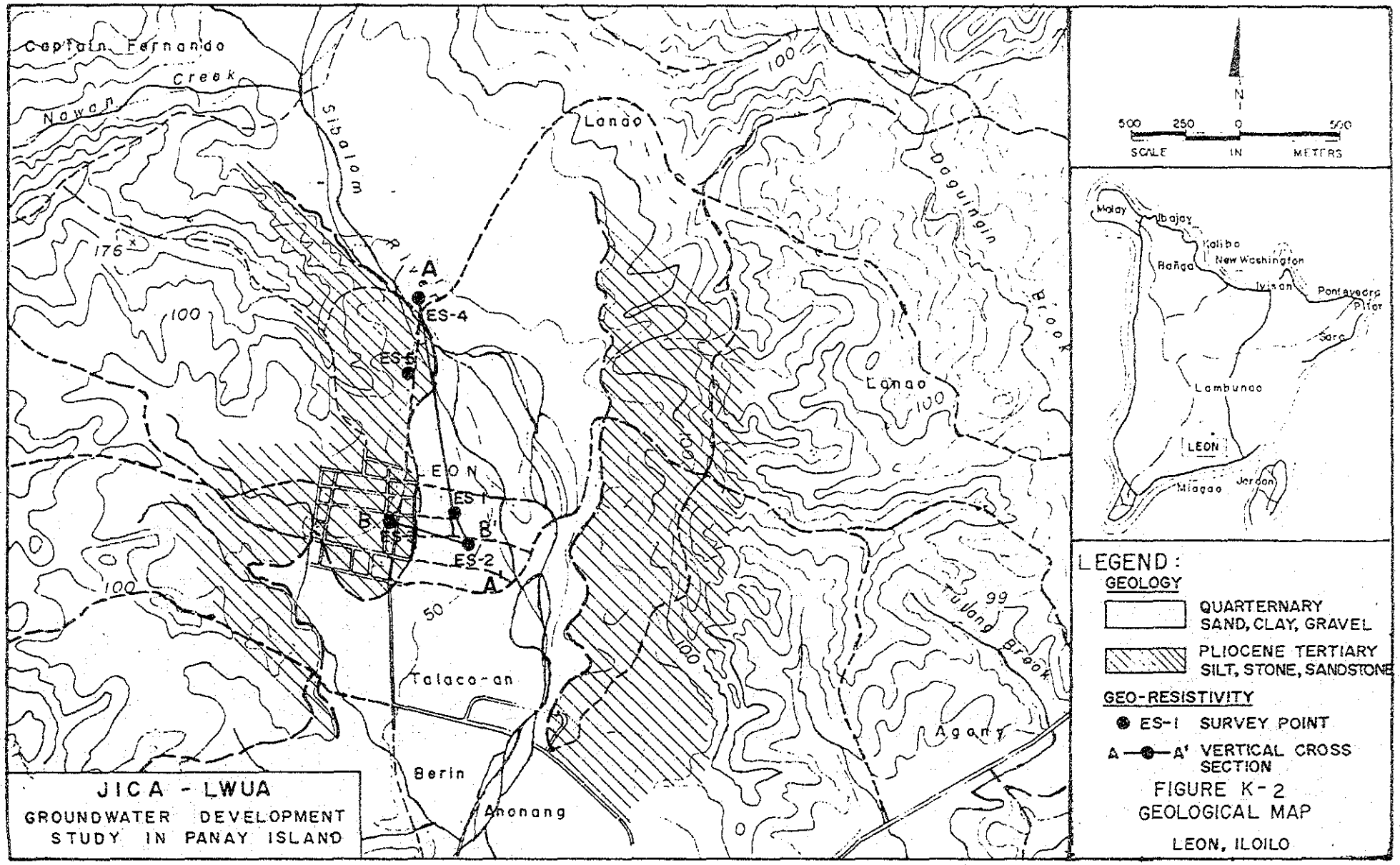

FIGURE K-2
GEOLOGICAL MAP
LEON, ILOILO

TABLE K-2 AVERAGE DAILY DISCHARGE (SIBALOM RIVER at Omambong, Leon, Iloilo) Unit: cu.m/sec.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1957	7.32	2.01	1.20	1.61	1.14	1.71	16.54	12.94	7.55	6.82	1.22	0.54
1958	0.36	0.33	0.22	0.17	0.65	1.79	5.18	4.32	8.41	14.18	********	3.51
1959	0.77	0.33	0.84	0.70	0.80	2.28	5.39	4.12	5.05	3.22	3.02	1.41
1960	0.33	0.14	0.14	0.25	0.42	6.51	4.40	9.26	4.09	8.11	2.10	0.40
1961	0.45	0.53	0.36	0.38	1.12	1.79	7.53	9.02	5.82	5.77	1.74	1.27
1962	0.85	0.92	0.79	1.41	0.98	2.46	6.82	11.40	10.51	7.49	2.75	1.41
1963	1.22	1.11	1.11	1.36	1.54	1.75	1.86	8.61	13.65	3.59	0.48	3.52
1964	0.16	0.16	0.16	0.17	0.22	3.80	9.91	14.23	0.89	2.14	9.04	3.27
1965	2.93	1.51	0.63	0.74	1.13	6.13	13.66	3.90	3.36	2.93	1.18	1.12
1966	**********	**********	**********	**********	**********	**********	**********	**********	**********	**********	**********	**********
1967	13.08	10.94	9.21	1.17	8.14	19.13	50.24	38.19	7.89	**********	**********	**********
1968	0.23	0.16	0.14	0.14	0.18	0.23	1.21	7.30	2.55	2.90	3.39	3.38
1969	**********	**********	**********	**********	**********	**********	**********	**********	12.59	2.05	0.29	0.66
1970	0.21	0.13	0.14	0.12	0.21	0.76	4.85	2.10	1.35	7.00	3.69	1.69
1971	**********	**********	**********	**********	**********	**********	**********	**********	**********	**********	**********	**********
1972	1.53	0.70	0.61	0.26	1.12	0.56	0.88	2.10	26.08	7.08	3.48	6.40
1973	**********	**********	**********	**********	**********	**********	**********	**********	**********	**********	**********	**********
1974	2.04	1.46	0.92	0.87	0.99	4.89	**********	**********	3.38	4.97	1.43	1.79
1975	1.63	********	0.62	**********	**********	**********	**********	**********	**********	**********	**********	**********
1976	**********	**********	**********	**********	**********	1.50	1.01	0.94	**********	**********	**********	1.16
MAXIMUM	13.08	10.94	9.21	1.61	8.14	19.13	50.24	38.19	26.08	14.18	9.04	6.4
AVERAGE	2.21	1.46	1.14	0.67	1.33	3.69	9.25	9.17	7.54	5.59	2.60	2.10
MINIMUM	0.16	0.13	0.14	0.12	0.18	0.23	0.88	0.94	0.89	2.05	0.29	0.4
SampleNo	15	14	15	14	14	15	14	14	15	14	13	15
ST. DEV.	3.51	2.79	2.26	0.53	2.00	4.69	12.69	9.35	6.43	3.26	2.24	1.62

ii) The total area of a cross section of the river flow was calculated as approximately 2.3 sq.m in dry season and 9.4 sq.m in rainy season.

iii) Therefore, an average flow velocity is calculated as 0.11 m/sec in dry season and 1.09 m/sec in rainy season.

Assuming that the annual run-off is 1272 mm which is adopted in the report by the National Water Resource Council, the annual run-off of the Sibalom River is estimated at 136 million cu.m. Therefore, the measured flow amount in dry season is equivalent to about 6% of estimated average daily discharge of 373,000 cu.m/day and 237% in rainy season.

On the other hand, the National Water Resources Council has a discharge record of the Sibalom River from 1957 as shown in TABLE K-2.

The discharge amount in this table was measured at Omambong located about 3 km downstream of the Poblacion of Leon and the discharge area of the river is 117 sq.km at the measuring point. Based on this table, the average daily discharge of the river is calculated at around 3.92 cu.m/sec or 338,600 cu.m/day that is equivalent to 1,056 mm as an annual run-off.

Wells

Residents in the Poblacion depend mainly on shallow wells or dug wells constructed privately or by the DPWH. These wells seem to obtain water from Terrace deposits. In the Poblacion, there is a deep well which was constructed in 1985 thru USAID funding. Unfortunately, no reliable data on this well is available at present. The records of depth and the results of the pumping test are therefore considered doubtful.

Well inventory survey in the field was carried out on seven (7) wells in the Poblacion, as shown in FIGURE K-3. TABLE K-3 presents the survey results.

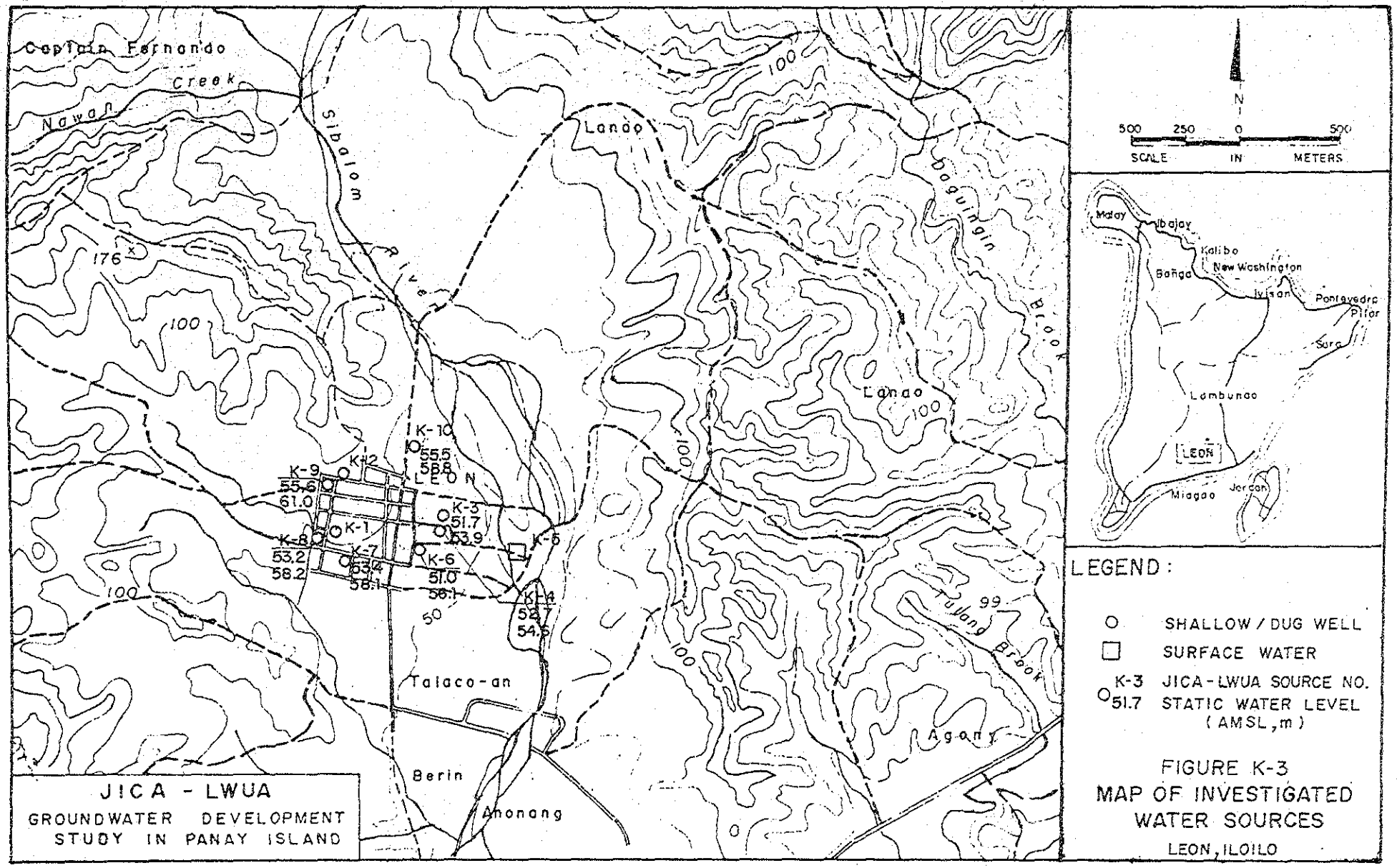
Captain Fernando
Creek
Nawal
Sibaloan
Lanao
Baguingin
Brook
176
100
K-10
55.5
58.8
K-9
55.6
61.0
K-12
LEON
K-3
51.7
53.9
K-1
K-8
53.2
58.2
K-7
53.4
58.1
K-6
51.0
56.1
K-5
K-4
52.7
54.6
50
99
Pulong
Talaco-an
Agan
Berin
Amonang
JICA - LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND
N
500 250 0 500
SCALE IN METERS
Malay
Ibajay
Kalibo
New Washington
Banga
Ivisan
Pontevedra
Pilar
Sara
Lambunao
LEON
Miagao
Jordan
LEGEND :
SHALLOW / DUG WELL
SURFACE WATER
K-3 JICA-LWUA SOURCE NO.
51.7 STATIC WATER LEVEL
(AMSL, m)
FIGURE K-3
MAP OF INVESTIGATED
WATER SOURCES
LEON, ILOILO

TABLE K-3 Well Data Summary

JICA-LWUA Source Number	Well Depth (M)	Ground Level (MAMSL)	Static Water Level Dry Season (May 21) (MBGL)	(MAMSL)*	Rainy Season (October 5) (MBGL)	(MAMSL)
K-3 Test Well of USAID	8.53	55.4	-3.71	51.7	-1.54	53.9
K-4 Dug Well Near K-3	4.05	55.6	-2.92	52.7	-1.00	54.6
K-6 Dug Well	8.96	57.6	-6.62	51.0	-1.45	56.1
K-7 Dug Well	8.02	58.7	-5.28	53.4	-0.60	58.1
K-8 Dug Well	9.63	59.4	-6.17	53.2	-1.20	58.2
K-9 Dug Well	7.37	61.9	-6.32	55.6	-0.88	61.0
K-10 Dug Well Near ES-5	6.61	60.0	-4.46	55.5	-1.17	58.8

* Estimated based on the 1/50,000 scale topographical map and supplemental topographic survey.

Survey results are summarized as follows:

i) There is no deep well in the town proper.

ii) The groundwater table declines from the northwestward to the southeastward and the eastward directions where the Sibalom River flows.

iii) The groundwater table rised up largely in rainy season by 2 - 3 m comparing with those in dry season.

Continuous monitoring of water level at the Well No. K-3 was conducted from April 19 to October 4 under the maintenance by a staff of the Leon Municipal Office. During said period, recording interruption for about 4 months occurred due to mismanagement.

Based on the analysis of records, the following are deduced:

1) The lowest level is 3.35 m below ground level last May 31, 1988.

2) The highest level is 2.41 m below ground level last June 8, 1988.

3) From the lowest peak last May 31, 1988, the groundwater was rising up continuously.

2.3 Survey for Potential Water Source

2.3.1 Evaluation of Georesistivity Survey

The survey area is covered by a flood plain composed of terrace deposits and alluvial sediments from the Sibalom River, over a basement of Tarao Formation. The georesistivity survey was therefore focused on the exploration of a possible aquifer in the quaternary deposit and underlying Tarao formation. A total of five (5) survey points, namely ES-1 to ES-5, are pinpointed in FIGURE K-2.

Field activities are summarized below:

Date	:	April 11 to 12, 1988
No. of Survey Points	:	five (5) points
Type of Survey	:	Vertical Sounding
Configuration	:	Wenner Method
Sounding Depth	:	100 to 150 meters

The results of the ρ-a curve analysis is shown in TABLE K-4 and the georesistivity section as shown in FIGUREs K-4 and K-5.

The following interpretations and assessments are available at this moment:

1) The aquifer is expected in the flood plain (ES-1 and ES-2) with a thickness of about 2 to 4 meters at a depth of about 3 to 5 mbgl, and in the terrace (ES-3) with a thickness of 11.5 meters at a depth of 12 mbgl.

2) Tarao Formation has resistivity ranging from 1 to 15 ohm.m in which clayey to silty facies are expected. Likewise, the possibility of potential aquifers is quite low in the deeper formations.

2.4 Water Quality Analysis

Ten (10) survey points were covered in the field analysis of water quality and two water samples from the existing water source

TABLE K-4 DEDUCTED VALUES OF GEORESISTIVITY READING INTERPRETATION

LEON, ILOILO

SURVEY POINT	ELEVATION (M,AMSL)	TOPOGRAPHY	RESISTIVITY LAYER									
			1		2		3		4		5	
			ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m
ES-1	56	flood plain	130	1.2	195	2.7	8	43	4			
ES-2	55	flood plain	32	0.8	48	5.0	15	40	1			
ES-3	60	terrace	6	0.5	37	12	2					
ES-4	58	flood plain	35	0.5	7	12	2					
ES-5	65	terrace	100	0.7	7	5.4	12	8.4	6	36	0.3	

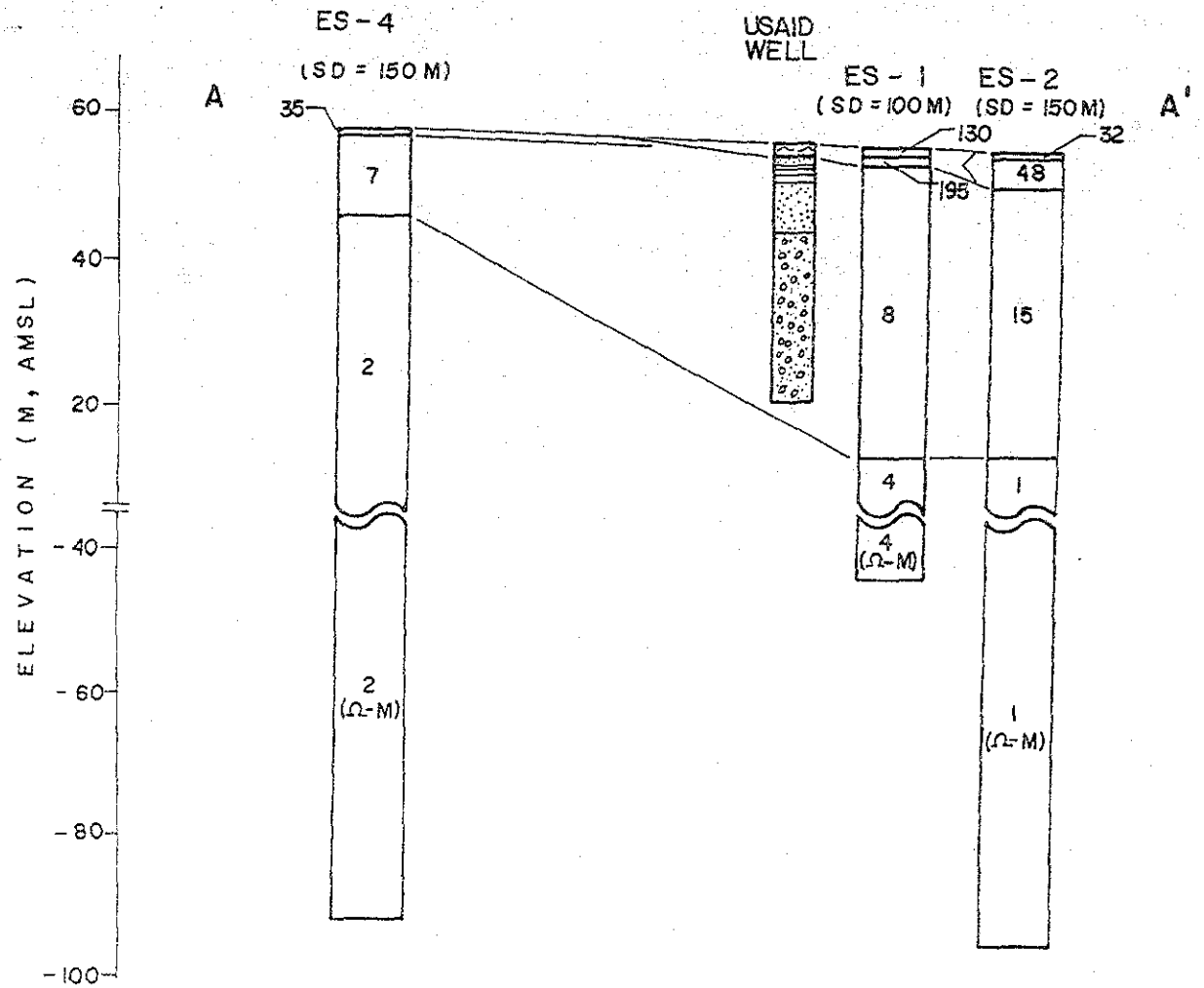

FIGURE K - 4

SCALE H = 10,000
V = 1,000

GEORESISTIVITY SECTION A-A'
LEON , ILOILO , PANAY ISLAND

JICA - LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND

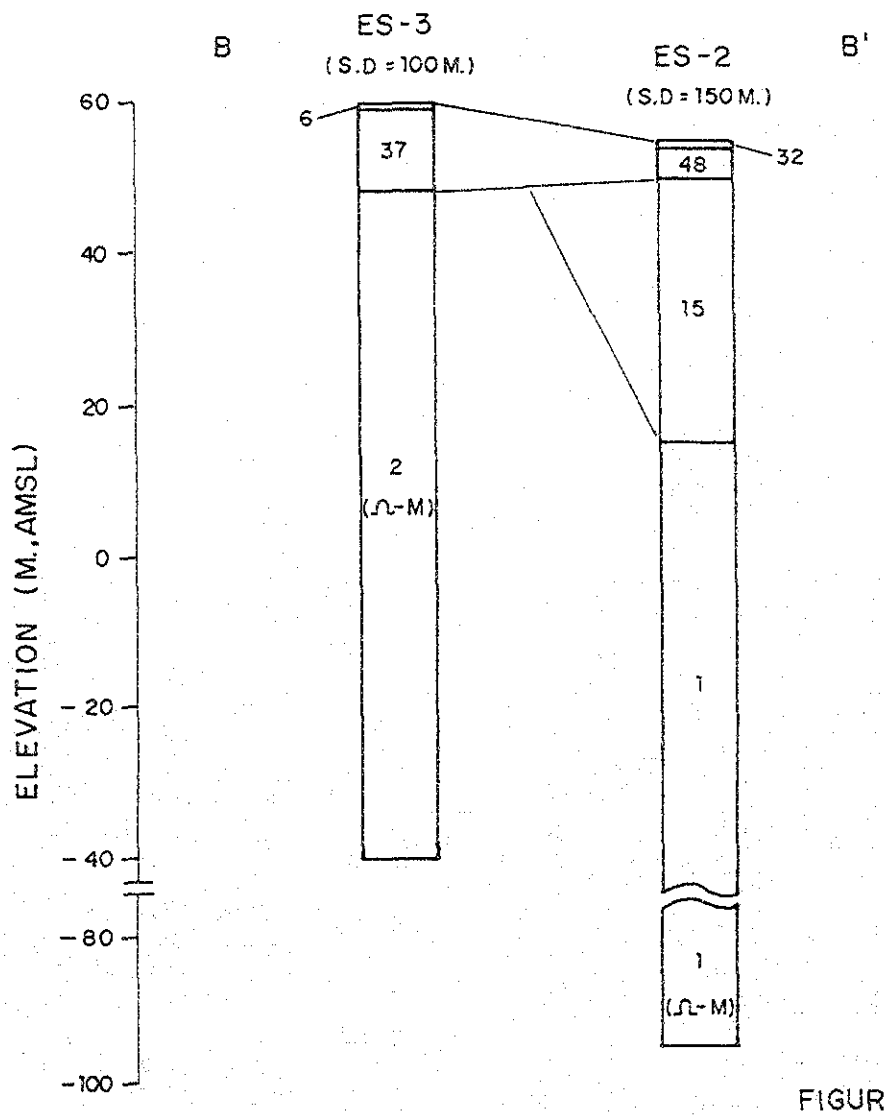

FIGURE K-5

GEORESISTIVITY SECTION B-B'
LEON, ILOILO, PANAY ISLAND

SCALE H = 1 : 10,000
V = 1 : 1,000

JICA - LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND

and the Sibalom River were collected for laboratory analysis. Survey points and analysis results are shown in FIGURE K-3 and TABLE K-5, respectively.

TABLE K-5 Water Quality Analysis Results

Sample		WT (°C)	pH (-)	EC (μS/cm)	T-FE (ppm)	Mn (ppm)	NH_4-N (ppm)
Dry Season							
K-1	Public Well, No. 5757, Bonifacio St.	29.2	7.1	730	0.3	nil	0.3
K-2	Public Well, Bonifacio St.	28.2	6.8	1,620	1.5	nil	2.8
K-3	Test Well of USAID	29.2	7.7	750	7.0	nil	1.8
K-4	Dug Well, near Well No. K-3	28.9	7.0	1,150	0.3	nil	nil
K-5	Sibalom River	34.2	8.2	720	0.2	nil	nil
Rainy Season							
K-1	Public Well, No. 5757, Bonifacio St.	29.3	7.2	770	0.5	-	0.4
K-2	Public Well, Bonifacio St.	28.0	7.1	1,330	0.2	-	0.4
K-4	Dug Well, Near Well No. K-3	27.8	7.3	1,510	Tr.	-	Tr.
K-5	Sibalom River	27.4	8.6	310	-	-	-
K-6	Dug Well	28.9	7.2	720	nil	-	nil
K-7	Dug Well	29.2	7.2	550	-	-	-
K-8	Dug Well	28.8	7.3	510	Tr.	-	nil
K-9	Dug Well	28.0	7.2	860	-	-	-
K-10	Dug Well	29.2	7.3	730	nil	-	nil

Generally, water in this study area contains a relatively large amount of dissolved solids as indicated by electric conductivity. Some of the survey points, i.e., K-3 and K-5, show high pH as alkaline condition. High iron content of the water at the test well constructed under USAID fund (K-3) was noted and is assumed to be caused by corrosion of steel casing pipes since this well has not been operated.

The following are the results of laboratory analysis for samples collected from the dug well and the Sibalom River.

Sample	Dug Well	Sibalom River
Date of Sampling	5.21.88	10.08.88
Turbidity (FTU)	3	125
Color (UNIT)	nil	200 (apparent)
TDS (mg/l)	416	336
pH (-)	7.9	7.9
EC (µS/cm)	650	605
Alkalinity as $CaCO_3$ (mg/l)	332	160
Hardness as $CaCO_3$ (mg/l)	412	188
Major Cations (meq/l)		
Sodium	1.6	2.2
Potassium	0.10	0.05
Calcium	6.45	2.5
Magnesium	1.81	1.3
Total	9.96	6.05
Major Anions (meq/l)		
Carbonate	0	1.1
Bicarbonate	6.6	2.1
Chloride	1.41	0.4
Sulfate	1.89	2.4
Total	9.90	6.0

Larger amount of chemical constituents is observed in groundwater than in surface water. Both water samples also show that they are under alkaline condition as indicated by high pH values. Groundwater shows a typical geochemical characteristic as the Carbonate-Hardness Type, while the Sibalom River shows only slight tendency of the Carbonate-hardness Type characteristic.

High turbidity and apparent color are believed to be caused by suspended solids, such as clay particles being eroded by rainwater run-off.

3. Conclusion and Recommendation

Considering the geological condition, due to the predominance of impermeable silt layer which comprises Tarao Formation, it is difficult to abstract an ample quantity of groundwater by deep wells. It is necessary to reclean the USAID well and confirm the condition of groundwater.

The groundwater potential may be roughly examined as follows:

Groundwater potential "Q" may be expressed as:

$$Q = P - E - D - M$$

Where, P - precipitation
E - evapotranspiration
D - discharge of river
M - moisture increase in soil (negligible)

In this case study, precipitation "P" can be taken from meteorological data at the nearest station, Iloilo City, Iloilo. Evapotranspiration "E" maybe calculated based on the data by Thornthwaite using average monthly temperature. Calculation results are shown in TABLE K-6.

TABLE K-6 Precipitation and Evapotranspiration

MONTH	JAN.	FEB.	MAR.	APR.	MAY.
Ave. Precipitation (mm)	44.0	23.1	35.3	50.4	117.3
Ave. Temperature (°C)	26.8	27.0	28.1	29.1	29.3
Evapotranspiration (mm)	137.7	126.9	153.1	160.8	170.1
Surplus Amount (mm)	-93.7	-103.8	-117.8	-110.4	-52.8

MONTH	JUN.	JUL.	AUG.	SEP.	OCT.
Ave. Precipitation (mm)	274.8	300.1	358.4	276.7	242.2
Ave. Temperature (°C)	28.2	27.7	27.5	27.6	27.9
Evapotranspiration (mm)	158.4	156.9	153.8	147.4	149.9
Surplus Amount (mm)	116.4	143.2	204.6	129.3	92.3

TABLE K-6 Precipitation and Evapotranspiration (Cont'd)

MONTH	NOV.	DEC.	ANNUAL
Ave. Precipitation (mm)	178.6	95.2	1996.1
Ave. Temperature (°C)	28.0	27.1	
Evapotranspiration (mm)	144.8	138.9	1798.7
Surplus Amount (mm)	33.8	-43.7	197.4

This table presents the annual run-off consisting of groundwater recharge and river discharge which is 197.4 mm or 63,276 cu.m/day for a discharge area of 117 sq.km.

If the annual run-off of the Sibalom River is 1056 mm as discussed previously, this surplus amount is too small. Moreover, taking the evapotranspiration into account, the groundwater potential is rather small in any case.

The flow quantity of the Sibalom River seems to be good even during dry season. Therefore, the most probable water source for a water supply system of the Poblacion is the effective utilization of the Sibalom River. The development of the riverbed water is a promising measure for a practical and feasible water supply system.

II. CONCEPTUAL WATER SUPPLY SYSTEM

1. Existing Water Supply Conditions

1.1 Water Use Condition

One of the most pressing problems that beset this municipality is inadequate source of potable water supply. At present, there is no existing water supply system that could meet the demand of its growing population. In the past, there has been an intention to put up one, yet no potential source could be found.

The three (3) artesian wells in the Poblacion are not enough to meet the need of the consuming public. Almost all of the households, therefore, resort to the digging of shallow wells for hand pumps (jetmatics), and others still depend on springs and rivers for their source. Out of 816 wells throughout the municipality (85 barangays), 320 wells exist in the Poblacion. At present, eight barangays are the recipient of communal water pumps under the PDAP Barangay Water-works Program. At any rate, the municipality of Leon is blessed with enough rainfall. Over the years, rain has been one major source of water, especially for farming, which is the primary source of income in the municipality.

1.2 Existing Water Supply System and Problems Encountered

There is no piped water supply system in the Poblacion area of this municipality, except shallow wells equipped with hand pumps.

2. Water Demand Projection

2.1 Criteria

The absence of an operational piped water supply system and poor water supply condition make it difficult to assess the per capita unit water consumption of the study area. Per capita unit water consumption is, there- fore, assumed to be 90 lpcd in 1988 considering the LWUA Methodology Manual and the experience in a similar water supply feasibility study, "Municipal Water Supply Project", conducted by JICA in 1987.

Design unit water consumption by consumer type is thereby esti mated in accordance with the said Manual, as follows:

- Domestic per capita unit water consumption is estimated at 100 lpcd in the year 1995 with an annual increase ratio of 2% from 1988 to 1990 and 1.5% from 1990 to 1995 against 90 lpcd in 1988.

- Commercial unit water consumption is estimated at 1.4 cu.m/connection/day with its connection density ratio of 1.2 per 100 inhabitants.

- Institutional unit water consumption in 1995 is estimated at 5.2 cu.m/connection/day with its connection density ratio of 1.0 per 2,000 inhabitants in the service area.

The ratio of unaccounted-for water is assumed to be 25% of the total distributed amount which is the standard ratio for new pipelines as adopted by the LWUA Methodology Manual.

2.2 Areas to be Served

The target year for water supply planning is set for the year 1995 for the purpose of intermediate water supply development/improvement.

With regard to the planned water supply service area of the target year, Poblacion is likewise designated as the project area and inclusion of others shall be considered upon accomplishment of the intermediate development of piped water supply system.

2.3 Population Projection

The National Economic and Development Authority (NEDA) has projected the municipality population in each calendar year from 1981 to 2000 based on population census it conducted in 1980.

Due to the absence of any other population data, this NEDA population projection is adopted as principal data. Percentage share of the poblacion population to the municipal population is assumed to be the same as that of the 1980 census result.

The projected service area (Poblacion) population is presented in TABLE K-7.

TABLE K-7 Population Projection of Service Area

Year	Municipality	Service Area (Poblacion)
1980	31,552	3,740
1985	34,720	4,120
1990	37,610	4,460
1995	39,970	4,740

The water supply service ratio is considered to be 80% taking into account the densely habitation pattern in the planned service area as stated before. The average number of persons per household is assumed to be 5,000 based on the standard figure adopted by NEDA.

2.4 Water Demand Projection

The future water consumption in 1995 is estimated based on the aforementioned planned service population and design unit water consumption by consumer type.

The estimated number of connection and future water consumption are shown in TABLE K-8.

TABLE K-8 Water Consumption in 1995

Service Area	Poblacion
Served Population	3,790
No. of Connections	
Domestic	758
Commercial	45
Institutional	2
Total	805
Water Consumption (cu.m/day):	
Domestic	379
Commercial	63
Institutional	10
Total	452
Unaccounted-for Water	151
TOTAL	603

The ratio of the daily maximum water demand to the daily average water demand is determined in relation to the planned service population based on the LWUA Methodology Manual as shown in TABLE K-9.

TABLE K-9 Demand Variation Factor for Daily Maximum Water Demand

Service Population	Ratio (Daily Max./Daily Ave.)
Less than 30,000	1.30 : 1
30,000 to 200,000	1.25 : 1
Over 20,000	1.20 : 1

The estimated daily maximum water demand is shown in TABLE K-10.

TABLE K-10 Daily Maximum Water Demand

Service Area	Water Demand (cu.m/day)
Poblacion	780

The peak hour water demand is estimated in proportion to the daily maximum water demand and service population in accordance with the LWUA Methodology Manual as shown below:

C = (Peak Hour Demand x 24)/(Daily Maximum Demand)

= 2.2 - 0.3 x log (Service Population/1,000)

The ratio of peak hour demand in the year 1995 is calculated at 2.03 and the peak hour water demand is estimated at 1,580 cu.m/day.

3. Proposed Water Supply Facilities

3.1 Basic Approach for Water Supply Improvement

3.1.1 Conditions and Constraints

The conceptual plan for water supply improvement is focused on major water supply facilities, such as water source, main transmission and distribution pipelines, and reservoir. Branch lines, service connections and fire hydrants are likewise excluded from conceptual planning. However, following conditions are taken into account as much as possible:

(1) Low cost in construction, operation and maintenance,
(2) Seasonal fluctuation of source capacity will not seriously affect stable water supply,
(3) Water source will be located within the administrative boundary of respective municipality.

3.1.2 Water Source Development

Based on the evaluation and analysis of field survey results including georesistivity survey, it is concluded that groundwater resource in the poblacion area and its vicinity is quite scarce and not favorable for the use in water supply development. Due to this hydrogeological constraint, the utilization of river bed water in Sibalom River is considered most appropriate in view of quality and quantity as well as reasonable distance from the poblacion area.

3.1.3 Transmission and Distribution Facilities

Due to absence of water supply system in the poblacion area, all the required facilities for water transmission and distribution shall be newly constructed.

3.2 Plan for Improvement of Water Supply Facilities

3.2.1 Water Source Facility

Infiltration gallery with intake/booster pump station will be constructed at the right bank of Sibalom River which is approximately 1.0 km upstream from the poblacion area. This water source facility will have a capacity to meet with the planed daily maximum water demand in 1995 (780 cu.m/day).

3.2.2 Transmission Facility

Transmission main will be installed along with the national road from intake/booster pump station to new reservoir. This pipeline will have a flow capacity to meet with the planned daily maximum water demand in 1995.

3.2.3 Distribution Facility

Distribution reservoir will be constructed on the hill at north end of the poblacion where is approximately 85 m of ground elevation. The reservoir will have a storage capacity of about 3 hours or 12.5% of the planned daily maximum water demand which is equivalent to 10% of the said demand as operation storage aside from the emergency storage volume. Chlorination facility will be installed at the reservoir.

Distribution main will be installed to form a looped line in the poblacion area and have a flow capacity to meet with the planned hourly maximum water demand.

3.2.4 Required Water Supply Facilities

Location of major water supply facilities is shown in FIGURE K-6, flow diagram of facilities in FIGURE K-7 and detail of distribution pipeline in proposed service area in FIGURE K-8.

Size and quantity of required facilities are listed below:

(1) Water Source Facility

Infiltration gallery:
RC, ϕ 600 mm, 200 m, EL+55.0 m

Intake pumping station: RC,
Pump-ϕ100 mm x 0.8 cu.m/min x 45 mH x 11 kW, 2 units

(2) Transmission Facility

Transmission main:
ϕ 150 mm, 1,100 m

(3) Distribution Facility

Reservoir:
RC, 7.0 mW x 7.0 mL x 3.5.mH, 100 cu.m, EL+85 m, 1 unit

Chlorination tank:
RC, 1.5 mW x 2.5 mL x 2.0 mH, 1 unit

Distribution main:
ϕ 100 mm pipe, 850 m
ϕ 150 mm pipe, 1,850 m

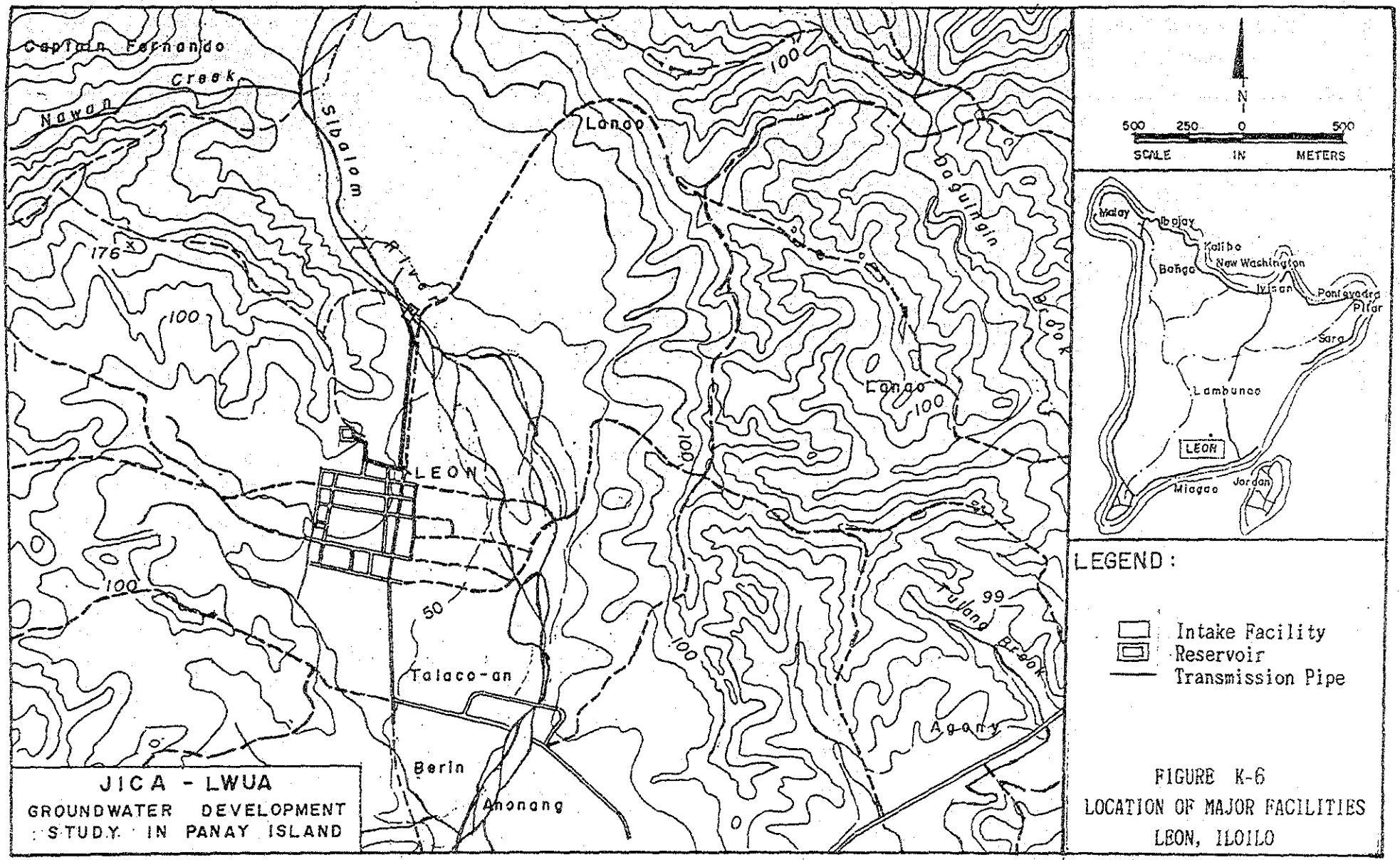

FIGURE K-6
LOCATION OF MAJOR FACILITIES
LEON, ILOILO

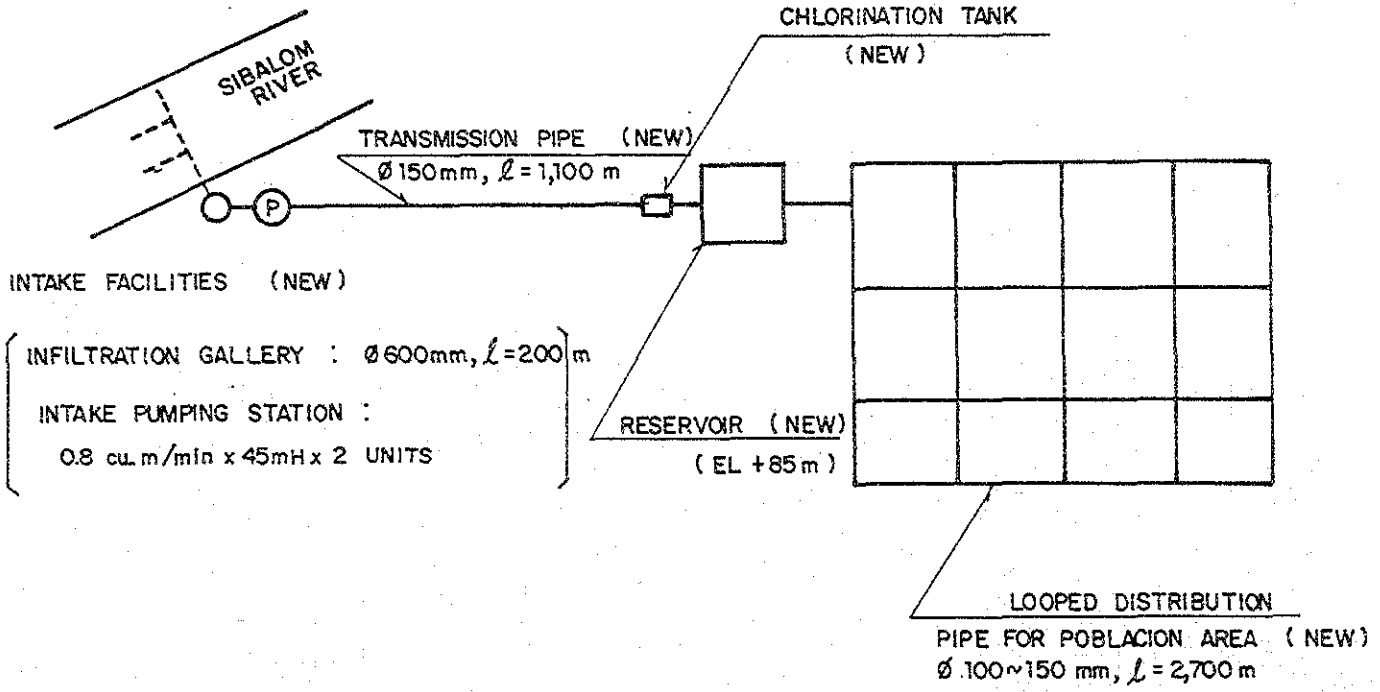

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FIGURE K-7
FLOW DIAGRAM
LEON, ILOILO

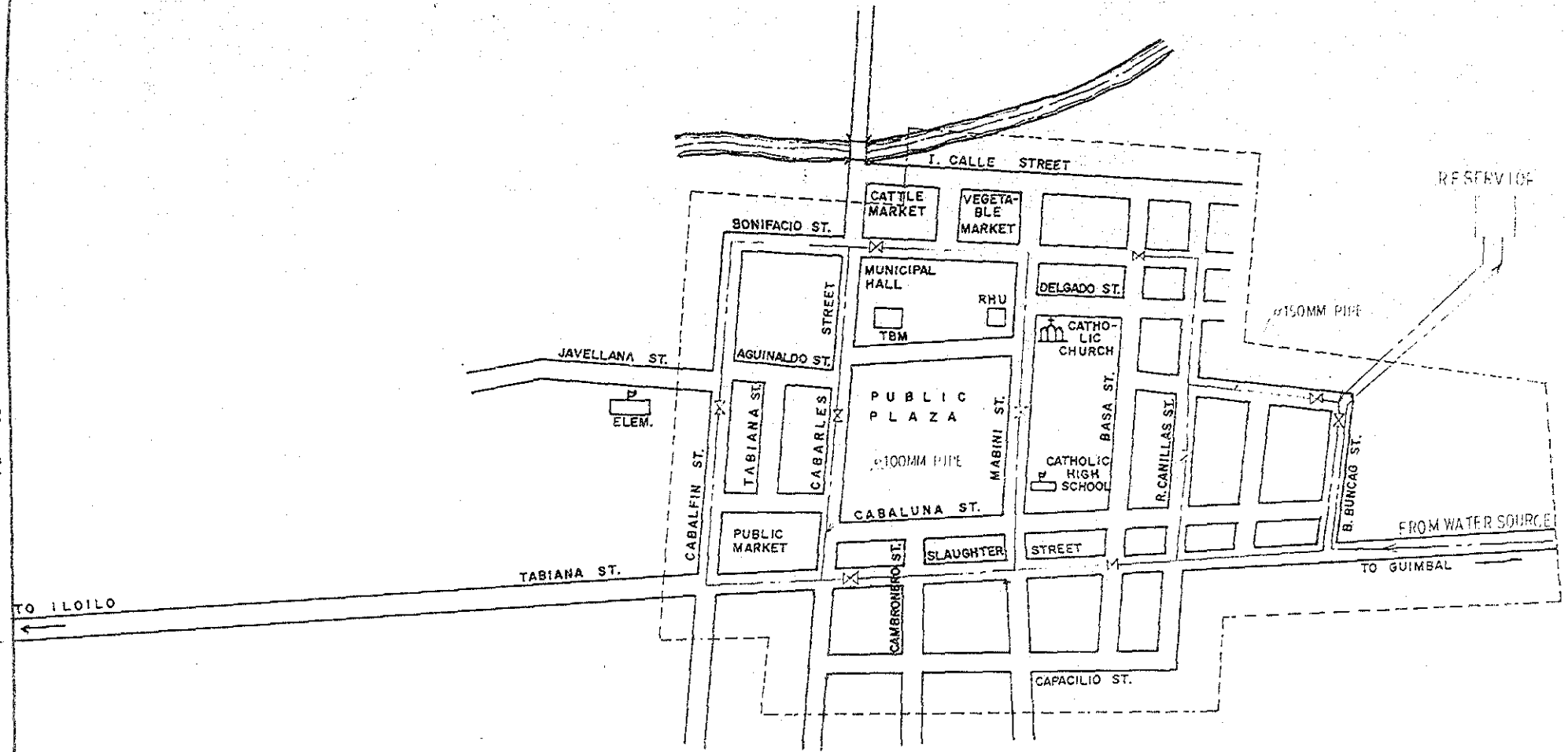

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FIGURE K-8
DISTRIBUTION PIPELINE
LEON, ILOILO

3.3 Rough Cost Estimate of Major Water Supply Facilities

3.3.1 Unit Construction Cost

Unit construction cost of required facilities is based on the "In-Place Cost of Waterworks Materials" (as of January 1989) of LWUA. Any unit cost not shown in this list is referred to "Unit Price Manual - Water Supply Feasibility Studies" (July 1983) upon consideration of price escalation that 15% per annum upto 1987 and 7% per annum from 1987 as adopted by LWUA.

All construction costs are estimated in Philippine Pesos and the total cost is only converted into U.S. Dollars and Japanese Yen based on the following exchange rate as of September 1989.

U.S. $1.00 = Yen 145.70 = Peso 20.78

Unit costs used in rough cost estimate are attached in Appendix-5.

3.3.2 Rough Cost Estimate

Facility	Cost (Thousand Peso)
Water Source Facility	
Infiltration gallery	
(RC, ø 600 mm, 200 m)	400.0
Intake/booster pump station	
(0.8 cu.m/min x 45 mH x 11 kW, 2 units)	960.3
Transmission Facility	
Transmission main	
(ø 150 mm, 1,100 m)	693.0
Distribution Facility	
Distribution reservoir	
(RC, 100 cu.m)	193.0
Chlorination tank	
(RC, 7.5 cu.m)	14.5
Distribution main	
(ø 100 mm pipe, 850 m)	229.5
(ø 150 mm pipe, 1,850 m)	999.0
(ø 100 mm valve, 3 pcs)	13.0
(ø 100 mm valve, 7 pcs)	39.9
Total	3,542.7

Total construction cost for improvement of major water supply facilities is estimated at approximately 3.54 million Pesos (24.8 million Yen or 0.17 million U.S. Dollar).