B. IBAJAY, AKLAN

B. IBAJAY, AKLAN

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 Ibajay is located at the northwestern part of Aklan or around the "nape" of the duckshaped province. It lies from north to south between 12°50'00 N and 12°32'07" S and from west to east between 122°6'24" W and 122°13'48" E. It is bounded on the east by the municipality of Tangalan, on the southeast by the municipalities of Makato and Malinao, on the south by the municipality of Madalag, on the north by the Sibuyan Sea, on the northwest by the municipality of Nabas, and on the southwest the province of Antique. It is about 36 km. from the provincial capital, Kalibo, and has a total land area of 16,004 ha covering 35 barangays. Location map is shown in FIGURE B-1.

1.1.2 Climate

There are two types of climate prevailing in the area. The northern portion has the third type of climate which has no distinct seasons. The southern part of Ibajay generally has a climate belonging to Type I, with very pronounced seasons, dry from November to April and wet during the rest of the year. In the northern part, heaviest precipitation occurs in different times of the year with November having the most rainfall (470 mm). In the southern part, precipitation is fairly continuous attaining its peak in August.

Temperature varies slightly, with the coolest month (January) averaging at 26°C and the hottest month (May) averaging at 29°C.

1.1.3 Terrain/Topography

Located at the Albina mountain ranges east of the rolling hills region of the "northern knot", Ibajay's topography is generally mountainous. It has the following land slope distribution: 0-3% slope, 20.9% of the total land area; 8-18% slope, 18.4%; 18-30% slope, 32.6%; and above 30% slope, 28.1%.

1.1.4 Soil

Six soil types could be found in Ibajay: the hydrosol coastal soil located at the marshlands of northwestern Ibajay; beach sand (coastal soil) at the mouth of the Ibajay River; San

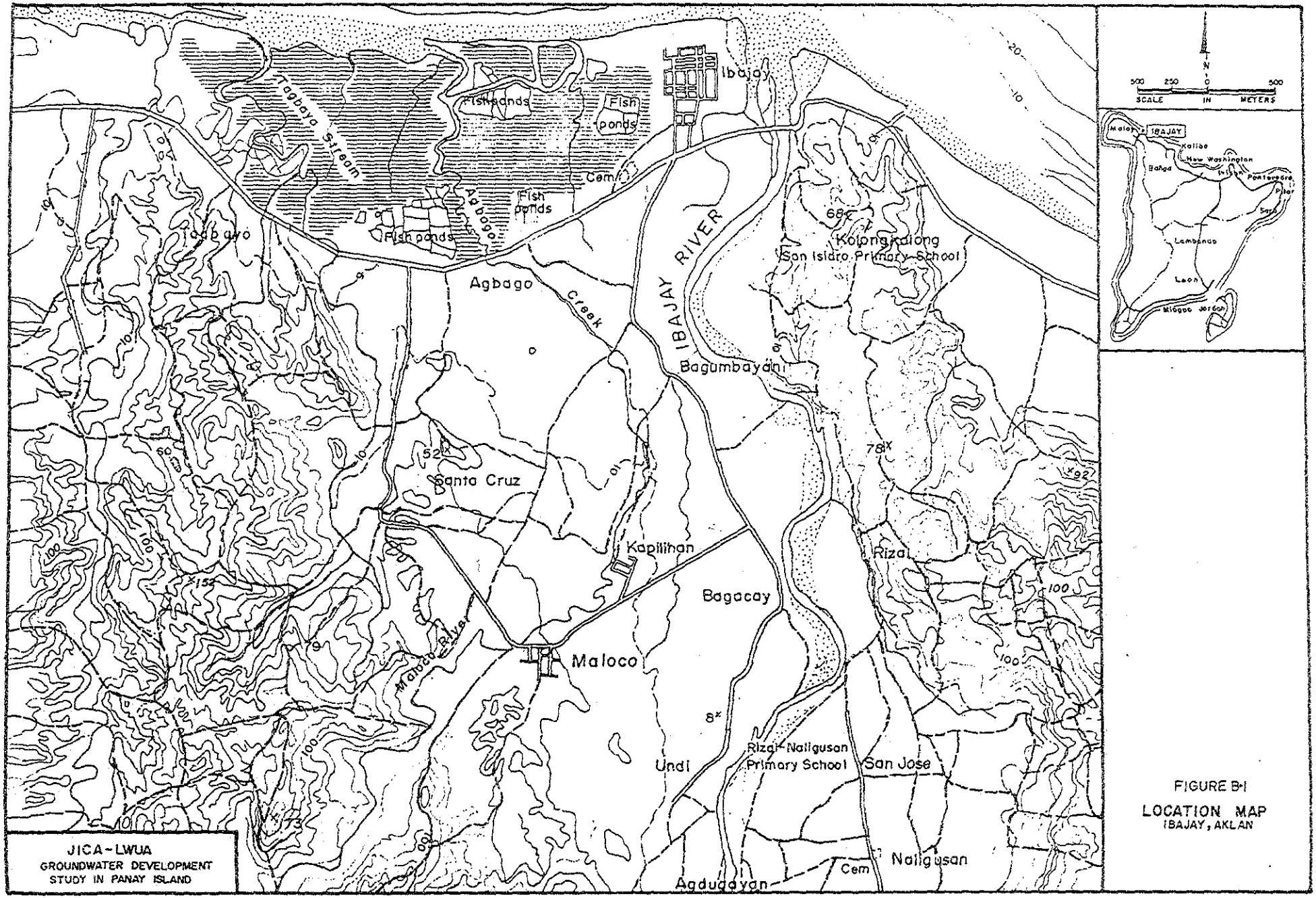


FIGURE B-1

LOCATION MAP
IBAJAY, AKLAN

Manuel clay loam at the plains of Ondoy and Ibajay Rivers; Bauang clay at the hills of eastern Ibajay; Alimodian clay at the hills of southern Ibajay; and undifferentiated mountain soils at the high mountains bordering Antique.

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 Ibajay belongs to the 3rd class.

Listed below are the 35 barangays composing the municipality:

1. Agbago
2. Agdugayan
3. Antipolo
4. Aparicio
5. Aquino
6. Aslum
7. Bagacay
8. Batuan
9. Buenavista
10. Bugtong Bato
11. Cabugao
12. Capilijan
13. Colongcolong
14. Laguingbanwa
15. Mabusao
16. Malindog
17. Maloco
18. Mina-a
19. Monlaque
20. Naile
21. Naisud
22. Naligusan
23. Ondoy
24. Poblacion
25. Polo
26. Regador
27. Rivera
28. Rizal
29. San Isidro
30. San Jose
31. Santa Cruz
32. Tagbaya
33. Tul-ang
34. Unat
35. Yawan

The municipality has a land area of 16,004 hectares, or 8.8 percent of the provincial land area. Of this area in 1983, more than two-thirds or 68.8% were grasslands, 14.5% were agricultural lands and 10% 2343 forest lands. The remaining areas were swamps, marshes and fishponds (3.3%); built-up areas (2.0%); open spaces and recreation areas (1.2%); and residential, commercial, industrial and institutional areas (0.2%).

1.1.6 Transportation

Buses are the main form of inter-provincial passenger land conveyance. Jeepneys and mini-buses primarily ferry passengers within the province. Motorized tricycles primarily service passengers within the municipality. Poblacion Ibajay could be reached through the Ibajay River on motorized bancas.

1.1.7 Infrastructure

As of 1988, Ibajay's total road network involved 16.266 kms. of national roads (all asphalted); 33.268 kms. of provincial roads (99.7% gravel and 0.3% concrete); 8.63 kms. of municipal roads (8.5% concrete and 91.5% gravel); and 35.70 kms. of barangay roads surfaced with gravel. Bridges are made of concrete.

Ibajay has a port at Colong-colong where improvements are ongoing for the provision of services even for large inter-island vessels.

Electric power is being delivered by the National Power Corporation through the Aklan Electric Cooperative, Inc. (AKELCO). Out of the 5,591 households in 1986, 72.03% were still unserved. In 1987, total connections reached 1,865 serving 1,821 residential units, 21 commercial, 18 public buildings and government offices and 5 industrial units.

1.2 Population and Living Conditions

1.2.1 Population Trend from the Past

Covering a total of 35 barangays, Ibajay posted a total population of 31,214 in 1980, reflecting only a 0.56% annual growth rate since 1975 or a 2.87% increase over the 1975 population.

Being the second most populous municipality next to Kalibo since 1970, Ibajay accounts for almost 10% of the provincial population. However, it only ranked 8th among the municipalities of the province in population density. Its population density was 169.6 persons per square kilometer in 1970 and became 195.1 in 1980.

TABLE B-1 Population and Number of Households by Barangay, Ibajay, Aklan 1980

Barangay	Population	No. of Households
Agbago	1,132	216
Agdugayan	891	145
Antipolo	686	113
Aparicio	771	126
Aquino	1,946	347
Aslum	654	110
Bagacay	793	143
Batuan	722	136
Buenavista	319	62
Bugtong Bato	671	117
Cabugao	373	59
Capilijan	752	159
Colong-colong	555	104
Laguingbanwa	1,778	322
Mabusao	340	72
Malindog	211	41
Maloco	1,798	344
Mina-a	479	83
Monlaque	561	108
Naile	2,063	336
Naisud	1,596	313
Naligusan	658	117
Ondoy	1,329	237
Poblacion	2,297	409
Polo	423	74
Regador	1,126	178
Rivera	264	41
Rizal	767	139
San Isidro	983	170
San Jose	978	155
Santa Cruz	978	183
Tagbaya	954	196
Tul-ang	420	67
Unat	705	125
Yawan	241	44
Total	31,214	5,591

1.2.2 Age Distribution

In 1980, population 15 to 64 years old comprising the productive age groups accounted for 53.4 of the total population. Persons under 15 years of age comprised 40.1% while those 65 years old and above made up 6.5%. Dependency rate therefore was 87.2%.

1.2.3 Morbidity/Mortality

Respiratory diseases primarily pneumonia, bronchitis, and tuberculosis lead the causes of illnesses and deaths along with gastrointestinal disease the more common of these are gastro-enteritis, diarrhea, gastritis and parasitism.

The province is saddled with widespread malnutrition and Ibajay has not been spared. Based on a survey taken last 1987, only 30.5% of the 3,417 children weighed were found to have normal weight. All the rest were considered malnourished of varying degrees: 6.3% severe, 20.0% moderate and 40.0% mild.

1.2.4 Sanitation

Almost one-fourth or 24.7% of the 5,411 households in 1984 were still without toilets. Majority (60.8%) were using the water-sealed type of waste disposal system; 6.2%, the pit privy type; 3.6%, flush with septic tank type; and 4.8%, the antipolo type (closed pit).

1.2.5 Public Services

Ibajay is lucky to be the site of a 48-bed emergency hospital which is, however, understaffed. In the Poblacion, there are 5 private clinics and 2 rural health units. There are also 5 barangay health centers. Public health personnel include 5 doctors, 8 nurses, 13 midwives and 1 dentist. They are complemented by the services of 3 private doctors and 3 private dentists.

Public elementary school teachers reached a total of 210 during school year 1987-1988 reflecting a teacher-pupil ratio of 1:30. In the secondary level, teacher-student ratio was registered at 1:23.

For communication, private citizen may avail of the services of the Bureau of Telecommunications whose facilities include a radio station in the municipality. The Bureau of Posts has its postal station in the poblacion at the municipal building and an office in Naile. RCPI, a private telecommunications firm, has established a station in the poblacion.

1.3 Economy and Industry

1.3.1 Agriculture

The municipality is predominantly agricultural. As of 1980, there were a total of 2,499 farms with an aggregate area of 3,493 ha. and with an average size of 1.40 ha.

The dominant agricultural crops in the municipality are coconut and palay. Of a total production for all crops of

52,540 metric tons, 40m709 metric tons or 77.48% were contributed by coconut followed by palay with a total figure of 7,703 metric tons or 14.66% of the total. Fruits and vegetables production reached 3,287 metric tons or 6.26%. Other minor crops included corn and other cereal, coffee, cacao, tobacco and fibers.

The livestock population of the municipality as recorded in the 1981 census of Agriculture totalled 35,176 heads. This consisted of 272 carabaos, 195 cattle, 340 goats, 1,579 hogs and 32,795 fowls, mainly chicken and ducks.

1.3.2 Other Industries

Fishing is also a major economic activity in Ibajay. Total fishpond area was posted at 611.81 ha. as of August 1983. In addition, a number of the town's household are engaged in marine fishing.

Among the rural industries, sinamay weaving and pottery making contribute to the household income of some of the households in Ibajay. There also exist other cottage industries in the municipality. As of 1987, there were 9 industries registered with the NACIDA: 2 engaged in metal-craft, 1 in ceramics, 4 in garments and 2 in furniture- making.

In the province, only Kalibo and Ibajay have large expansive community shopping centers. In 1987, commercial establishments in Ibajay registered a total of 44 of which 20 were sari-sari stores, 1 grocery, 4 eateries/restaurants, parlor shops, etc., 4 drugstores, 5 dry goods and general merchandise, 2 rice/corn retailers, 2 auto supply and machineries, 4 funeral homes and 2 bakeries.

2. Analysis of Potential Water Source

2.1 Topography and Geology

The municipality of Ibajay is located on the wide plain along the Ibajay River. The Poblacion lies on the delta of the Ibajay River. The river in the study area is bounded in the eastern bank by a steep mountain and in the western bank by rolling hills.

The geology in the study area differs distinctly in the eastern and western banks of the Ibajay River. In the eastern area, sedimentary rocks such as Miocene are distributed. On the other hand, in the western hilly area, Pliocene sediments are extended. These two units maybe meet at the fault which runs from south to north. Geological map is shown in FIGURE B-2.

Miocene Sediments (Tertiary).

This unit consists of alternations as sandstone, conglomerate and shale with limestone partially. Pronounced weathering is observed in conglomerate.

Pliocene Sediments (Tertiary).

This unit consists of sandstone, shale, conglomerate and volcanics alternately.

Alluvial Deposits (Quaternary).

The deposits are found along the Ibajay River, and compose a plain. It consists of sand, clay and pebbles. These sediments were transported by river water from the upland as a result of erosion and weathering. These formations are considered to be bearing the potential aquifer.

2.2 Existing Water Source

Springs

In Barangay Rizal, there is a spring, originating from a crack in the limestone, which yields barely enough water to supply to the Barangay Rizal.

Taking into account the needs for potable water source, the survey was conducted in the mountain area. Consequently, the existence of a spring was confirmed in Barangay Antipolo about 5.5 km southwest of the Poblacion. Flow rate measurement was conducted on the spring by volumetric measurement method. Since there are two gushes at the spring, measurement was conducted individually on April 28, 1988 to assess the potentiality of springs in the dry season. However, survey during the rainy season was not conducted due to the reason of security. The survey results are presented in TABLE B-2.

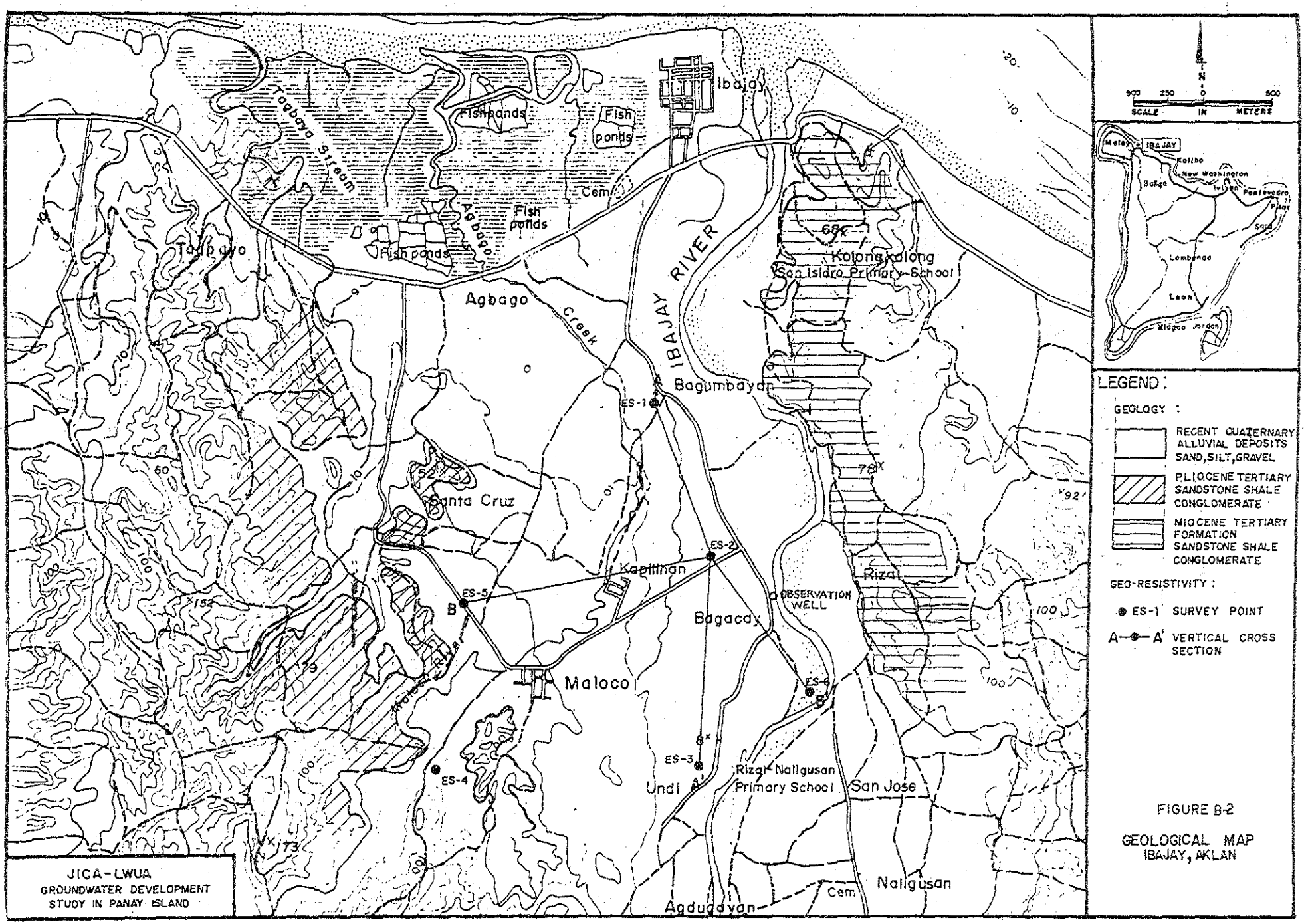


FIGURE B-2

GEOLOGICAL MAP
IBAJAY, AKLAN

TABLE B-2 Spring Yield Measurement

JICA-LWUA Source No.	Location	Flow Rate Dry Season (April 28)
B-10	Antipolo (small spring)	35 cu.m/day (0.41 liter/sec)
	(bigger spring)	86 cu.m/day (0.99 liter/sec)
Total		121 cu.m/day (1.40 liter/sec)

As a result, flow rate of small gush-out was 0.41 liter/sec and another one was 0.99 liter/sec. A total of 1.40 liter/sec or 120 cu.m/day is, therefore, considered as the minimum potential discharge of the spring during the dry season.

Surface Water

The Ibajay River with a drainage area of 244 sq.km, runs beside the Poblacion of Ibajay and flows into the Sibuyan Sea.

The flow rate measurement of the Ibajay River was also conducted at a point about 4 km upstream of the Poblacion by means of a portable current meter and cross section survey of the river on April 28, and September 20, 1988.

In April, the flow amount of the river is estimated at approximately 342,000 cu.m/day and a section area of the river water is calculated at approximately 7.65 sq.m. Consequently, the average flow speed is approximately 0.417 m/sec.

On the other hand, 817,000 cu.m/day of flow amount, 12.43 sq.m of river section and 0.761 m/sec of average speed are surveyed in September.

TABLE B-3 Flow Amount of Ibajay River

	Flow Rate (cu.m/day)	Flow Section (sq.m)	Average Velocity (m/sec)
Dry Season (April 28)	342,000	7.65	0.417
Rainy Season (September 20)	817,000	12.43	0.761

Wells

One deep well with a depth of 36 m (by hearing, no definite record) was constructed in 1979-1980 with a fund from USAID. This deep well is the only source utilized by the Ibajay Waterworks Association and provides the water in the Poblacion area. However, residents customarily do not use the water from deep well for drinking due to light iron content. For drinking purposes, residents are mostly depending on privately constructed shallow wells.

In addition, the existence of two free flowing wells was confirmed by the Survey Team. One well was located at the public market in the Poblacion. This well has a depth of 130 feet (by hearing, not measurable) and a yield of about 0.15 liter/sec which is constant both in dry and rainy season. Another well was located inland about 1 km far from the Poblacion. Though some people utilize the said wells as drinking water sources, water drawn from them is not potable due to a high iron content and sulfurous or hydrogen sulfide odor. This is caused by anaerobic decomposition of organic materials which sedimented in alluvial deposits on the delta of the Ibajay River together with sand and clay.

Well inventory survey was conducted in the Poblacion and its surrounding areas toward the inland area as shown in FIGURE B-3. Preliminary survey based on the records of LWUA, DPWH and NIA was conducted prior to the field survey. However, useful data including well lithologic log was not available.

During the field survey period, depths and static water levels of three wells were surveyed. Collected data are shown in TABLE B-4.

TABLE B-4 Well Data Summary

JICA-LWUA Source Number	Well Depth (M)	Ground Level (MAMSL)	Static Water Level: Dry Season (April 28) (MBGL)	(MAMSL)	Rainy Season (September 20) (MBGL)	(MAMSL)
B-1	3.22	4.0	-1.41	2.6	-0.93	3.1
B-2	4.81	5.0	-2.41	2.6	-1.22	2.8
B-3	5.26	6.0	-3.12	2.9	--	--
B-17	14.35	30.0	--	--	-0.25	27.8

The results are summarized as follows:

i) There is a pressure aquifer about 40 m below ground surface at the coastal area.
ii) Free groundwater table slightly declines from inland to coast.

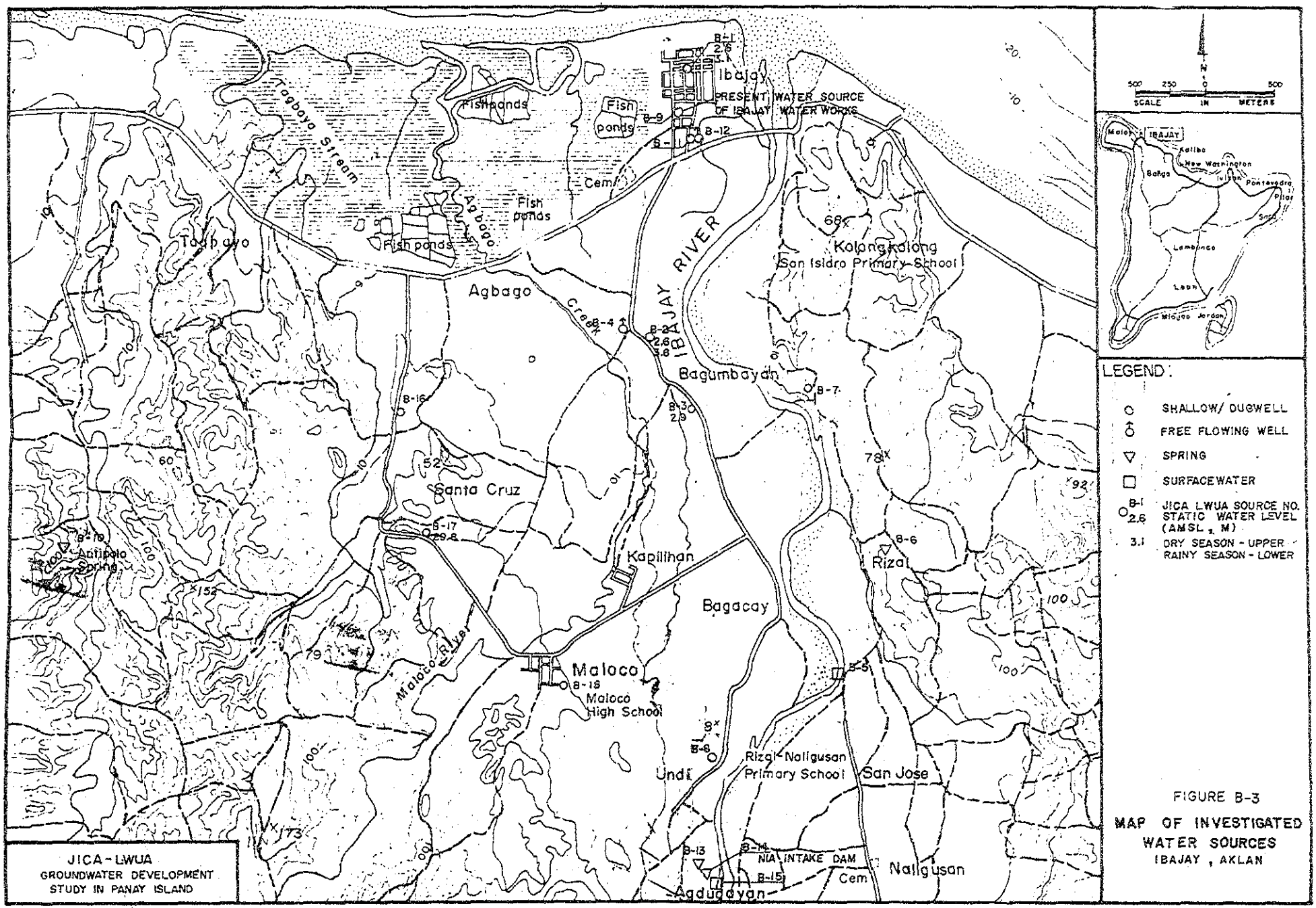


FIGURE B-3
MAP OF INVESTIGATED WATER SOURCES
IBAJAY , AKLAN

2.3 Survey for Potential Water Source

2.3.1 Evaluation of Georesistivity Survey

The survey area lies in the alluvial plain extended between Ibajay River and Maloco River.

The purpose of the survey is the exploration of the aquifer in alluvium.

A total of six (6) points, namely ES-1 to ES-6 are shown in FIGURE B-2

The field activities are mentioned below:

Date	:	April 27 to 28, 1988
No. of Survey Points	:	Six (6) points
Type of Survey	:	Vertical Sounding
Configuration	:	Wenner Method
Sounding Depth	:	100 to 150 meter

The results of the ρ-a curve analysis is shown in TABLE B-5 and the georesistivity sections based on TABLE B-5 are drawn in FIGURES B-4 and B-5.

1) The electrical character of alluvial deposits as drawn in FIGURE B-4, A-A section consists of 2 or 3 layers differing in resistivity.

2) The layer with resistivity from 13 to 27 ohm.m is considered to be clayey to silty facies. Therefore, the potential existing groundwater in such layer is little.

3) On the other hand, the layer with 44 ohm.m, which lies at a depth deeper than 25 mbgl at ES-3 shows to be sandy facies and has possibility of aquifer.

4) The distribution of the resistivity layers at ES-5 point is complex and suggests the existence of aquifers at this point.

2.3.2 Observation/Test Well Drilling

Based on the results of the field survey discussed previously, the following may be deduced:

The young Tertiary and Quaternary Sediments in the western side of the Ibajay River was assessed to be a great potential water bearing formation capable of supporting deep wells. The location selected in the upstream area of the Poblacion. (cf. FIGURE B-2)

TABLE B-5 DEDUCTED VALUES OF GEORESISTIVITY READING INTERPRETATION

IBAJAY, AKLAN

SURVEY POINT	ELEVATION (M,AMSL)	TOPOGRAPHY	RESISTIVITY LAYER													
			1		2		3		4		5		6		7	
			ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m
ES-1	5	alluvial plain	10	2	7	3.4	13	32	25							
ES-2	6	alluvial plain	10	4.2	25											
ES-3	8	alluvial plain	20	0.5	13	4	27	25	44							
ES-4	35	flood plain	34	2.2	102	8	18	42	34	62	13					
ES-5	30	flood plain	28	1.2	19	3	126	7	31	17.5	73	32	5	90	72	
ES-6	5	alluvial plain	170	4.2	17	40	27									

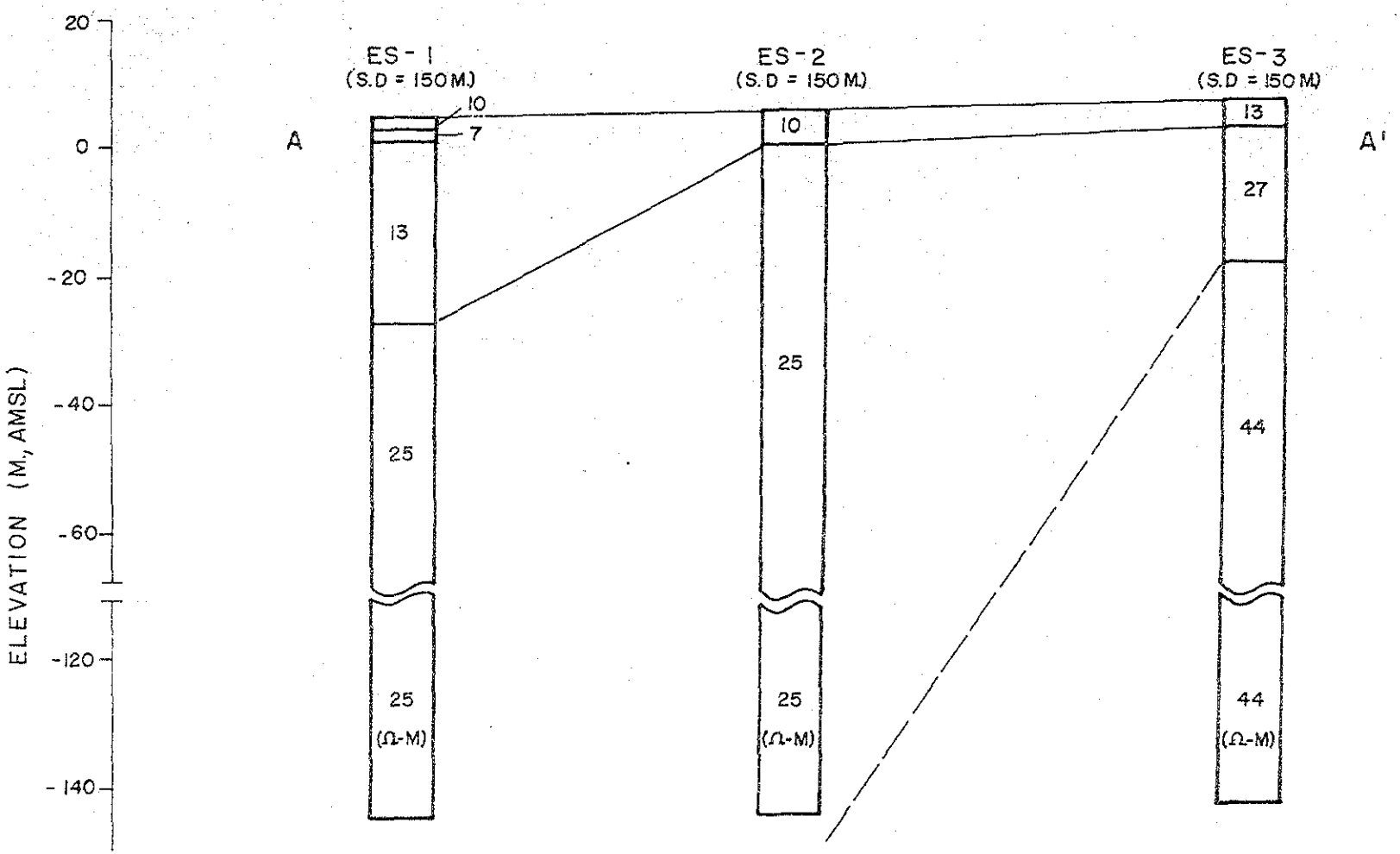


FIGURE B-4

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

GEORESISTIVITY SECTION A - A'
IBAJAY, AKLAN, PANAY ISLAND

JICA - LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND

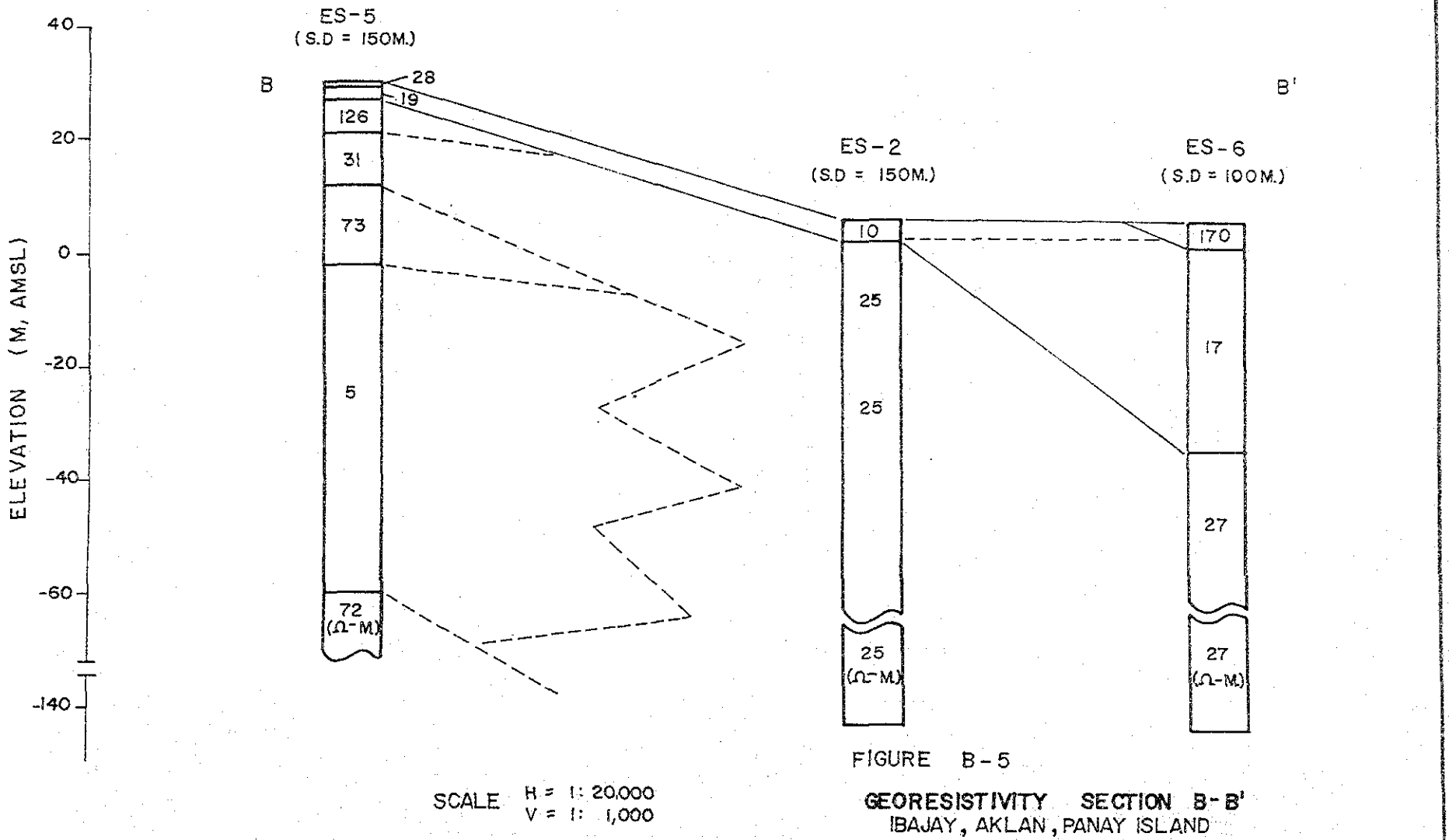


FIGURE B-5

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

GEORESISTIVITY SECTION B-B'
IBAJAY, AKLAN, PANAY ISLAND

JICA - LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND

Observation Well No. 1
Date : May 20 to 30, 1989
Depth : 70.35 m

Well data is shown in FIGURE B-6. Several gravel beds were hit but no groundwater unfortunately.

Gravel bed between 0.8m (-GL) and 7.45m (-GL) are bearing plenty infiltrated water from Ibajay River.

2.3.3 Well Design and Pumping Test

Into the above-mentioned observation well, ϕ2"PVC casing pipes of 60m length with 6 meters screen (54 to 60 m). The well design was shown in FIGURE B-7.

2.4 Water Quality Analysis

Field investigation of water quality was carried out for a total of 15 existing/potential water sources including Ibajay River. Water samples were collected from the deep well of existing Level III system and from the public well and flowing well in the public market. Laboratory analysis of these water samples was carried out to LWUA. TABLE B-6 presents field analysis results and their survey points are indicated on FIGURE B-3.

The deep well (B-9) of existing Level III system showed a high concentration of ammonium nitrogen, total iron as well as high electric conductivity. Similar geochemical characteristics were observed at flowing well (B-4) about 1 km inland of the Poblacion, public well (B-11) and flowing well (B-12) both in the public market and public well (B-8) near ES-8. It is assessed that the presence of ammonium nitrogen is caused by anaerobic decomposition of organic deposits. An unfavorable smell of hydrogen sulfide was also detected from the flowing wells.

TABLE B-6 Water Quality Analysis Results

	Sample	WT (°C)	pH (-)	EC (μS/cm)	T-Fe (ppm)	Mn (ppm)	NH_4-N (ppm)
Dry Season							
B-4	Flowing Well	28.6	7.4	720	0.2	-	<8
B-5	Ibajay River	32.7	8.6	220	nil	nil	nil
B-6	Spring, Bgy. Rizal	27.0	7.3	600	nil	nil	nil
B-7	Public Well Tulong Elem. School, BPW4-75-6	29.5	7.5	650	<0.2	-	nil
B-8	Public Well near ES-8 MPWH 06-1-86-4	29.5	7.5	550	10<	1	5
B-9	Deep Well, Level III	30.5	8.1	1,800	1	0.5	10<
B-10	Spring, Bgy. Antipolo	26.5	8.2	270	nil	nil	nil
B-11	Public Well, Market	28.7	7.8	320	0.2	nil	4
B-12	Flowing Well, Market	28.0	7.8	540	0.2	nil	4
B-13	Spring, Bgy. Agdugayon	27.0	7.2	350	-	-	-
B-14	Spring, NIA Canal	27.5	7.5	385	-	-	-
B-15	Surface Water, NIA Canal	31.5	8.1	295	-	-	-

TABLE B-6 Water Quality Analysis Results (Cont'n)

	Sample	WT (°C)	pH (-)	EC (μS/cm)	T-Fe (ppm)	Mn (ppm)	NH_4-N (ppm)
Rainy Season							
B-4	Flowing Well	28.2	7.3	490	0.5	-	<8
B-6	Spring, Bgy. Rizal	26.6	7.3	510	-	-	-
B-7	Public Well, Tulong Elem. School BPW4-75-6	28.4	7.7	445	0.2	-	nil
B-9	Deep Well, Level III	27.0	8.1	1,090	0.2	-	8.0
B-11	Public Well, Market	28.0	7.9	500	nil	-	3.2
B-12	Flowing Well, Market	27.6	8.0	620	0.2	-	4.0
B-16	Jetmatic Pump at Middle Point Between Agubago and Sta. Cruz	27.6	7.2	490	-	-	-
B-17	Jetmatic Pump Along the Road at Sta. Cruz	27.5	7.5	510	-	-	-
B-18	Maloco High School	28.0	7.5	505	nil	-	nil

FIG.-B-6 OBSERVATION WELL DATA

SCALE :

LOCATION : IBAJAY , AKLAN

WELL NO. : 1 DEPTH : 70.35m DIAMETER : ø 110mm CASING PIPE : ø 50mm PVC

DATE : 20 TO 30 MAY , 1989 TOTAL DAYS: 10

SCALE	DATE D.	DATE M.	DEPTH	GEOLOGICAL MAP	STRATA M. THKS.	GEOLOGICAL NAME	COLOUR
			0.8m		0.8	TOP SOIL	
					0.7	GRAVEL	
					5.15	SAND , CLAY	
5			7.45		6.65	SAND, GRAVEL ↓ W	BLUE GRAY
10	25	5	11.00			CLAY	BLUE GRAY
15			18.10		10.65		
20			21.30		3.20	GRAVEL, SAND CLAY	BLUE GRAY
25	26	5	26.80			CLAY, SAND	BLACK GRAY
			27.70		6.40		
30			34.5		6.45	GRAVEL, SAND CLAY (ORGANIC MATERIAL) RICH NO WATER	BLUE GRAY
35			42.10		7.95	CLAY	BLUE GRAY
			42.95		0.85	GRAVEL, SAND, CLAY	-do-
45			51.50		8.55	CLAY	-do-
50	27	5	60.50				
			59.5		7.65	↓ W GRAVEL, BRECCIA CLAY	BLUE GREEN
60	28	5	60.25				
			63.10		2.85	CLAY	DARK RED, BLUE GRAY, GREEN
65			65.10		5.00	GRAVEL BOULDER CLAY	BLUE GREEN
70	29	6	70.35		2.25	ANDESITE CRACK RICH	

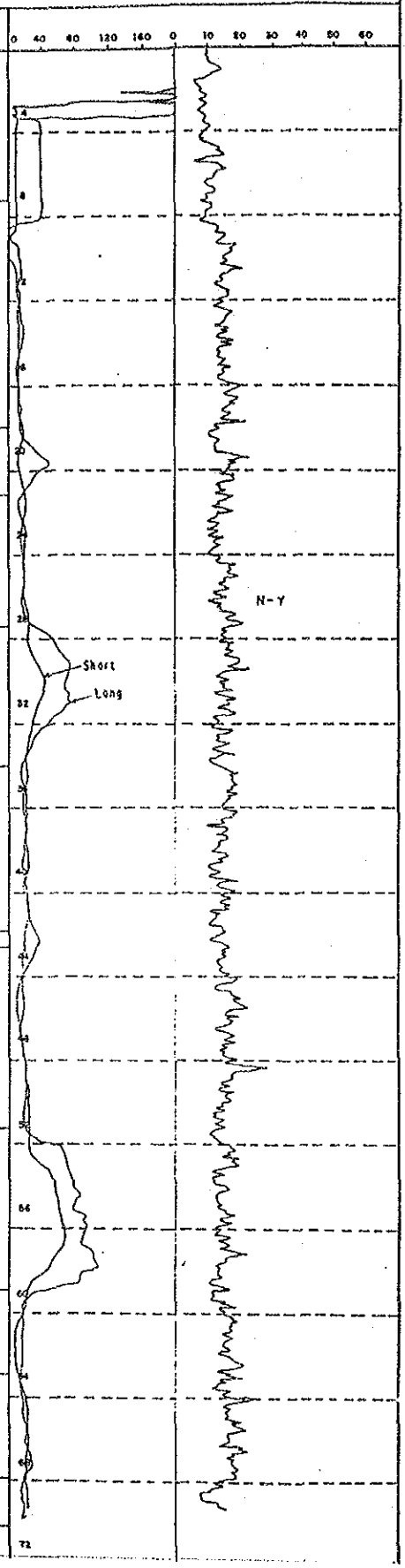
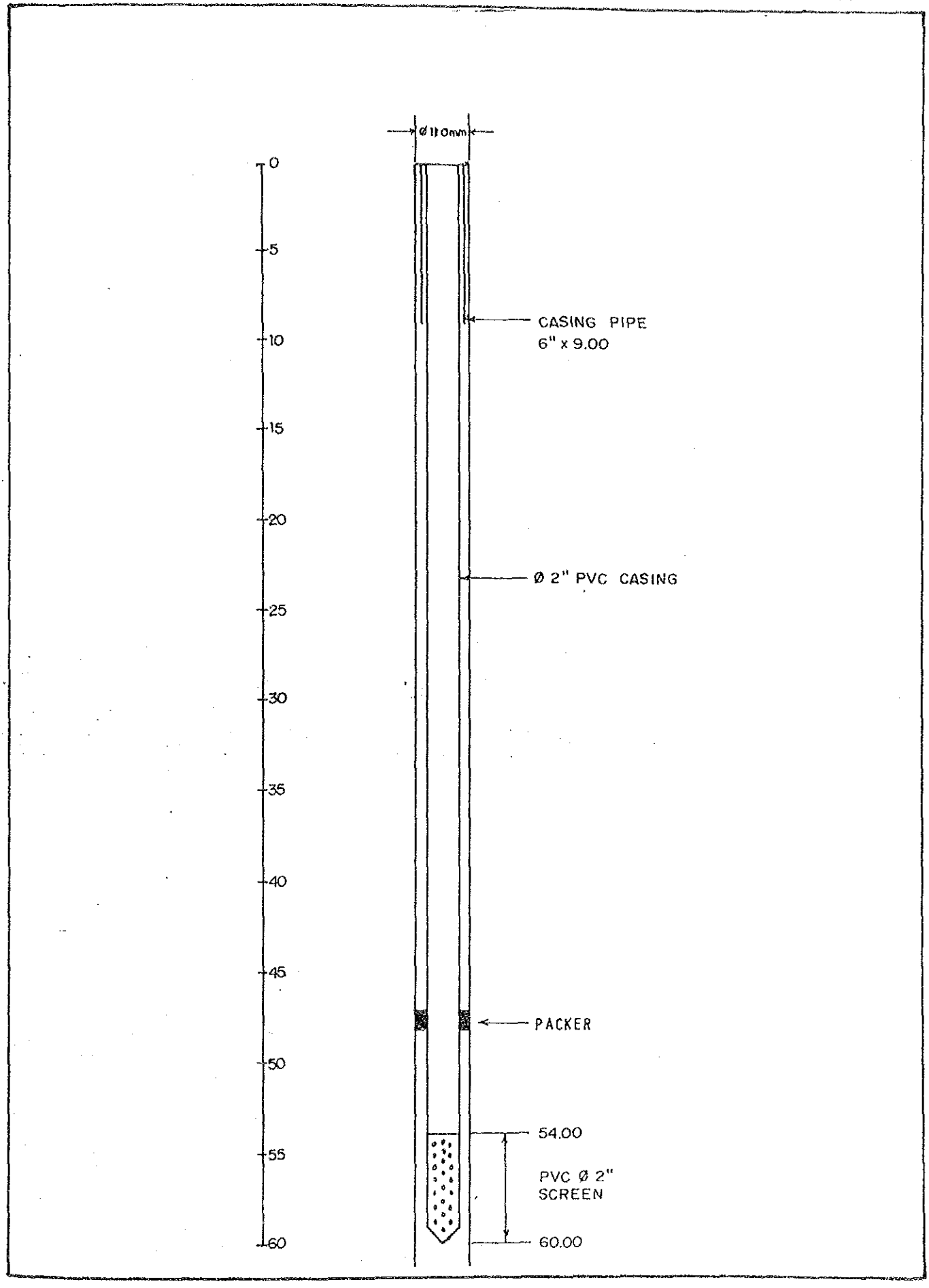


FIG. B-7 WELL DESIGN OF OBSERVATION WELL AT IBAJAY



The following data are results of laboratory analysis.

Sample	B-9		B-12		Maloc High Sch.	
Date of Sampling	6.08.88	9.20.88	6.07.88	9.20.88	6.07.88	9.20.88
Turbidity (FTU)	1	0.9	0.7	0.8	2	0.6
Color (UNIT)	5	85	5	28	nil	nil
TDS (mg/l)	1,216	1,280	403	401	422	420
pH (-)	7.5	7.8	7.4	7.8	7.6	7.7
EC (µS/cm)	1,900	1,900	630	620	660	650
Alkalinity as $CaCO_3$ (mg/l)	418	423	285	270	285	297
Hardness as $CaCO_3$ (mg/l)	547	674	255	232	270	282
Major Cations (meq/l)						
Sodium	7.2	4.3	1.1	1.3	1.1	0.9
Potassium	0.6	0.6	0.2	0.3	0.2	0.05
Calcium	7.6	7.4	3.4	3.2	3.7	4.2
Magnesium	3.3	6.0	1.6	1.4	1.6	1.4
Total	18.7	18.3	6.3	6.2	6.6	6.55
Major Anions (meq/l)						
Carbonate	0	2.2	0	0	0	0
Bicarbonate	8.4	6.3	5.7	5.4	5.7	5.9
Chloride	10.5	9.9	0.5	0.8	0.6	0.6
Sulfate	nil	nil	nil	nil	0.3	0.02
Total	18.9	18.4	6.2	6.2	6.6	6.52

Sample from B-9 shows high concentration of hardness constituents (Ca + Mg) and bicarbonate with chloride. This well is considered to have an origin of Carbonate-hardness dominant presence of chloride in major anions. Other two samples also show Carbonate Hardness Type, but are not predominant with chloride. Sample from B-12 shows color. Sample from a well in Maloc High School presents generally acceptable water quality for drinking purpose.

II. CONCEPTUAL WATER SUPPLY SYSTEM

1. Existing Water Supply Conditions

1.1 Water Use Conditions

A total of 175 households in three (3) barangays in the Poblacion area have connections to the Level III water supply system. Water supplied by the system, however, is not used for drinking purposes due to poor water quality and foul odor.

Residents in the Poblacion area are, therefore, constrained to obtain drinking water from public and private shallow wells and flowing wells. Some of those surveyed also yield groundwater containing high concentrations of iron and ammonium nitrogen, but are still used as drinking water sources due to lack of alternative potable water source in the subject area.

Likewise, a development of potable water source is badly needed in this specific area and the existing water distribution facilities are readily available to connect with a new water source.

1.2 Existing Water Supply System and Problems Encountered

A Level II water supply system was constructed from 1979 to 1980 by the Provincial Engineer's Office under the Barangay Water Program financed by the USAID. System con- figurations are as follows:

- a deep well (ø 200 mm, 36 m of total depth) equipped with a submersible pump (3.5 HP, 16 cu.m/hr)
- an elevated tank (RC, 15 mH, 15 cu.m)
- transmission line (GI, ø 50/100 mm)
- distribution lines (PVC/PB/GI, mainly ø 50 mm)
- 175 service connections (150 metered connections)

This system owned by the municipal government is named "Ibajay Waterworks Association (IWA)". The IWA is manned by one manager, one plumber and two water bill collectors. The IWA is not registered either as "Rural Waterworks and Sanitation Association" (RWSA) or "Water District" (WD).

The system is operated 16 hours a day from 5:00 a.m. until 9:00 p.m. to minimize running costs. A total of about 175 households are presumed to consume approximately 100 cu.m/day.

Water rates are placed at ₱3.5 per cubic meter for metered connection and ₱35 per month for unmetered connections. The municipal government is amortizing construction cost at ₱433 per month to

the provincial government from the earnings of IWA operations.

Inasmuch as the water source yields unsafe drinking water, this Level III System cannot be categorized as a potable water supply system. In this regard, there exists no piped water supply system in the Poblacion area.

Aside from IWA, there are two other small scale Level II rural water supply systems in Barangays Maloco and Rizal, respectively. Both have spring water sources and distribution lines for communal faucets. Maloco is situated approximately 4 km southwest of the Poblacion, while Rizal is situated along the right bank of the Ibajay River about 3.5 km upstream from the river mouth. These systems serve about 50 households each, and do not possess any surplus capacity to serve the Poblacion area.

2. Water Demand Projection

2.1 Criteria

The existing water supply system is providing water to 175 service connections, but the distributed water are not consumed for drinking purposes due to poor quality. In this regard, per capita potential water demand is assumed at 100 lpcd based on the LWUA Methodology Manual and on the experience in a similar water supply feasibility study, "Municipal Water Supply Project", which was conducted by JICA in 1987.

Design unit water consumption is also estimated in accordance with the said Manual for domestic, commercial and institutional purposes, as follows:

- Domestic unit water consumption is estimated at 112 lpcd for 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 is estimated at 1.4 cu.m/connection/day in 1995 with its connection density ratio of 1.2 per 100 inhabitants.

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

In accordance with the LWUA Methodology Manual, the unaccounted-for water is considered at 40% of the total distributed amount. This is the standard ratio to be applied for combined new and old pipelines since the existing pipelines will be utilized continuously.

2.2 Areas to be Served

The target year for water supply planning is set for the year 1995 for the purpose of an intermediate water supply development/improvement. In this regard, the planned service area of this target year is determined to be the densely populated area. The Poblacion is likewise given the highest priority at this time.

Most barangays in Ibajay are situated throughout the municipality with considerable distance from the Poblacion. Inclusion of these barangays in the planned service area will be determined in relation to the water source availability based on the result of field survey to be conducted during the rainy season.

2.3 Population Projection

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

The municipal government also estimated the municipal and barangay population toward the year 1990 based on 1970 census data. The population projected by the municipality for the year 1980 is higher than the census result as shown in TABLE B-7.

TABLE B-7 Population Projection of Ibajay

Year	NEDA Projection	Municipal Projection
1980	31,311	33,930
1985	33,400	37,940
1990	35,130	42,460
1995	36,430	----

The municipal government applied a uniform growth rate of 2.25 percent per year, while NEDA employed declining growth rates for every 5 years; 1.3 percent per year from 1980 to 1985; 1.0 percent per year from 1985 to 1990; and 0.73 percent per year from 1990 to 1995, respectively.

The population projection of the planned service area is carried out based on the NEDA projection. Percentage share of barangay population to municipal population in the year 1995 is assumed to be the same as the 1980 census result. The result of population projection is shown in TABLE B-8.

TABLE B-8 Population Projection of Service Area

Year	Municipality	Planned Service Area (Poblacion)
1980	31,311	2,297
1985	33,400	2,450
1990	35,130	2,580
1995	36,430	2,670

With regard to the water supply service ratio, 80% of the service area population are assumed to be served by the piped water supply system considering the habitation pattern in the service area. Likewise, the design population in 1995 is estimated at 2,140. Average number of persons per household is assumed at 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 connections and future water consumption are shown in TABLE B-9.

TABLE B-9 Water Consumption in 1995

Service Area	Poblacion
Served Population	2,140
No. of Connection	
Domestic	428
Commercial	26
Institutional	1
Total	455
Water Consumption	
(cu.m/day)	
Domestic	240
Commercial	36
Institutional	5
Total	281
Unaccounted-for	
Water	187
TOTAL	468

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 B-10.

TABLE B-10 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 B-11.

TABLE B-11 Daily Maximum Water Demand

Service Area	Water Demand (cu.m/day)
Poblacion	608

The estimated peak hour water demand is proportionate 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 water demand in the year 1995 is calculated as 2.10 and the peak hour water demand is estimated at 1,280 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

Water from the existing deep well in the poblacion contains heavy anmonia nitrogen and iron as well as high conductivity, so that residents do not utilize for drinking. In this regard, an observation well was constructed in approx 3.6 km south of poblacion along Ibajay River, water source for potable water, however, could not obtain due to lack of aquifer except sand and grovel layer with clay. Thus Ibajay River with proper condition in both quantity and quality was determined as a water source providing intake pipe of infiltration to prevent suspended solids and turbidity. The location of intake was decided at 2.5 km upstream of the poblacion, taking account of the tide and slope of the river.

3.2 Plan for Improvement of Water Supply Facilities

3.2.1 Water Source Facility

New infiltration intake, intake pumping station and chlorination facilities will be constructed at 2.5 km upstream from poblacion along Ibajay River.

3.2.2 Transmission Facility

Water supplied from intake facilities will be pumped to new reservoir through south end of poblacion area.

Two new reservoirs will have following functions in addition to their original purpose for water storage:

Water served for poblacion is suppled from the reservoir connected to the existing elevated tank.

Diameters of transmission pipes are determined by daily maximum water consumption, however, diameters of distribution pipes are by hourly maximum water consumption.

Due to the lack of capacity of existing elevated tank, new reservoir will be constructed at the south end of Poblacion. Capacity will be 15% of daily maximum water demand with consideration to operation and emergency storage.

3.2.3 Distribution Facility

Due to small served area and pipe diameter, new distribution main for all poblacion area will be installed with diameter suitable for hourly maximum water consumption. On the other hand, the existing distribution pipes and elevated tank connected with new distribution main will be utilized.

3.2.4 Required Water Supply Facility

Layout of major water supply facilities is shown in FIGURE B-8, flow diagram of facilities in FIGURE B-9 and detail of distribution pipeline in proposed service area in FIGURE B-10.

Size and quantity of required facilities are listed below:

(1) Water source facility

Infiltration Gallery at riverbed of Ibajay River:
ø600 mm pipe, 100 m, EL+10.0 m

Pumping station:
0.65 cu.m/min x 40 mH, 2 units

Chlorination tank

(2) Transmission Line

Transmission line : ø 150 mm, 3,000 m

(3) Distribution facility

Elevated Tank:
RC, ø6.0 m x 3.5 mH, 99.0 cu.m,
1 unit, EL + 15.0 m

Distribution main:
ø 100 mm, 2,400 m
ø 150 mm, 2,300 m

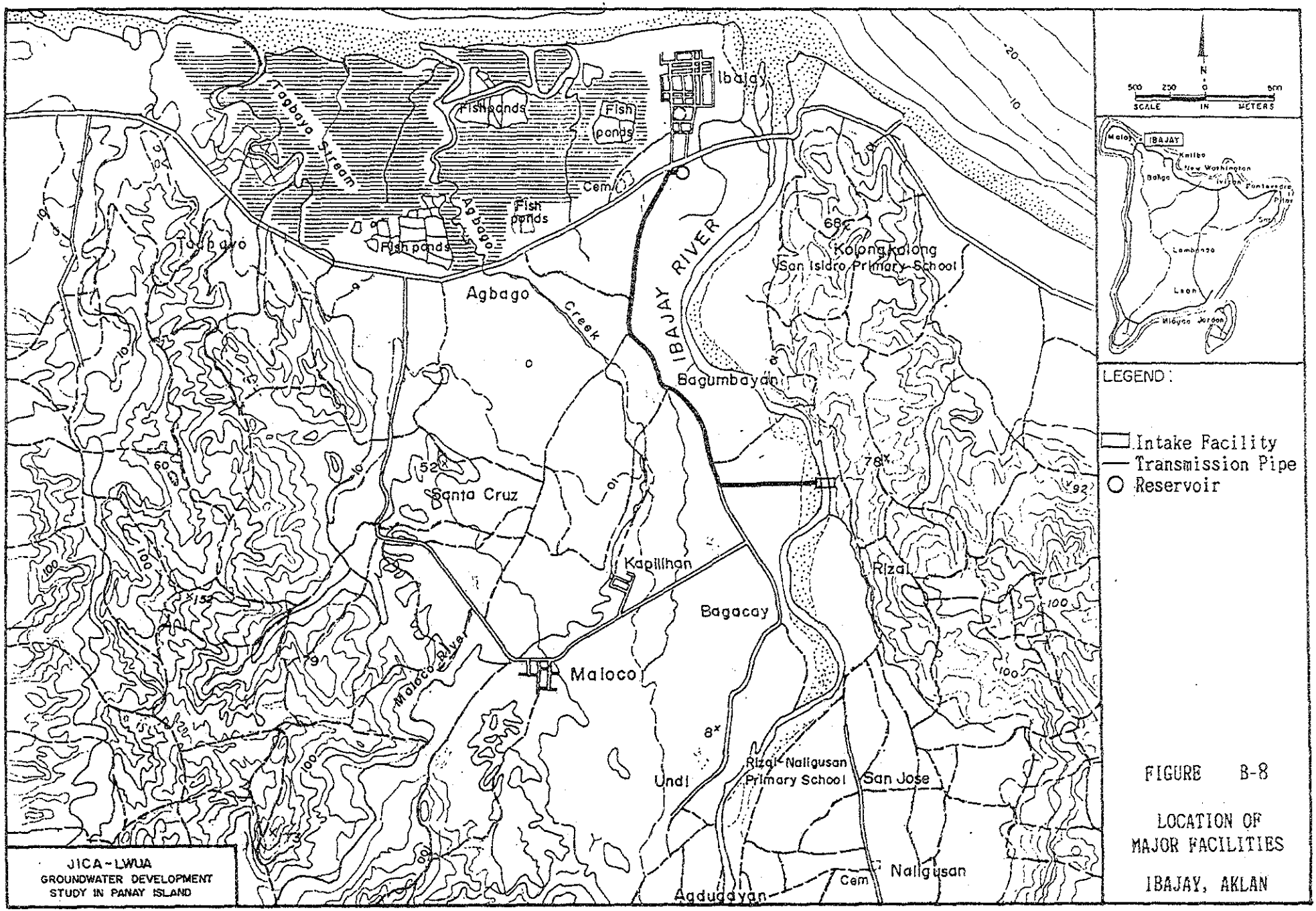
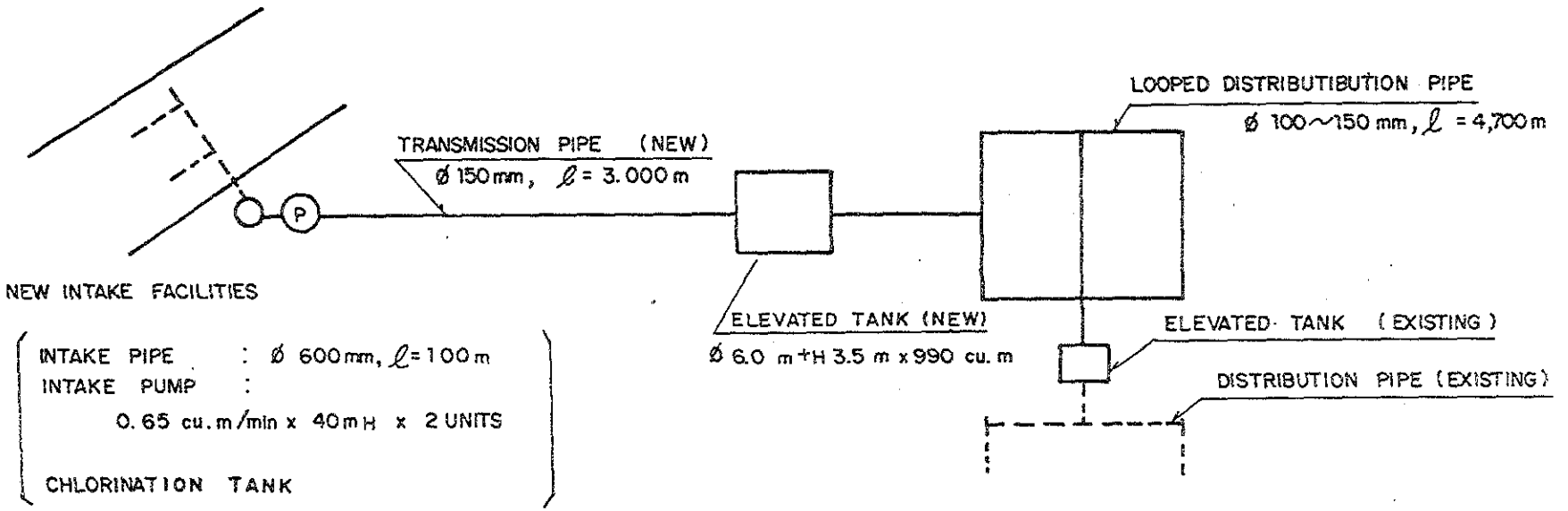


FIGURE B-8

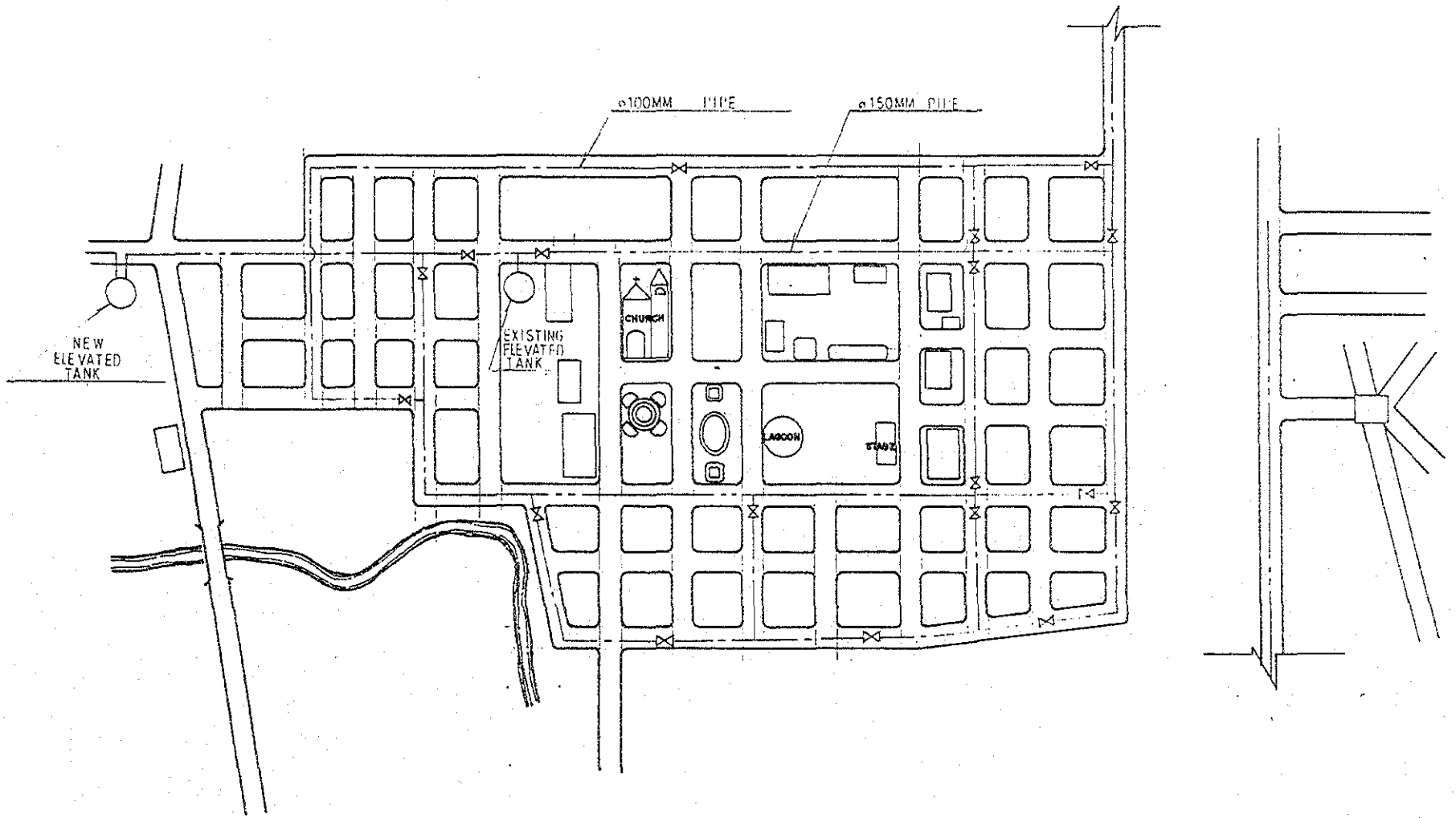
LOCATION OF MAJOR FACILITIES

IBAJAY, AKLAN



JICA - LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND

FIGURE B-9
FLOW DIAGRAM
IBAJAY, AKLAN



JICA – LWUA
GROUNDWATER DEVELOPMENT STUDY IN PANAY ISLAND

FIGURE B-10
DISTRIBUTION PIPELINE
IBAJAY, AKLAN

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	
Intake pipe (ø 600 mm, 100 m)	370.0
Pumping station	
(0.65 cu.m x 40 mH, 2 units)	836.3
Chlorination tank	14.5
Transmission Line	
(ø 150 mm pipe, 3,000 m)	1,890.0
Distribution Facility	
Elevated Tank (99 cu.m)	738.0
Distribution Line	
(ø 100 mm pipe 2,400 m)	648.0
(ø 150 mm pipe 2,300 m)	1,242.0
(ø 100 mm Valve 13 pcs.)	58.5
(ø 150 mm Valve 5 pcs.)	28.5
Total	5,825.8

Total construction cost for improvement of major water supply facilities is estimated at approximately 5.82 million Pesos (40.8 million Yen or 0.28 million U.S. Dollar).

C. NEW WASHINGTON, AKLAN

C. NEW WASHINGTON, AKLAN

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 New Washington, composed of 16 barangays covering a total land area of 6,139 ha., lies at the eastern part of Aklan. The political boundaries are the Sibuyan Sea on the northeast, the municipality of Batan on the southeast, Altavas on the south, Balete on the southwest, Banga on the northwest and Kalibo on the north. It is 10 km from the provincial capital, Kalibo. Location map is shown in FIGURE C-1.

1.1.2 Climate

Having a Type III climate, New Washington has wet and dry seasons that are not very pronounced. The Month of October usually has the heaviest rainfall (414 mm) while April has the least (80 mm).

Temperatures vary very little with the coolest month being January, averaging 26^{o}C, and the warmest month being May, averaging 29^{o}C.

1.1.3 Terrain/Topography

New Washington lies within the AG Tawagon Range which forms the western boundary of a rolling hill and swampland area. Drainage is good except for some coastal marshland. There is a plain extending alongside the swamplands making the municipality's terrain generally flat, i.e., the area is level to nearly level with slope ranging from 0-3%.

1.1.4 Soil

There are five types of soil found in the area. Hydrosol is found in the marshland of the western area; beach sand along the coast; San Manuel sandy clay loam on the north-central area; Santa Rita clay on the northwestern area; and Bantog clay on the southwestern area.

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

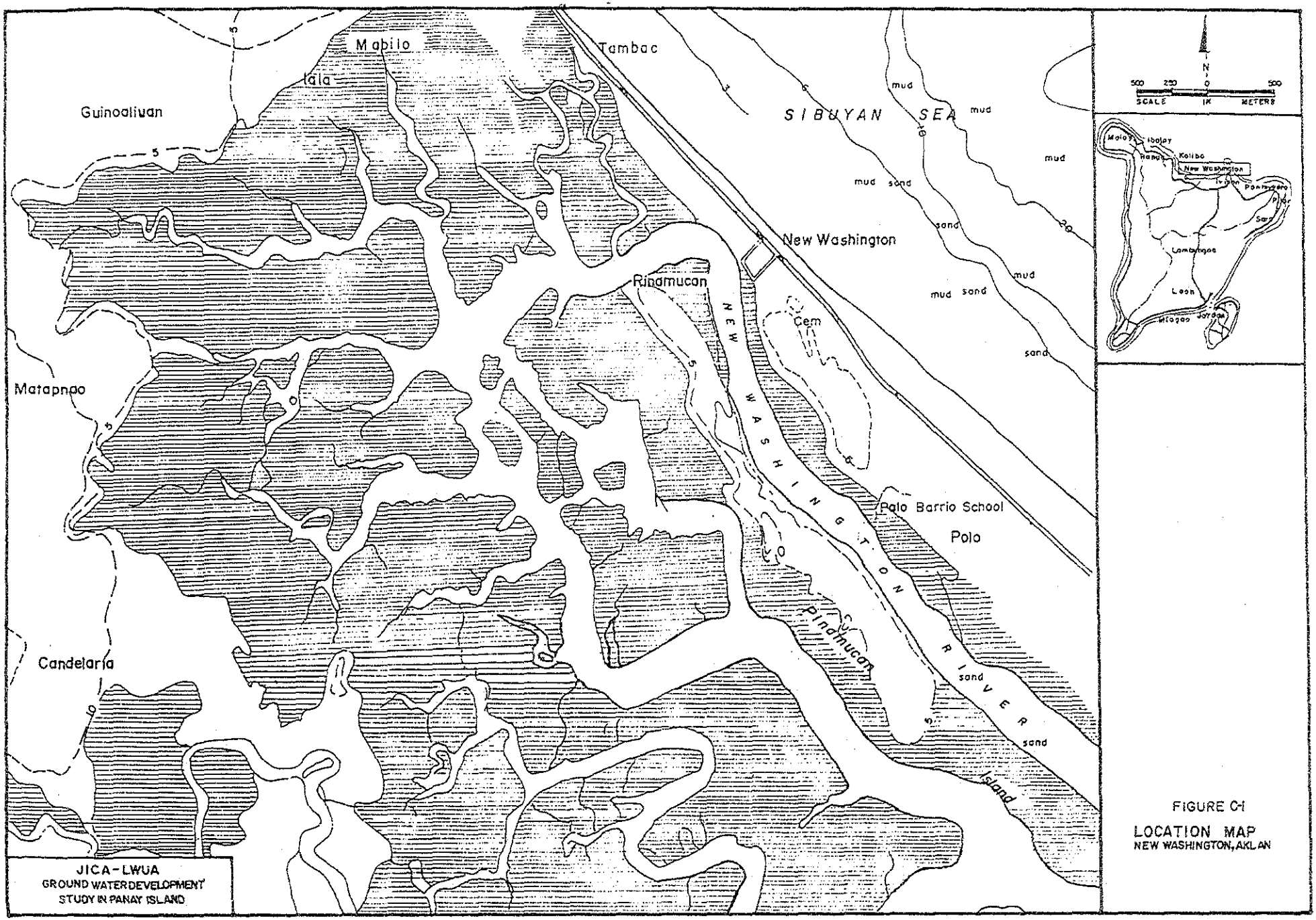


FIGURE C-1

LOCATION MAP
NEW WASHINGTON, AKLAN

legislative body. Under the municipality are the barangays, the smallest political subdivision, which are headed by the 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 new Washington belongs to the third class.

The municipality of New Washington covers 16 barangays, namely:

1. Candelaria
2. Cawayan
3. Dumaguit
4. Fatima
5. Guinbaliwan
6. Jalas
7. Jugas
8. Lawa-an
9. Mabilo
10. Mataphao
11. Ochando
12. Pinamuk-an
13. Poblacion
14. Polo
15. Puis
16. Tambak

Of the municipality's total land area of 6,139 ha., 52.8% are devoted to agriculture; 17.1% are forest lands; 16.7% are swamps, marshes and fishponds; and 13.4% are built-up areas, open spaces or recreation areas and residential, commercial, industrial and institutional areas.

1.1.6 Transportation

Buses, jeepneys/jitneys and tricycles constitute the means of land transportation. Water transportation is also another vital mode of travel with ships docking at the New Washington (Poblacion) and Dumaguit ports. Pumpboats are the primary coastal transportation between the municipality of Batan and Dumaguit.

1.1.7 Infrastructure

As of 1988, the total kilometerage of New Washington's road network was registered at 84.894 km. Of this, 3.278 km are national roads (45.1% asphalt, 30.5% gravel and 6.1% concrete); 10 km, provincial roads (97.7% gravel, 1.3% concrete and 1.0% asphalt); 4.24 km, municipal roads (32.2% concrete, 67.8% gravel); and 47.579 km (gravel) of barangay roads.

There are two ports in the municipality. The port of poblacion is generally used by large interisland cargo ships which also accept passengers. This port on the New Washington River is well protected during stormy weather but would require dredging to accommodate the largest inter-island vessels.

The port of Dumaguit can also serve large inter-island vessels and has been judged to be the best location for major port to serve the needs of the province. It is relatively near the major population and economic center of Kalibo and is presently used by one shipping line, which maintains a Manila-Dumaguit-Manila route accepting both passengers and cargoes.

These two ports are the only ports in the province serving western Aklan and northern Antique. As a result, during certain periods of time such as the start and end of the school year and the Ati-atihan festival, the ports are congested.

Although 53.66% of the total number of households (4,555) were still without electricity in 1986, New Washington is one of the few municipalities in the province that are relatively adequately energized by the Aklan Electric Cooperative, Inc. (AKELCO).

1.2 Population and Living Conditions

1.2.1 Population Trend From the Past

The municipality's population posted an average annual growth rate of 2.96% from 1970 to 1975 and 3.37% from 1975 to 1980, far outpacing the province's growth rates of 2.18% and 2.04%, respectively. With a total population 26,119 or 8.05% of the provincial population, New Washington is the third most populous municipality, next to Ibajay and Kalibo.

Having an area of 61.4 square kilometers, New Washington's population density was 425.39 persons per square kilometer in 1980 making New Washington the fourth most densely populated municipality.

Rural population accounted for 84.51% of the total municipal population.

TABLE C-1 Population and Number of Households by Barangay, New Washington, 1980

Barangay	Population	No. of Households
Candelaria	996	168
Cawayan	2,505	448
Dumaguit	1,312	240
Fatima	700	131
Guinbaliwan	1,674	304
Jalas	863	165
Jugas	1,497	270
Lawa-an	701	124
Mabilo	1,616	317
Mataphao	1,223	214
Ochando	1,966	333
Pinamuk-an	1,660	280
Poblacion	4,047	665
Polo	1,762	290
Puis	1,688	295
Tambac	1,909	315
Total	26,119	4,555

1.2.2 Age Distribution

Fifty-four percent of the municipal population belonged to the productive age group while 41% belonged to age group below 14 years old and 5% to age group above 64 years old. Dependency rate was therefore 85%.

Male population outnumbered female population reflecting a ratio 102.5 males for every 100 females.

1.2.3 Morbidity/Mortality

As in previous years, the leading causes of morbidity and mortality in 1985 are respiratory in nature. For morbidity, the major causes are bronchitis, influenza, and upper respiratory tract infection. the major causes of mortality are bronchopneumonia, heart failure and tuberculosis.

Malnutrition is also a problem in the municipality. Of the 4,044 preschool children weighed for the operation Timbang conducted in 1983, 78.4% were found to be malnourished.

1.2.4 Sanitation

More than one-third of 37.8% of the households still do not have toilet facilities. Around 29.3% have the open-pit

type for their waste disposal system; 20.3% the water-sealed with cesspool type; 2.1%, water-sealed with septic tank; and 1.1%, flush with septic tank.

1.2.5 Public Services

A maternity hospital/puericulture center, which has a capacity of 10 beds, serves the municipality and part of the municipality of Batan.

There also exist one rural health hospital and 3 barangay health stations. The hospital which is located in the Poblacion is manned by 3 physicians, 2 nurses, 3 midwives, 2 sanitary inspectors and 1 dentist. The health stations, located in Candelaria, Ochando and Puis, are manned by midwives.

As to education facilities and services, the municipality has 16 elementary schools, 3 secondary schools and 1 college. Pupil-classroom ratio average at 1;29 in the elementary level and 1:47 in the secondary level. Pupil- teacher ratio averaged at 1:29 in the elementary level and 1:38 in the secondary level.

For communication, the Bureau of Telecommunications (BUTEL) has telephone facilities covering Kalibo and some of New Washington and Numancia. A telegraph station under BUTEL is located in the municipal building. There are also two postal offices, one in Poblacion and the other in Dumaguit.

1.3 Economy and Industry

1.3.1 Agriculture

The economy depends greatly on agriculture. Total number of farms was 1,473 in 1980 covering an aggregate area of 1,282.93 ha. Average farm size was small (0.87 ha).

Fishing industry is also a dominant industry in the municipality. the total fishpond area, 1,619.96 ha, is the second biggest in the province, next to Batan. Offshore fishing is done by four fishing boat operators with home ports at Polo, New Washington.

Agricultural production records of 1980 showed the predominance of palay and coconut. Of a total of 6,410 metric tons produced for that year, palay constituted 5,770 metric tons or 90.14% and coconut 529 metric tons or 8.27% of total. Fruits and vegetable production reached only 102 metric tons or 1.59%.

The livestock population of the municipality as recorded in the 1980 Census of Agriculture totaled 19,584 heads. This consisted of 276 carabaos, 195 cattle, 2 goats, 1,597 hogs and

fowls, mainly chicken and ducks.

1.3.2 Other Industries

Manufacturing establishments totaled 16 in 1980, majority of which were family-owned and operated as cottage industry enterprises.

In 1987, 12 cottage industries registered with DTI: 2 engaged in tinscraft, 3 in manufacture, 2 in food processing, 1 in garments, 3 in fibercraft and 1 in mat weaving.

2. Analysis of Potential Water Source

2.1 Topography and Geology

The Poblacion area of New Washington is situated in the narrow sandbank along the coastal line and is flanked by the sea and swamp/fish ponds. The sandbank measures about 300 to 500 m in width, 10 km in length and 5 m in elevation. The Sibuyan Sea extends to the north of the municipality. Expansive portions of the low-lands have been developed into ricefields which extend inland across a swampy area. Geological map is shown in FIGURE C-2.

The geology of New Washington consist of alluvial deposits.

Alluvial Deposits (Quaternary)
The sandbank is composed of large amount of sandy, silty materials transferred from the mouth of Aklan, Mabilo river by current.

The low-land is characterized by sandy clay.

2.2 Existing Water Source

Surface Water

The Lagatic River (New Washington River) runs along the sand bank on which the Poblacion is situated. However, the surface water of the river and its tributaries could not be considered as possible water source due to sea water intrusion.

Wells

The major sources of water in the Poblacion of New Washington are limited to a dug well and a shallow well due to its geographical features.

Although the major water supply system including dug well source, elevated concrete reservoir, transmission and distribution pipelines were constructed for the Poblacion in 1980 by the then MPWH, the system has not been in operation for various reasons. At that time, an attempt to drill a 90 m deep well was made in the Poblacion with the objective of acquiring a water source for the system. However, this project was abandoned because the yield was purely salt water.

This phenomena is caused essentially by the sandbank which is composed of permeable sand and is saturated with salt water about 5 m below ground level.

Also there are two small scale water supply systems by dug well, both of which are not operational.

Well inventory survey in the field was conducted in the

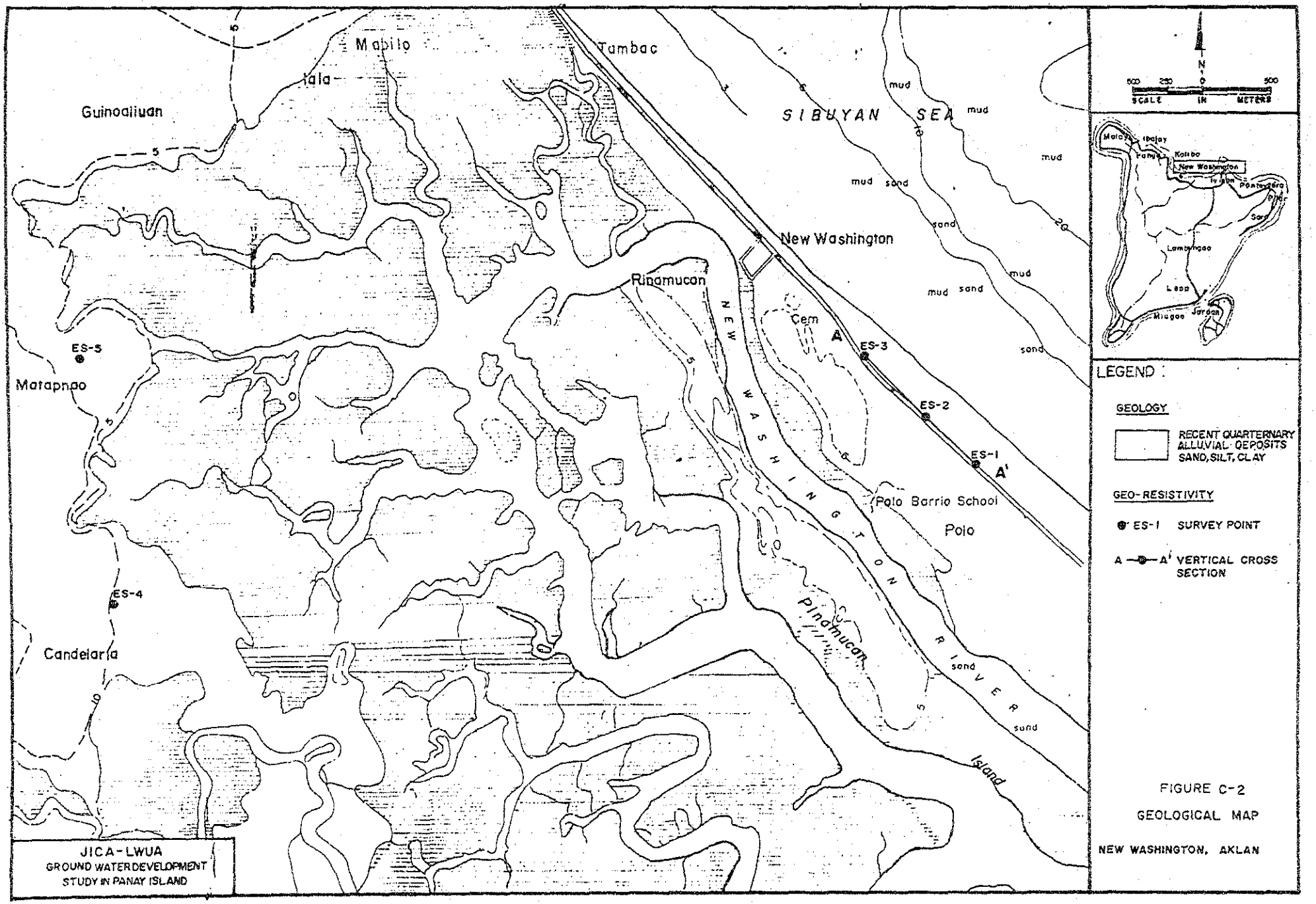


FIGURE C-2
GEOLOGICAL MAP
NEW WASHINGTON, AKLAN

Poblacion as shown in FIGURE C-3 to assess the present groundwater condition. The collected data are shown in TABLE C-2.

TABLE C-2 Well Data Summary

JICA-LWUA Source Number		Well Depth (M)	Ground Level (MAMSL)	Static Water Level Dry Season (April 26) (MBGL)	(MAMSL)*	Rainy Season (Sept. 17) (MBGL)	(MAMSL)
C-1	Dug well beside DPWH Level II well	2.93	2.1	-1.98	0.1	-1.36	0.7
C-2	Shallow well near Fisheries College	2.87	2.7	-2.43	0.3	-1.30	1.4
C-3	Dug well at center of Plaza	2.51	2.9	-2.37	0.5	-1.42	1.5
C-4	Dug well at side of Plaza	2.40	2.5	-2.01	0.5	-1.13	1.4
C-5	Dug well between Plaza and mun. hall	2.95	2.5	-2.38	0.1	-2.27	0.2

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

The results are summarized as follows:

i) There is no deep well in the Poblacion.

ii) The depth of wells located in the Poblacion ranges from 2.4 to 3.0 m below the ground.

iii) Static water level of wells are estimated at about 0 m to 0.5 m above mean sea water level in dry season, and 0.2 m to 1.5 m in rainy season.

iv) Though the sea water level at the time of survey in rainy season was 0.5 m lower than that in dry season, the groundwater table in rainy season was higher than that in dry season at the central area of the Poblacion.

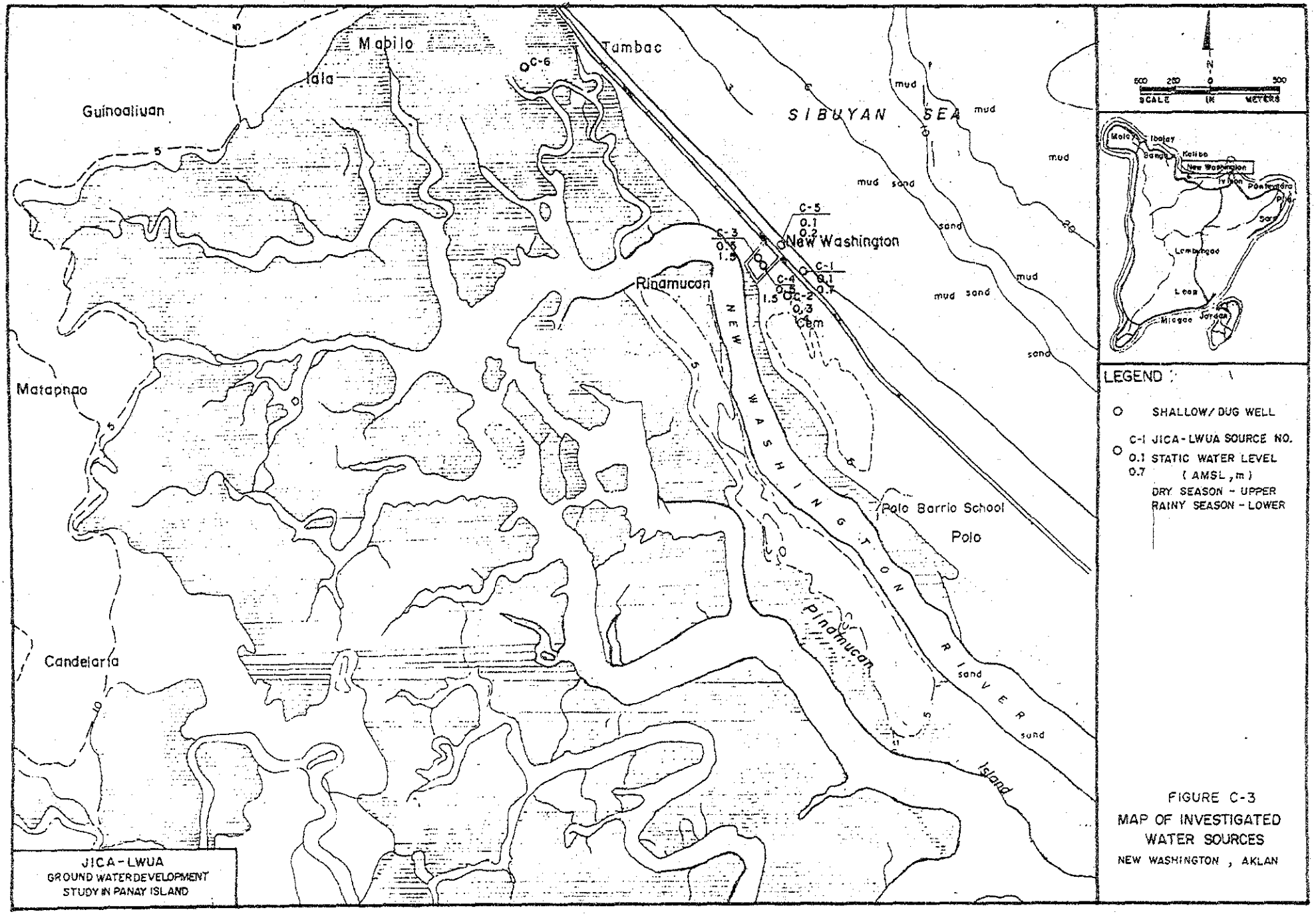


FIGURE C-3
MAP OF INVESTIGATED
WATER SOURCES
NEW WASHINGTON , AKLAN

2.3 Survey for Potential Water Source

2.3.1 Evaluation of Georesistivity Survey

The survey area is divided into the sandbank which extrudes to the Sibuyan Sea and the lowland which faces a swamp.

The purpose of the survey is the exploration of possible groundwater in the deep portion of the above-mentioned area.

A total of five (5) points, namely ES-1 to ES-5 are shown in FIGURE C-2.

The field activities are shown below:

Date	:	May 6, 1988
No. of Survey Points	:	Five (5) points
Type of Survey	:	Vertical Sounding
Configuration	:	Wenner Method
Sounding Depth	:	40 to 150 meters

The results of the ρ-a curve analysis is shown in TABLE C-3 and the resistivity section based on TABLE C-3 is drawn on FIGURE C-4.

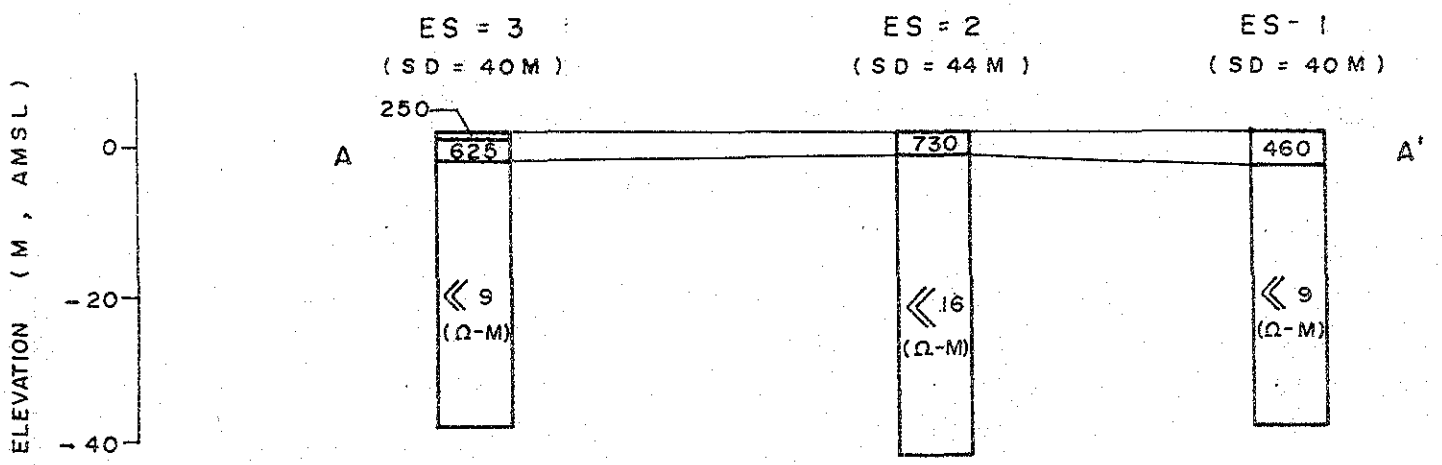
1) ρ-a curves at ES-1 to ES-3 show the simple curves composed of two layers. The resistivity ranging from 3 to 4 meters BGL drops down abruptly to low resistivity. These phenomena is interpreted to mean the saturation by salt water from nearby surface.

2) The resistivities at ES-4, ES-5 are almost below 20 ohm.m and show clayey to silty facies. The potential of the existing aquifer is not anticipated in the lowland.

TABLE C-3 DEDUCTED VALUES OF GEORESISTIVITY READING INTERPRETATION

NEW WASHINGTON, AKLAN

SURVEY POINT	ELEVATION (M,AMSL)	TOPOGRAPHY	RESISTIVITY LAYER 1		2		3		4		5		6	
			ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m
ES-1	2	sand bank	250	1.1	625	3.8	<<9							
ES-2	2	sand bank	780	3	<<16									
ES-3	2	sand bank	460	4.4	<<9									
ES-4	11	alluvial plain	16	1.3	11	2.2	20	7	11	25	37	36	6	
ES-5	10	alluvial plain	7	1.3	11	10	7	36	3					



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

FIGURE C-4

GEORESISTIVITY SECTION A-A'
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2.4 Water Quality Analysis

Three existing water sources were examined at the site. Two water sample was also collected for laboratory analysis at LWUA. TABLE C-4 shows the result of field analysis and survey points are pinpointed on FIGURE C-3.

TABLE C-4 Water Quality Analysis Results

Sample	WT (°C)	pH (-)	EC (μS/cm)	T-Fe (ppm)	Mn (ppm)	NH_4-N (ppm)
Dry Season						
C-4 Dug well at Plaza	30.2	7.5	260	nil	nil	nil
C-6 Dug well, Level II, Mabilo	28.8	7.0	245	nil	-	0.8
Rainy Season						
C-2 Shallow well near Fisheries College	30.8	7.1	300	0.2	-	nil
C-4 Dug well at Plaza	29.3	7.4	250	nil	-	0.4
C-6 Dug well, Level II, Mabilo	28.3	7.4	950	0.2	-	6.0

Wells at C-2 and C-4 exhibited fairly good characteristics, while the dug well (C-6) of Level II water source in Mabilo showed a slight brownish color with the presence of ammonium nitrogen. Water quality characteristics of the latter dug well were also observed in Kalibo. As in the preceding case of Ibajay, this phenomenon is presumed to be caused by anaerobic decomposition of organic deposits.

The following data are results of laboratory analysis for water samples collected from C-2 and C-4.

Sample	C-2	C-4
Date of Sampling	9.17.88	6.07.88
Turbidity (FTU)	0.6	0.6
Color (UNIT)	5	5
TDS (mg/l)	200	493
pH (-)	8.0	7.6
EC (μS/cm)	330	770
Alkalinity as $CaCO_3$ (mg/l)	75	247
Hardness as $CaCO_3$ (mg/l)	95	240
Major Cations (meq/l)		
Sodim	1.4	3.0
Potassium	0.01	0.1
Calcium	0.6	2.2
Magnesium	1.3	2.5
Total	3.31	7.8
Major Anions (meq/l)		
Carbonate	1.4	0
Bicarbonate	0.1	4.9
Chloride	1.4	2.2
Sulfate	0.3	0.4
Total	3.2	7.5

Both samples are dominant with hardness components in cations, but anions show different characteristics of samples. Sample from C-2 may be classified to Non-Carbonate-Hardness Type, while sample from C-4 apparently belongs to Carbonate-Hardness Type.

3. Conclusion and Recommendation

Conclusively, the development of groundwater through deep well construction in this study area is not feasible because of the salt water intrusion.

Construction of dug wells or shallow wells are the only effective way to get fresh groundwater in this area. However, the construction of dug/shallow wells for the water supply system is not advisable because of the following reasons:

1) Fear of water pollution by seepage of human waste and other pollution materials.

2) Fear of sea water intrusion by pumping of a large amount of water.

3) Fear of making groundwater table going down which may cause heavy damage to the existing wells.

II. CONCEPTUAL WATER SUPPLY SYSTEM

1. Existing Water Supply Conditions

1.1 Water Use Condition

Presently, no piped water supply system is being operated. Most of the residents in this municipality draw drinking water from public or private shallow tube/dug wells. Private dug wells are generally unprotected. Some of the residents in the Poblacion area purchase drinking water from private water purveyors, who fetch water from Kalibo where the Kalibo Water District supplies potable water.

In general, the Poblacion area has inadequate water sources for drinking purposes and the capacity of existing water sources are too small to meet potential water demand.

The municipal government, therefore, proposed a resolution to form a Water District in August 1982, but it was not approved by LWUA. A second resolution, finalized in January 1987, was submitted to LWUA for approval in August 1987. The municipal government intended to purchase water from the Kalibo Water District by installing a pipeline for about 5 km, if an appropriate water use is not available within the municipal boundary. The Kalibo Water District, on the other hand, has signified its intention to absorb New Washington into its area of responsibility.

1.2 Existing Water Supply System and Problems Encountered

Three small scale Level II water supply systems were constructed in the Poblacion area, but these were abandoned for various reasons:

- the first system in the Poblacion has a deep well with a depth of 90 m, but the well is intruded by salt water.
- the second, which was constructed to serve Barangay Tambac, had water source facilities (a dug well with an electric motor pump and an elevated tank) in Barangay Mabilo, but the pump was reportedly stolen. The dug well yields free groundwater with brownish color and ammonium nitrogen.
- the third, which is situated in Barangay Polo has the same facilities as that in Barangay Tambac, but its operation has been suspended because the users do not have the capability to pay for the running cost.

The dug wells of these facilities are protected and covered by concrete, but the surrounding environment is not hygienic. All the elevated concrete tanks have the same structural design (H=5 m, 6 cu.m). Details of these systems are not available since no technical data or drawings are kept by the municipality or agencies concerned.

2. Water Demand Projection

2.1 Criteria

The absence of functioning piped water supply system couple with poor water supply conditions in the study area caused difficulty to assess per capita potential unit water demand. Based on the LWUA Methodology Manual and on the experience previously obtained from similar water supply feasibility study, "Municipal Water Supply Project" conducted by JICA in 1987, the per capita unit water consumption was placed at 100 lpcd.

Design unit water consumption by consumer type is thereby 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 is estimated at 1.4 cu.m/connection/day in 1995 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.

In accordance with the LWUA Methodology Manual, the unaccounted-for water is considered to be 25% of the total distributed amount which is the standard ratio for new pipelines.

2.2 Areas to be Served

The target year for water supply planning is set for the year 1995 for the purpose of an intermediate water supply development/improvement. In this regard, the planned service area of this target year is determined to be the densely populated area, with the Poblacion given top priority.

Most of the barangays in New Washington are situated in land area as rural areas and isolated from the Poblacion by swamps. Inclusion of these barangays in the planned service area will depend on the pipeline route to be extended from the Kalibo Water District. Such will be determined based on the results of a field survey to be conducted during rainy season.

2.3 Population Projection

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

The municipal government also estimated the municipal and barangay population from 1980 to 2000 based on the NEDA population census conducted in 1970 and 1975.

A comparison of theses population projections are shown in TABLE C-5.

TABLE C-5 Population Projection of New Washington

Year	NEDA Projection	Municipal Projection
1980	(26,201)	24.220
1985	29,350	28,560
1990	32,290	31,210
1995	34,900	34,140
2000	36,780	37,360

* ( ) shows census result.

The municipal projection from 1980 to 1995 is lower than that of the NEDA projection. The NEDA projection is, therefore, considered more realistic as the principal population projection since this is based on the latest census result carried out in 1980.

Percentage share of barangay (Poblacion) population to the municipal population in the year 1995 is assumed to be the same as the 1980 census result. The result of population projection is shown in TABLE C-6.

TABLE C-6 Population Projection of Service Area

Year	Municipality	Service Area (Poblacion)
1980	(26,201)	(4,047)
1985	29,350	4,530
1990	32,290	4,990
1995	34,900	5,390

* ( ) shows census result.

The water supply service ratio was placed at 80% of the service area population, considering the habitation pattern in the subject area wherein houses are gathered along the major streets located on the narrow sand strip sandwiched by coastal line and swamps. Likewise, the design population for the year 1995 is estimated at

4,310 and the 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 area population and design unit water consumption by consumer type.

The estimated number of connections and future water consumption are shown in TABLE C-7.

TABLE C-7 Water Consumption in 1995

Service Area	Poblacion
Served Population	4,310
No. of Connection	
Domestic	862
Commercial	52
Institutional	2
Total	916
Water Consumption (cu.m/day)	
Domestic	483
Commercial	73
Institutional	10
Total	566
Unaccounted-for Water	189
TOTAL	755

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 C-8.

TABLE C-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 C-9.

TABLE C-9 Daily Maximum Water Demand

Service Area	Water Demand (cu.m/day)
Poblacion	982

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:

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

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

The ratio of peak hour water demand in the year 1995 is calculated as 2.01 and the peak hour demand is estimated at 1,970 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 as well as inland area to ward Kalibo, the neighboring town, is quite scarce and not favorable for the use in water supply development. Due to this hydrogeological constraint, water source shall be obtained outside of the municipality. In this connection, groundwater from deep well at right bank of Aklan River in Kalibo is considered the most practical and water supply system of these two municipality shall be integrated from the view point of both water source availability and economical operation of water supply system.

3.1.3 Transmission and Distribution Facilities

There are abandoned water supply facilities, such as small size RC elevated water tank (approximately 5 cu.m), but its height and capacity is far below the requirement for water supply improvement. Likewise, all the required transmission and distribution facilities will have to be newly constructed.

One booster pump station exclusively for water transmission to New Washington will be constructed near the airport in Kalibo. Transmission main will be laid from this pump station upto the elevated tank in poblacion. Water will be distributed by means of gravity flow.

Chlorination in New Washington is not considered since the water will be disinfected in Kalibo.

3.2 Plan for Improvement of Water Supply Facilities

3.2.1 Water Source Facility

Water source facility is not considered within the administrative jurisdiction of New Washington.

3.2.2 Transmission Facility

The booster pump station will equip with two units of booster pump having capacity of 1.0 cu.m/min and total dynamic head of 53 m.

Transmission main will be ø 150 mm for a total length of 8.0 km.

3.2.3 Distribution Facility

Elevated tank with capacity of approximately 15% of the daily maximum water supply quantity will be newly constructed. New looped distribution main will be also constructed.

3.2.4 Required Water Supply Facilities

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

Size and quantity of required facilities are listed below:

(1) Water Source Facility

Not considered.

(2) Transmission Facility

Booster pump station:
Pump-ø 100 mm x 1.0 cu.m/min x 53.0 mH x 15 kW, 2 units

Transmission main:
ø 150 mm pipe, 8,000 m

(3) Distribution Facility

Elevated water tank:
RC, ø7.5m x total height 16 m x
effective depth 3.5 m, 154 cu.m, 1 unit

Looped distribution main: ø150 mm pipe, 1,600 m

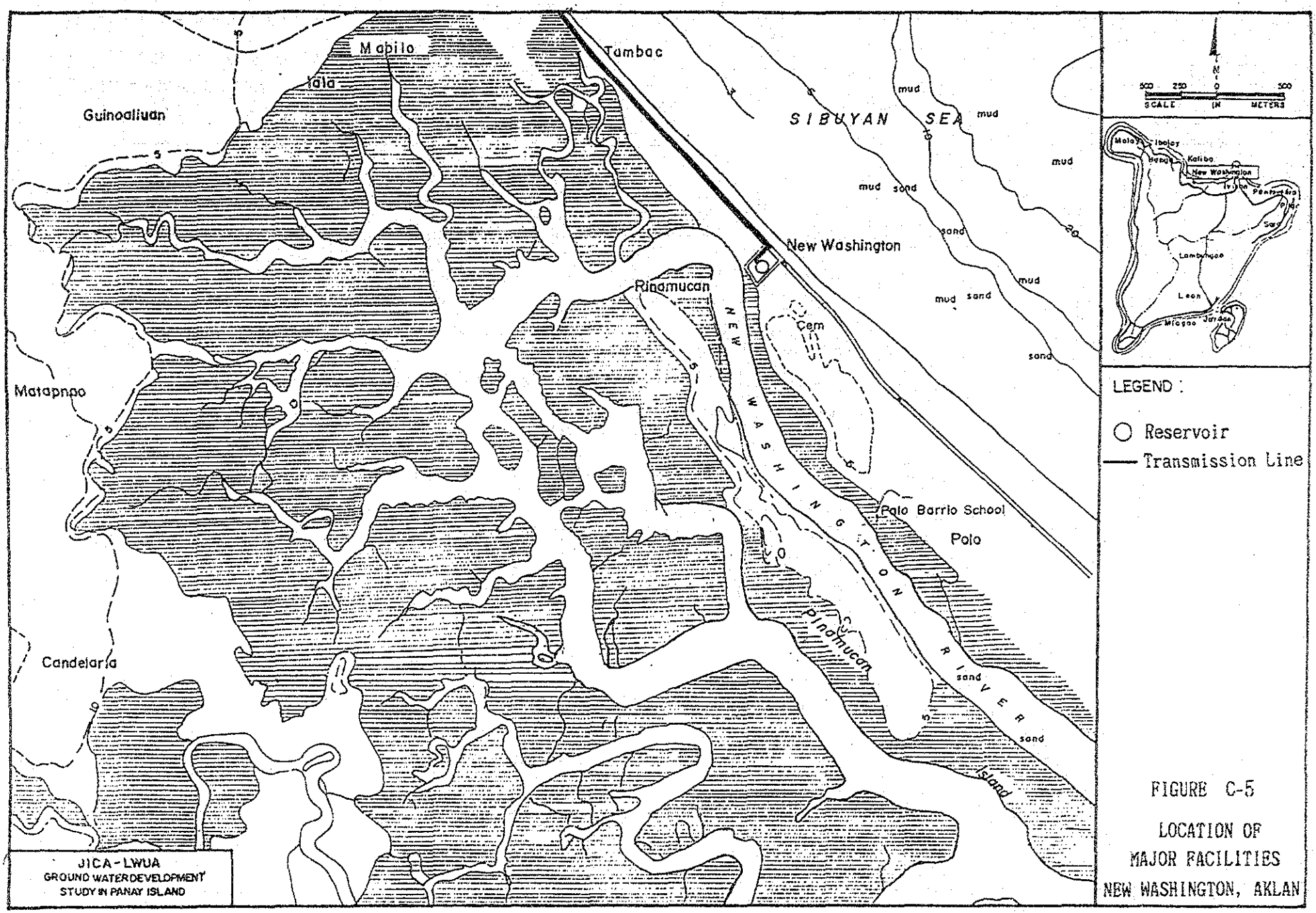

FIGURE C-5

LOCATION OF MAJOR FACILITIES NEW WASHINGTON, AKLAN

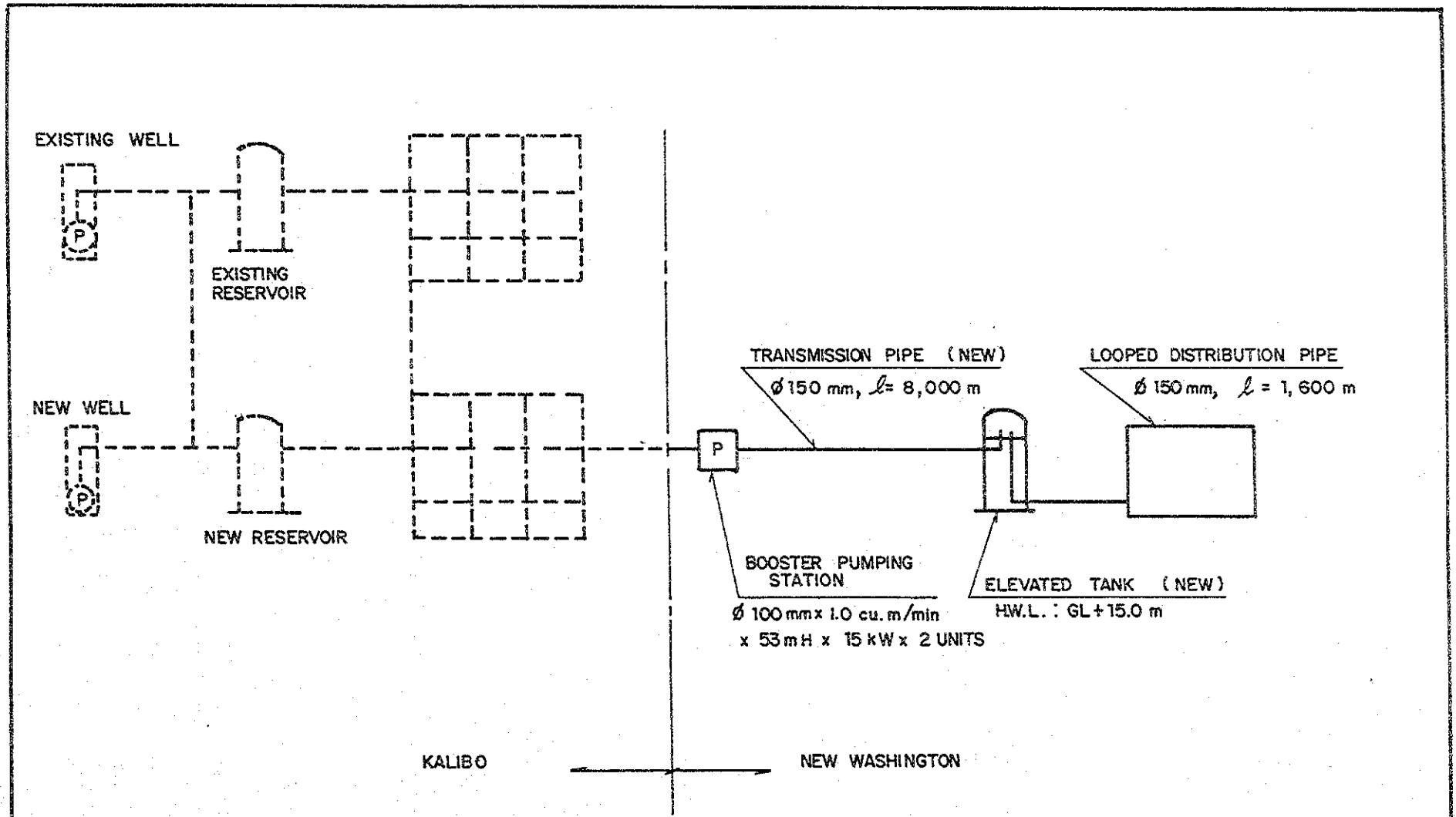

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FIGURE C-6
FLOW DIAGRAM
NEW WASHINGTON, AKLAN

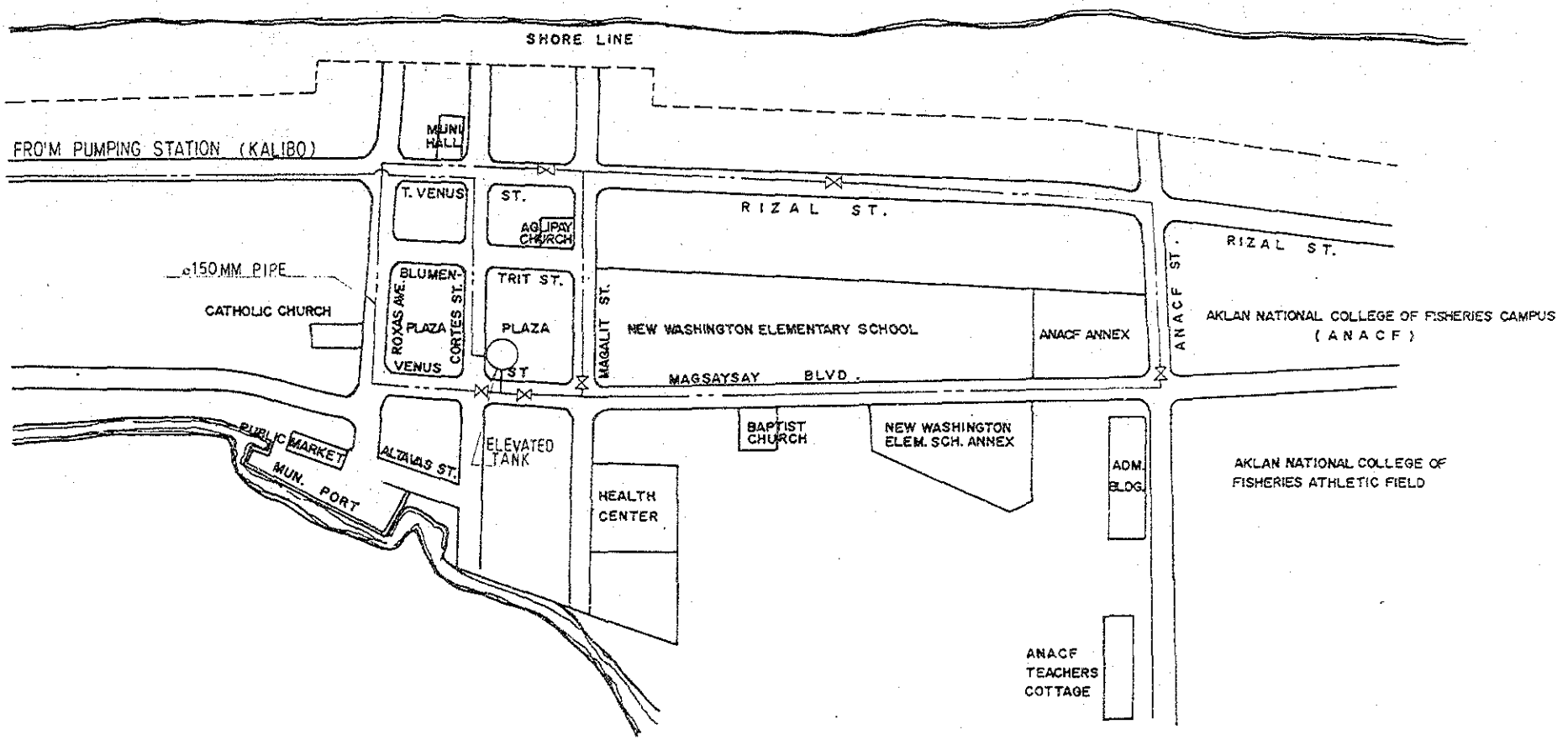

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FIGURE C-7
DISTRIBUTION PIPELINE
NEW WASHINGTON, AKLAN

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	---
Not considered	
Transmission Line	
Booster pump station	
(RC, 1.0 cu.m/min, 53 mH, 15 kW, 2 units)	1,130.4
Transmission main	
(ø 150 mm, 8,000 m)	5,040.0
Distribution Facility	
Elevated water tank	
(RC, ø7.5 m, 16 mH, 154 cu.m)	1,148.4
Distribution main	
(ø 150 mm pipe 1,600 m)	864.0
(ø 150 mm valve 6 pcs.)	34.2
Total	8,217.0

Total construction cost for improvement of major water supply facilities is estimated at approximately 8.22 million Pesos (57.6 million Yen or 0.40 million U.S. Dollar).