14. Alternative Feasibility Study

14.1 General

This section deals, as previously described in 1. General, with a study for a project comprising Phase I and Phase II in order to explore the feasibility.

14.2 Proposed Water Supply Plan

The project area for the target year covers approximately 2,100 ha, the population served increases to 55,030 and the total water demand is 13,230 cu m/d, which are described in the preceding sections of this part.

The schematic diagram and the location of major facilities for proposed water supply systems are shown in Figs 3.14.1 and 3.14.2.
The facilities to be constructed are recapitulated in Table 3.14.1.
The construction schedule is as Fig 3.14.3 and the project cost and disbursement schedule are shown in Table 3.14.2 and Table 3.14.3 respectively.

14.3 Financial Feasibility Analysis

14.3.1 Source of Funds and Rate of Interest on Borrowing

In this financial feasibility study, forecasts are constructed on the assumption that 20 % of the total capital investment is financed by government susidies and the rest by the government loans. Forecasts of loan disbursement and debt service are presented in Financial Table 3.

These estimates are based on the assumption that the Water District will be able to obtain loan funds through government sources (LWUA), which represent a blending of funds obtained locally and internationally.

The assumed interest rate is 9.0 percent per annum and other assumed terms include a six-year period (construction period) of grace on principal payment, and twenty-four year instalment repayment.

Approximately 60% of the project cost is composed of foreign currency portions and the rest composed of local currency portions. In view of the magnitude of foreign currency requirements, the government is recommended to seek loans from foreign sources such as the Overseas Economic Cooperation Fund, Japan (OECF), the World Bank or the Asian Development Bank, though the effect of such borrowing will not directly affect the forecasts of the Water District's financial performance.

14.3.2 Financial Feasibility

Carefully constructed financial forecasts based on the above mentioned assumptions indicate that the project covering Phases I and II will be positively viable in financial terms.

14.3.3 Water Rate

In calculating revenue, water rates for domestic user were projected less than 5% of the average household income of the Water District Area. (See Financial Table 7)

One of the salient features of the project is that the revenue units costs at 1981 constant prices of production toward the target year period 1990-1993, will be significantly lower than at present.

14.4 Economic Feasibility Analysis

14.4.1 Increase of Served Population and Area

Served population in the target year is estimated at 55,030 which is a gain of 295 % over the present served population. And the served area will increase from 790 ha to 2,100 ha in the target year.

14.4.2 Internal Economic Rate of Return

The internal economic rate of return calculated proved positive economic vaibility as to the recommended master plan as shown below.

1) Based on Cost Value without Conversion: 16 %
2) Based on Cost Value with Conversion A : 15 %
3) Based on Cost Value with Conversion B : 18 %
4) Based on Cost Value with Conversion C : 14 %

Legaspi
(I + II)

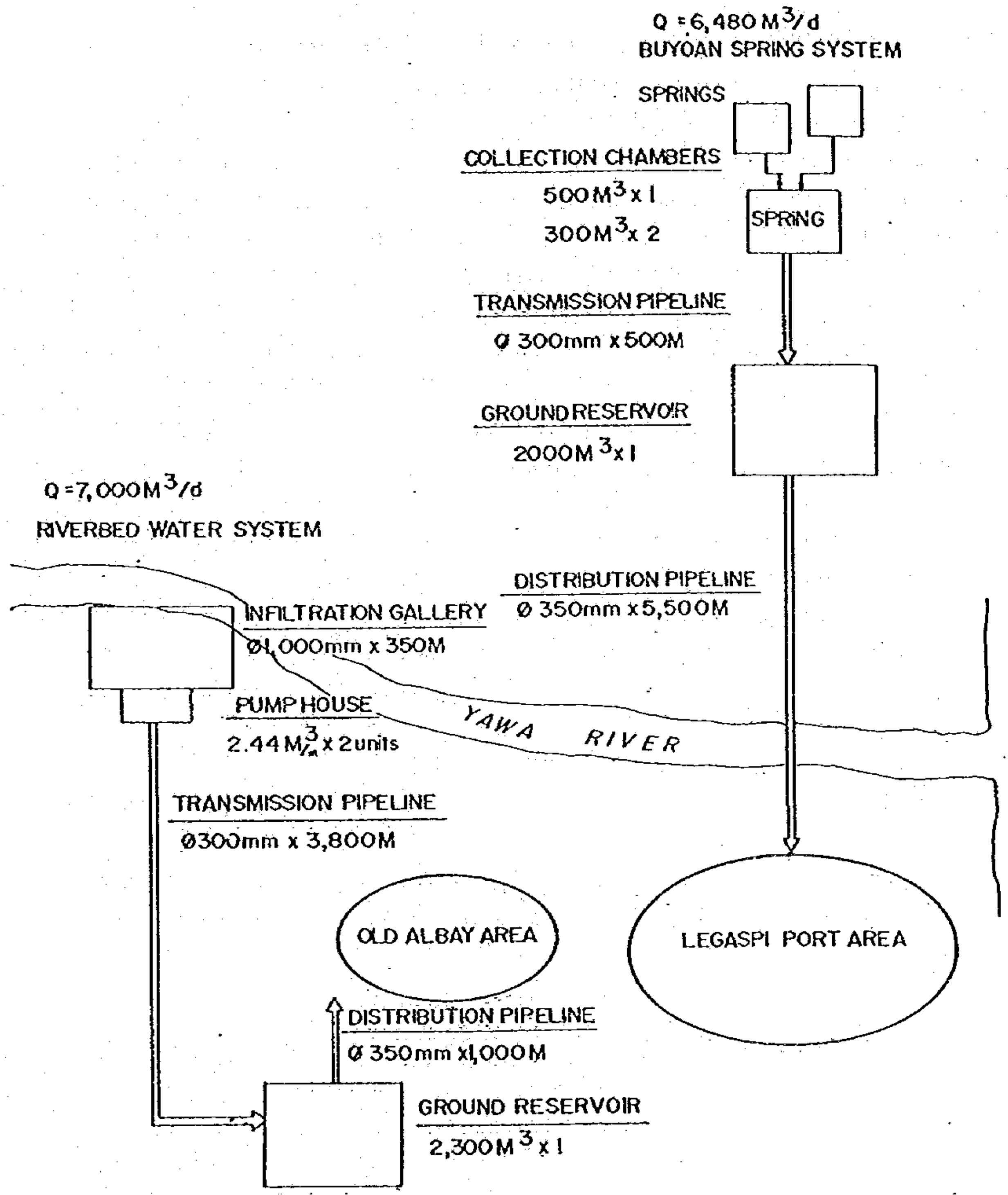


Fig 3.14.1 Proposed Water Supply System

(Target Year : 1993)

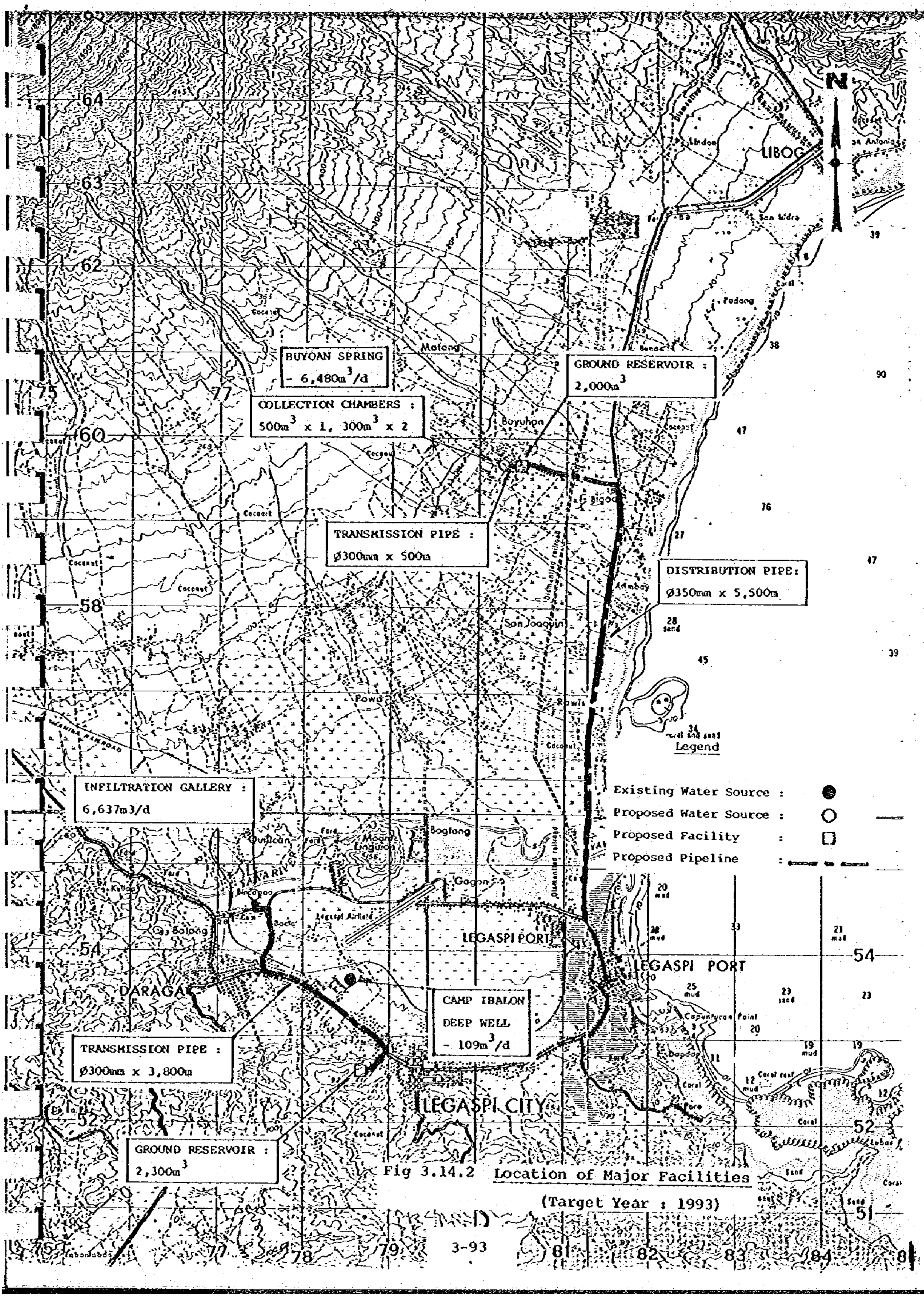


Fig 3.14.2 Location of Major Facilities

(Target Year : 1993)

Table 3.14.1 Facilities required

(Target Year : 1993)

1) Buyoan Spring System (6,480 m^3/day)

a. Construction of Collection Chamber:
Made of reinforced concrete
Capacity and Number: 500 m^3 x 1 unit; and
300 m^3 x 2 units

b. Installation of Transmission Pipeline:
(From the Buyoan Spring (Collection Chamber) to the ground reservoir)
Diameter and Length : ∅ 300 mm x 500 m

c. Construction of Ground Reservoir:
Made of reinforced concrete
Capacity: 2,000 m^3
Number of basin: 1 basin

d. Installation of Distribution Pipeline:
(From the reservoir to the entrance of Legaspi Port)
Diameter and Length : ∅350 mm x 5,500 m

2) Riverbed Water System on the Yawa River (7,000 m^3/day)

a. Construction of Infiltration Gallery:
Material : Reinforced concrete pipe
Diameter and Length : ∅ 1,000 mm x 350 m

b. Intake Pump and Pump House:
Type of pump : Turbine pump
Capacity : 2.44 m^3/min x 60 m x 55 kw
Number of units: 2 units

c. Installation of Transmission Pipeline:
(From the infiltration gallery to the ground reservoir)
Diameter and Length: ∅300 mm x 3,800 m

d. Construction of Ground Reservoir:
Made of reinforced concrete
Capacity: 2,300 m^3
Number of basin: 1 basin

e. Installation of Distribution Pipeline:
(From the reservoir to the entrance of Old Albay)
Diameter and Length: ∅350 mm x 1,000 m

- to be continued-

3) Reinforcement and Expansion of Distribution Pipelines:

a. ø300 mm x 1,500 m
b. ø200 mm x 700 m
c. ø150 mm x 1,530 m
d. ø100 mm x 3,420 m
e. ø 75 mm x 14,300 m
f. ø 50 mm x 8,280 m

4) Other Equipment

a. Service Meter:
ø 13 mm x 10,200 pieces

b. Bulk Meter:
ø350 mm x 2 pieces
ø300 mm x 2 pieces
ø100 mm x 1 piece

c. Valve:
72 pieces (ø300 mm - ø 75 mm)

d. Fire Hydrant:
80 pieces

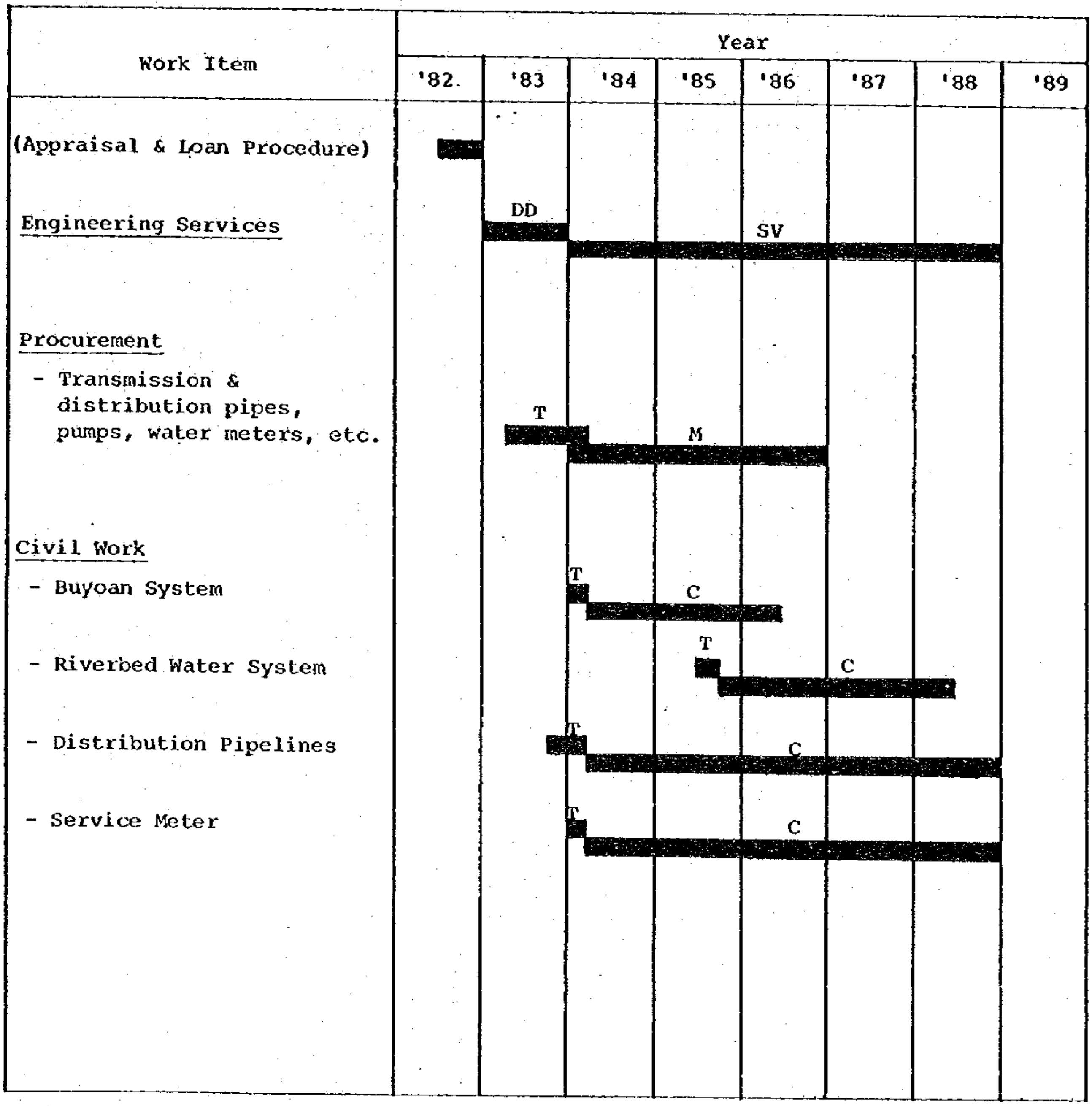
e. Chlorinator:
2 sets

f. Vehicle:
3 units

Legaspi
(I + II)

Fig 3.14.3 Construction Schedule

(Target Year : 1993)



Note: DD = Detailed Design
SV = Supervision of Construction
T = Tendering Procedure (Advertisement/Tendering/Evaluation/Award)
M = Manufacturing & Shipping
C = Construction/Installation

Legaspi

Table 3.14.2 Project Cost (Target Year : 1993) (I+II)

Note: - Unit = One Thousand Pesos = '000 Pesos
- Prices as of 1st July 1981
- Foreign Exchange Rate: US $ 1.00 = Peso 7.80

Work Items	Cost		
	Total Cost	Foreign Currency Component	Local Currency Component
A. Buyoan System	8,413	4,133	4,280
B. Riverbed Water System	9,670	4,903	4,767
C. Reinforcement/Expansion of Distribution Pipelines	4,663	3,124	1,539
D. Other Equipment	7,880	5,939	1,941
Sub Total	30,626	18,099	12,527
Detailed Design Cost (10.5%)	3,216	1,901	1,315
Supervision Cost (3.5 %)	1,072	634	438
Land Cost	143	-	143
Total	35,057	20,634	14,423
Physical Contingency (10 %)	3,506	2,064	1,442
Total	38,563	22,698	15,865
Price Contingency	28,839	15,659	13,180
Grand Total (Project Cost)	67,402	38,357	29,045
	(Equivalent to US$8.64 M)	(Equivalent to US$4.92 M)	(Equivalent to US$3.72 M)

Table 3.14.3 Disbursement Schedule

(Target Year : 1993)

NOTE:
- F/C = Foreign Currency Component
- L/C = Local Currency Component
- Unit: One Thousand Pesos = '000 Pesos
- Prices: As of 1st July 1981
- Foreign Exchange Rate: US$1.00 = Pesos 7.80

(Thousand Pesos)

Description	Cost			Yearly Disbursement											
	Total Cost	Breakdown		1983		1984		1985		1986		1987		1988	
		F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C
A. Buyoan System															
a) Collection Chamber (500 m³ x 1, 300 m³ x 2)	1,780	445	1,335			445	1,335								
b) Transmission (ø300 mm x 500 m)	488	327	161			327	161								
c) Ground Reservoir (2,000 m³ x 1)	1,800	450	1,350					225	675	225	675				
d) Distribution (ø350 mm x 5,500 m)	4,345	2,911	1,434			1,941	717	970	717						
B. Riverbed Water System															
a) Infiltration Gallery (ø1,000 mm x 350 m)	1,400	350	1,050							175	525	175	525		
b) Pump House (2.44 m³/min x 60 m x 2)	1,700	1,020	680							816	340	204	340		
c) Transmission (ø300 mm x 3,800 m)	3,710	2,486	1,224					622	244	1,864	490		490		
d) Ground Reservoir (2,300 m³ x 1)	2,070	518	1,552									173	552	345	1,000
e) Distribution (ø350 mm x 1,000 m)	790	529	261							529	130		131		
C. Reinforcement/Expansion of Distribution															
a) ø300 mm x 1,500 m	975	653	322			400	193			253			129		
b) ø200 mm x 700 m	273	183	90			183	90								
c) ø150 mm x 1,530 m	421	282	139			141	70			141	69				
d) ø100 mm x 3,420 m	616	413	203			68	34	139	70	206	34		65		
e) ø 75 mm x 14,300 m	1,716	1,150	566			230	113	230	113	690	113		113		114
f) ø 50 mm x 8,280 m	662	443	219			89	44	89	44	265	44		44		43

(to be continued)

NOTE:
- F/C = Foreign Currency Component
- F/C = Local Currency Component
- Unit: One Thousand Pesos = '000 Pesos
- Prices: As of 1st July 1981
- Foreign Exchange Rate: US$1.00 = Pesos 7.80

NOTE: Price Escalation Rate (Price Contingency)
Present - 1984: 15% Annual both for F/C and L/C
1985 - 1989: 12% Annual both for F/C and L/C
1990 - : 10% Annual both for F/C and L/C

(Thousand Pesos)

Description	Cost			Yearly Disbursement											
	Total Cost	Breakdown		1983		1984		1985		1986		1987		1988	
		F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C
D. Other Equipment															
a) Service Meter (ø13 mm x 10,208)	6,635	5,109	1,526			3,065	306	2,044	306		306		306		302
b) Bulk Meter (ø350 mm x 2, ø200 mm x 2, ø100 mm x 1)	47	38	9					38	9						
c) Valve (72)	432	315	117			79	30	79	30	157			30		27
d) Fire Hydrant (80)	536	354	182			89	45	89	50	176			50		37
e) Chlorinatort (2)	20	18	2					18	1						1
f) Vehicle (3)	210	105	105			70	70	35	35						
Sub-Total	30,626	18,099	12,527			7,127	3,208	4,578	2,294	5,497	2,726	552	2,775	345	1,524
Detailed Design Cost (10.5%)	3,216	1,901	1,315	1,901	1,315										
Supervision Cost (3.5%)	1,072	634	438			128	88	126	87	126	87	126	87	128	89
Land Cost	143		143				48		30		30		35		
Total	35,057	20,634	14,423	1,901	1,315	7,255	3,344	4,704	2,411	5,623	2,843	678	2,897	473	1,613
Physical Contingency (10%)	3,506	2,064	1,442	190	132	726	334	471	241	562	284	68	290	47	161
Total	38,563	22,698	15,865	2,091	1,447	7,981	3,678	5,175	2,652	6,185	3,127	746	3,187	520	1,774
Price Contingency	28,839	15,659	13,180	674	467	4,157	1,916	3,640	1,865	5,615	2,838	848	3,623	725	2,471
Grand Total (Project Cost)	67,402	38,357	29,045	2,765	1,914	12,138	5,594	8,815	4,517	11,800	5,965	1,594	6,810	1,245	4,245

Legaspi (I + II)

Legaspi

I + II

FINANCIAL TABLE 1

LEGASPI WATER SUPPLY PROJECT

PORJECT COSTS BY YEAR OF CONSTRUCTION

(₱1,000's)

Project Components By Major Elements	Costs as of 7-1-81 By Construction Year						
	Total	1983	1984	1985	1986	1987	1988
1. Collection Chambers	1,780	-	1,780	-	-	-	-
2. Reservoirs	3,870	-	-	900	900	725	1,345
3. Pumps	1,700	-		-	1,156	544	
4. Transmission	4,198		488	866	2,354	490	-
5. Distribution	9,798	-	4,313	2,372	2,474	482	157
6. I/G	1,400	-	-	-	700	700	-
7. Meters	6,682		3,371	2,397	306	306	302
8. Hydrants	536	-	134	139	176	50	37
9. Chlorinators	20	-	-	19	-	-	1
10. Vehicles	210	-	140	70	-	-	-
11. Engineering	3,216	3,216	-	-	-	-	-
12. Lands	143		48	30	30	35	
13. Physical Cont.	3,506	322	1,060	712	846	358	208
14. Valves	432	-	109	109	157	30	27
15. Supervision	1,072	-	216	213	213	213	217
16.							
17.							
18.							
TOTAL, 7-1-81	38,563	3,538	11,659	7,827	9,312	3,933	2,294
ESCALATION FACTORS		1.322500	1.520875	1.703380	1.907785	2.136719	2.393126
ESCALATED COSTS	67,402	4,679	17,732	13,332	17,765	8,404	5,490

FINANCIAL TABLE 2

LEGASPI WATER SUPPLY PROJECT

I + II

OPERATION AND MAINTENANCE COSTS

(₱1,000's)

Year	Fixed, 7-1-81 Costs				Escalated Costs	
	Power	Chemicals	Others	Total	Factor 1/	Amount
1981	22	34	140	196	1.000000	196
1982	22	34	159	215	1.150000	247
1983	22	34	179	235	1.322500	311
1984	22	35	198	255	1.520875	388
1985	-	68	217	285	1.703380	485
1986	-	73	275	348	1.907785	664
1987	-	78	343	421	2.136719	899
1988	37	91	401	529	2.393126	1,266
1989	87	108	459	654	2.680301	1,753
1990	145	127	527	799	2.948331	2,356
1991	210	149	594	953	3.243164	3,091
1992	284	174	652	1,110	3.567480	3,960
1993	369	202	710	1,281	3.924228	5,027
1994	369	202	710	1,281	4.316657	5,530
1995	369	202	710	1,281	4.748316	6,083
1996	369	202	710	1,281	5.223148	6,691
1997	369	202	710	1,281	5.745463	7,360
1998	369	202	710	1,281	6.320009	8,096

1/ Escalation currently 15 percent per year to 1984 (1981 = 1.00), 12 percent per year between 1985 and 1989 and 10 percent per year in 1990 and afterwards.

FINANCIAL TABLE 3

LEGASPI WATER SUPPLY PROJECT
LOAN DISBURSEMENTS AND DEBT SERVICE
(₱1,000's)

Year	Disbursement 1/		Loans Outstanding		Interest Payments 4/		Principal Payments 3/	Total Debt Service
	Grant 20%	Loan 80%	Beginning	Ending	First Year 2/	Later Years		
1981								
1982								
1983	936	3,743		3,911				
1984	3,546	14,186	3,911	19,087				
1985	2,666	10,666	19,087	31,950				
1986	3,553	14,212	31,950	49,676				
1987	1,681	6,723	49,676	61,172				
1988	1,098	4,392	61,172	71,266				
1989			71,266	71,103		6,414	163	6,577
1990			71,103	70,308		6,399	795	7,194
1991			70,308	68,977		6,328	1,331	7,659
1992			68,977	66,907		6,208	2,070	8,278
1993			66,907	64,358		6,022	2,549	8,571
1994			64,358	61,389		5,792	2,969	8,761
1995			61,389	58,420		5,525	2,969	8,494
1996			58,420	55,451		5,258	2,969	8,227
1997			55,451	52,482		4,991	2,969	7,960
1998			52,482	49,513		4,723	2,969	7,692

1/ From Financial Table 1.

2/ Disbursements assumed to be equally spread during year. Charge with 50 per cent of annual interest in first year.

3/ Principal payments are made in equal yearly instalments.

4/ Interest is capitalized during construction.

FINANCIAL TABLE 4

LEGASPI WATER SUPPLY PROJECT

CASH REQUIREMENTS PER REVENUE UNIT

(₱1,000's)

Year	Debt Service	O & M	Total Costs	Estimated Reserves 1/	Cost With Reserves	Revenue Units 2/	Cost Per Revenue Unit 3/
1981		196	196		196	845	0.23
1982		247	247		247	871	0.28
1983		311	311		311	924	0.34
1984		388	388		388	951	0.41
1985		485	485		485	1,756	0.28
1986		664	664		664	1,987	0.33
1987		899	899		899	2,268	0.40
1988		1,266	1,266		1,266	2,597	0.49
1989	6,577	1,753	8,330	417	8,747	3,003	2.91
1990	7,194	2,356	9,550	478	10,028	3,493	2.87
1991	7,659	3,091	10,750	1,075	11,825	4,073	2.90
1992	8,278	3,960	12,238	1,224	13,462	4,709	2.86
1993	8,571	5,027	13,598	1,360	14,598	5,422	2.69
1994	8,761	5,530	14,291	1,429	15,720	5,422	2.90
1995	8,494	6,083	14,577	1,458	16,035	5,422	2.96
1996	8,227	6,691	14,918	1,492	16,410	5,422	3.03
1997	7,960	7,360	15,320	1,532	16,852	5,422	3.11
1998	7,692	8,096	15,788	1,579	17,367	5,422	3.20

1/ Reserve estimate equal to 10 per cent of total costs. (5 per cent for the first two years)

2/ Revenue units from Tables 9A, 9B and 9C.

3/ Revenue units divided into costs with reserves.

FINANCIAL TABLE 5 - A

LEGASPI WATER SUPPLY PROJECT

ABILITY TO PAY FOR WATER

1	2	3	4	5	6	7	8
Year	Ave. Monthly Family Income 1/	Available 5%	Average Family Size	Household Water Use		Revenue Units Per Month 2/	Max. Ability Per Rev. Unit
				lpcd	Cubic Meters/ Month		
1981	620.00	31.00	5.70	55	9	25	1.24
1982	713.00	35.65	5.69	55	9	25	1.43
1983	819.95	41.01	5.68	55	9	25	1.64
1984	942.94	47.15	5.67	55	9	25	1.89
1985	1,056.09	52.80	5.66	70	12	27	1.96
1986	1,182.82	59.14	5.65	70	12	27	2.19
1987	1,324.76	66.24	5.64	115	20	37	1.79
1988	1,483.73	74.19	5.63	115	20	37	2.01
1989	1,661.78	83.09	5.62	116	20	37	2.25
1990	1,827.96	91.40	5.61	117	20	37	2.47
1991	2,010.75	100.54	5.60	119	20	37	2.72
1992	2,211.83	110.92	5.59	120	20	37	3.00
1993	2,433.01	121.65	5.58	120	20	37	3.29

1/ Average monthly income escalated by 15 per cent per year to 1984, 12 per cent per year between 1985 and 1989, and 10 per cent in 1990 and afterwards.

2/ Assumed 1/2" service.

I + II

FINANCIAL TABLE 5 - B

LEGASPI WATER SUPPLY PROJECT

ABILITY TO PAY FOR WATER

I + II

Year	Ave. Monthly Family Income 1/	Available 5%	Average Family Size	Household Water Use		Revenue Units Per Month 2/	Max. Ability Per Rev. Unit
				lpcd	Cubic Meters/ Month		
1994	2,676.31	133.82	5.57	120	20	37	3.62
1995	2,943.94	147.20	5.56	120	20	37	3.98
1996	3,238.33	161.92	5.55	120	20	37	4.38
1997	3,562.16	178.11	5.54	120	20	37	4.81
1998	3,918.38	195.92	5.53	120	20	37	5.30

1/ Average monthly income escalated by 15 percent year to 1984, 12 percent per year between 1985 and 1989, and 10 percent in 1990 and afterwards.

2/ Assumed 1/2" service.

I + II

FINANCIAL TABLE 6 - A

LEGASPI WATER SUPPLY PROJECT
ILLUSTRATIVE CASH FLOW TABLE
₱1,000's EXCEPT CHARGES PER UNIT

Year	Revenue Units 1/	Charges Per Unit	Gross Revenues	Net Revenue 2/		Basic Costs 3/	Required Reserves 4/	Total Costs 5/	Net Income	
				%	Amount				Annual	Cumulative
1981	845	0.60	507	95	482	196		196	286	286
1982	871	0.60	523	95	497	247		247	250	536
1983	924	0.95	877	95	834	311		311	523	1,059
1984	951	1.50	1,427	96	1,369	388		388	981	2,040
1985	1,756	1.50	2,634	96	2,529	485		485	2,044	4,084
1986	1,987	1.70	3,378	97	3,277	664		664	2,613	6,697
1987	2,268	1.70	3,856	97	3,740	899		899	2,841	9,538
1988	2,597	2.00	5,194	97	5,038	1,266		1,266	3,772	13,310
1989	3,003	2.00	6,006	97	5,826	8,330	300	8,630	-2,804	10,506
1990	3,493	2.45	8,558	98	8,387	9,550	428	9,978	-1,591	8,915
1991	4,073	2.45	9,979	98	9,779	10,750	998	11,748	-1,969	6,946
1992	4,709	2.70	12,714	98	12,460	12,238	1,271	13,509	-1,049	5,897
1993	5,422	2.70	14,639	98	14,346	13,598	1,464	15,062	-716	5,181

1/ From Tables 9A, 9B and 9C.
2/ Gross revenues from water sales reduced by bad debt allowance.
3/ Total of project debt service, operation and maintenance costs.
4/ Ten percent of gross water sales, after completion of construction. (5 percent for the first two years)
5/ Includes the costs of replacing the first complement of project components with seven years of life expectancy.

FINANCIAL TABLE 6 - B

LEGASPI WATER SUPPLY PROJECT

ILLUSTRATIVE CASH FLOW TABLE

₱1,000's EXCEPT CHARGES PER UNIT

I + II

Year	Revenue Units 1/	Charges Per Unit	Gross Revenues	Net Revenues 2/		Basic Costs 3/	Required Reserves 4/	Total Costs 5/	Net Income	
				%	Amount				Annual	Cumulative
1994	5,422	2.9	15,724	98	15,409	14,291	1,572	15,863	-454	4,727
1995	5,422	2.9	15,724	98	15,409	14,577	1,572	16,149	-740	3,987
1996	5,422	2.9	15,724	98	15,409	14,918	1,572	16,490	-1,081	2,906
1997	5,422	3.2	17,350	98	17,003	15,320	1,735	17,055	-52	2,854
1998	5,422	3.2	17,350	98	17,003	15,788	1,735	17,523	-520	2,334

1/ From Tables 9A, 9B and 9C.

2/ Gross revenues from water sales reduced by bad debt allowance.

3/ Total of project debt service, operation and maintenance costs.

4/ Ten percent of gross water sales, after completion of construction.

5/ Includes costs of replacing the dirst complement of project components with seven years of life expectancy.

FINANCIAL TABLE 7

LEGASPI WATER SUPPLY PROJECT

ILLUSTRATIVE RATE SCHEDULE

DOMESTIC AND GOVERNMENTAL SERVICE CONNECTIONS, 1/2"

Year	First 10 m^3 1/	Charge for Each Added m^3 2/			Charge 3/ per Revenue Unit
		11-20	21-45	over 45	
1981	15.00	0.72	0.84	1.02	0.60
1982	15.00	0.72	0.84	1.02	0.60
1983	23.75	1.14	1.33	1.62	0.95
1984	37.50	1.80	2.10	2.55	1.50
1985	37.50	1.80	2.10	2.55	1.50
1986	42.50	2.04	2.38	2.89	1.70
1987	42.50	2.04	2.38	2.89	1.70
1988	50.00	2.40	2.80	3.40	2.00
1989	50.00	2.40	2.80	3.40	2.00
1990	61.25	2.94	3.43	4.17	2.45
1991	61.25	2.94	3.43	4.17	2.45
1992	67.50	3.24	3.78	4.59	2.70
1993	67.50	3.24	3.78	4.59	2.70

Note: 1/ To obtain charge per m^3 for the first 10 m^3 classified by connection size, multiply R.U. charge shown in 3/ above by the following connection size factors.

Domestic : 1.0 for 3/8"; 2.5 for 1/2"; 4.0 for 3/4"; 8 for 1"
Commerical: 5.0 for 1/2"; 8.0 for 3/4"; 16.0 for 1"; 40.0 for 1 1/2"

2/ To obtain charge for each added m^3, multiply R.U. charges shown in 3/ by the following block factors.

Domestic : 1.2 for 11-20 m^3; 1.4 for 21-45 m^3; 1.7 for over 45 m^3
Commercial: 2.4 for 21-45 m^3; 2.8 for 45-100 m^3; 2.4 for over 100 m^3

FINANCIAL TABLE 8

LEGASPI WATER SUPPLY PROJECT
GROWTH IN POPULATION, SERVICE CONNECTIONS
AND IN DELIVERED AND PROCURED WATER

1	2	3	4	5	6	7	8
Year	Ave. Number Service Connections	Number For Service	Persons Served	Daily Use lpcd 1/	Annual Water Supply (1,000 M^3)		
					Delivered	% Unacct.	Produced
1981	1,367	13.6	18,600	69	466	45	759
1982	1,411	13.6	19,200	69	483	43	778
1983	1,570	13.0	20,400	69	515	40	803
1984	1,716	12.1	20,900	69	526	40	836
1985	1,974	11.0	22,100	127	1,025	40	1,710
1986	2,322	10.0	23,300	135	1,151	37	1,798
1987	2,698	9.1	24,520	144	1,288	34	1,899
1988	3,298	8.5	28,100	144	1,479	32	2,034
1989	4,103	7.9	32,400	145	1,717	30	2,193
1990	5,178	7.2	37,200	147	1,997	28	2,342
1991	6,623	6.4	42,600	149	2,324	26	2,490
1992	8,628	5.6	48,500	150	2,664	25	2,631
1993	11,575	4.6	55,030	150	3,017	25	2,777

1/ Liters per capita per day.

FINANCIAL TABLE 9A

I + II

LEGASPI WATER SUPPLY PROJECT
CALCULATION OF REVENUE UNITS

A) AVERAGE NUMBER OF CONCESSIONAIRES

Year	Residential and Government					Commercial and Industrial					Total
	3/8"	1/2"	3/4"	1"	S-Total	1/2"	3/4"	1"	1 1/2"	S-Total	
1981	363	836	11	1	1,211	133	14	7	2	156	1,367
1982	363	836	11	1	1,211	133	14	7	2	156	1,367
1983	392	902	12	1	1,307	133	14	7	2	156	1,463
1984	428	985	13	1	1,427	141	15	7	2	165	1,592
1985	500	1,150	15	2	1,667	175	18	10	2	205	1,872
1986	587	1,350	18	2	1,957	260	27	15	3	305	2,262
1987	676	1,555	20	2	2,253	380	40	22	3	445	2,698
1988	852	1,960	26	2	2,840	391	41	23	3	458	3,298
1989	1,090	2,506	33	3	3,632	402	42	24	3	471	4,103
1990	1,408	3,239	42	5	4,694	413	44	24	3	484	5,178
1991	1,838	4,227	55	6	6,126	424	45	25	3	497	6,623
1992	2,435	5,601	73	9	8,118	436	46	25	3	510	8,628
1993	3,315	7,625	99	11	11,050	448	47	26	3	525	11,575

B) SERVICE REVENUE UNITS PER CUBIC METER

Year	Residential and Government					Commercial and Industrial					Total
	1.00	2.50	4.0	8.0	S-total	5.0	8.0	16.0	40.0	S-Total	
1981	363	2,090	44	8	2,505	665	112	112	80	969	3,474
1982	363	2,090	44	8	2,505	665	112	112	80	969	3,474
1983	392	2,255	48	8	2,703	665	112	112	80	969	3,672
1984	428	2,463	52	8	2,951	705	120	112	80	1,017	3,968
1985	500	2,875	60	16	3,451	875	144	160	80	1,259	4,710
1986	587	3,375	72	16	4,050	1,300	216	240	120	1,876	5,926
1987	676	3,888	80	16	4,660	1,900	320	352	120	2,692	7,352
1988	852	4,900	104	16	5,872	1,955	328	368	120	2,771	8,643
1989	1,090	6,265	132	24	7,511	2,010	336	384	120	2,850	10,361
1990	1,408	8,098	168	40	9,714	2,065	352	384	120	2,921	12,635
1991	1,838	10,568	220	48	12,674	2,120	360	400	120	3,000	15,674
1992	2,435	14,003	292	72	16,802	2,180	368	400	120	3,068	19,870
1993	3,315	19,063	396	88	22,862	2,240	376	416	120	3,152	26,014

FINANCIAL TABLE 9B1

LEGASPI WATER SUPPLY PROJECT

CALCULATION OF REVENUE UNITS

DOMESTIC

Year	Delivered Water (x1000 cum)	Service Connections (x 0.12)	Net	11 - 20 cum		21 - 45 cum		over 45 cum		Total CRU's
				cum	x 1.2	cum	x 1.4	cum	x 1.7	
1981	415	145	270	145	174	125	175	-	-	349
1982	430	145	285	145	174	140	196	-	-	370
1983	458	157	301	157	188	144	202	-	-	390
1984	468	171	297	171	205	126	176	-	-	381
1985	912	200	712	200	240	512	717	12	20	977
1986	1,024	235	789	235	282	554	776	-	-	1,058
1987	1,146	270	876	270	324	606	848	-	-	1,172
1988	1,316	341	975	341	409	634	888	-	-	1,297
1989	1,528	436	1,092	436	523	656	918	-	-	1,441
1990	1,777	563	1,214	563	676	651	911	-	-	1,587
1991	2,068	735	1,333	735	882	598	837	-	-	1,719
1992	2,371	974	1,397	974	1,169	423	592	-	-	1,761
1993	2,685	1,326	1,359	1,326	1,591	33	46	-	-	1,637

FINANCIAL TABLE 9B2

LEGASPI WATER SUPPLY PROJECT
CALCULATION OF WATER REVENUES UNITS

I + II

COMMERCIAL

Year	Delivered Water (x1000 cum)	Service Connections (x 0.12)	Net	11 - 45 cum		46 - 100 cum		Over 100 cum		Total CRU's
				cum	x 2.4	cum	x 2.8	cum	x 3.4	
1981	51	18	33	33	79	-	-	-	-	79
1982	53	18	35	35	84	-	-	-	-	84
1983	57	18	39	39	94	-	-	-	-	94
1984	58	19	39	39	94	-	-	-	-	94
1985	113	24	89	86	206	3	8	-	-	214
1986	127	36	91	91	218	-	-	-	-	218
1987	142	53	89	89	214	-	-	-	-	214
1988	163	54	109	109	262	-	-	-	-	262
1989	189	56	133	133	319	-	-	-	-	319
1990	220	58	162	162	389	-	-	-	-	389
1991	256	59	197	197	473	-	-	-	-	473
1992	293	61	232	214	514	18	50	-	-	564
1993	332	63	269	221	530	48	134	-	-	664

FINANCIAL TABLE 9C

SUMMARY OF REVENUE UNITS

Legaspi I + II

Year	Residential and Governmental				Commercial and Industrial				Total All
	Service			Total R & C	Service			Total C & I	
	RU/Serv. Connection	Multiplied by 0.12	Commodity Rev. Units		RU/Serv. Connection	Multiplied by 0.12	Commodity Rev. Units		
1981	2,505	301	349	650	969	116	79	195	845
1982	2,505	301	370	671	969	116	84	200	871
1983	2,703	324	390	714	969	116	94	210	924
1984	2,951	354	381	735	1,017	122	94	216	951
1985	3,451	414	977	1,391	1,259	151	214	365	1,756
1986	4,050	486	1,058	1,544	1,876	225	218	443	1,987
1987	4,660	559	1,172	1,731	2,692	323	214	537	2,268
1988	5,872	705	1,297	2,002	2,771	333	262	595	2,597
1989	7,511	901	1,441	2,342	2,850	342	319	661	3,003
1990	9,714	1,166	1,587	2,753	2,921	351	389	740	3,493
1991	12,674	1,521	1,719	3,240	3,000	360	473	833	4,073
1992	16,802	2,016	1,761	3,777	3,068	368	564	932	4,709
1993	22,862	2,743	1,637	4,380	3,152	378	664	1,042	5,422

I + II

ECONOMIC TABLE 1

LEGASPI WATER SUPPLY PROJECT
SUMMARY OF PROJECT COST

Costs as of July 1, 1981 in 1,000 Pesos

Components	Total Cost	Foreign Currency Portion	Local Currency Portion
1. Collection Chambers	1,780	445	1,335
2. Reservoirs	3,870	968	2,902
3. Pumps	1,700	1,020	680
4. Transmission	4,198	2,813	1,385
5. Distribution	9,798	6,564	3,234
6. I/G	1,400	350	1,050
7. Meters	6,682	5,147	1,535
8. Hydrants	536	354	182
9. Chlorinators	20	18	2
10. Vehicles	210	105	105
11. Engineering	3,216	1,901	1,315
12. Lands	143	-	143
13. Valves	432	315	117
14. Supervision	1,072	634	438
15.			
16.			
17.			

Source: From Cost Estimates

ECONOMIC TABLE 2

LEGASPI WATER SUPPLY PROJECT

ANNUAL DEMAND AND GROSS PRODUCTION IN 1,000 M^3

1	2	3	4	5	6	7	8	9
Year	Average Connections	Persons Per Service Connection	Population Served	Average Water Use		Net Increase in Delivered Volume	Unacounted Percentage	Annual Production
				Liters/ Capita Per Day	Water Delivered Annually			
1981	1,367	13.6	18,600	62	418	-	45	759
1982	1,367	13.6	18,600	63	418	-	45	778
1983	1,463	12.7	18,600	65	442	-	45	803
1984	1,592	12.1	19,200	66	460	18	45	836
1985	1,872	11.0	20,800	135	1,026	584	40	1,710
1986	2,262	10.0	22,600	137	1,133	691	37	1,798
1987	2,698	9.1	24,250	140	1,253	811	34	1,899
1988	3,298	8.5	28,100	135	1,383	941	32	2,034
1989	4,103	7.9	32,400	130	1,535	1,093	30	2,193
1990	5,178	7.2	37,200	124	1,686	1,244	28	2,342
1991	6,623	6.4	42,600	119	1,843	1,401	26	2,490
1992	8,628	5.6	48,500	112	1,973	1,531	25	2,631
1993	11,575	4.6	55,030	104	2,083	1,641	25	2,777

Legaspi
I + II

ECONOMIC TABLE 3-A

LEGASPI WATER SUPPLY PROJECT

CONVERSION OF CONSTRUCTION COST TO ECONOMIC COST

Costs as of July 1, 1981 in 1,000 Pesos

Component	Foreign Costs	Local Costs	Common Labor Costs	Residual Local Cost	Converted Value			
					Foreign x 1.25	Labor x 0.5	Residual x 0.95	Total
1. Collection Chamber	445	1,335	868	467	556	434	444	1,434
2. Reservoir	968	2,902	1,886	1,016	1,210	943	965	3,118
3. Pumps	1,020	680	340	340	1,275	170	323	1,768
4. Transmission	2,813	1,385	346	1,039	3,516	173	987	4,676
5. Distribution	6,564	3,234	1,294	1,940	8,205	647	1,843	10,695
6. I/G	350	1,050	525	525	438	263	499	1,200
7. Meters	5,147	1,535	307	1,228	6,434	154	1,167	7,755
8. Hydrants	354	182	73	109	443	37	104	584
9. Chlorinators	18	2	-	2	23	-	2	25
10. Vehicles	105	105	-	105	131	-	100	231
11. Engineering	1,901	1,315	-	1,315	2,376	-	1,249	3,625
12. Lands	-	143	-	143	-	-	136	136
13. Valves	315	117	23	94	394	12	89	495
14. Supervision	634	438	-	438	793	-	416	1,209
15.								
16.								
17.								

ECONOMIC TABLE 3-B

LEGASPI WATER SUPPLY PROJECT
CONVERSION OF CONSTRUCTION COST TO ECONOMIC COST
Costs as of July 1, 1981 in 1,000 Pesos

Component	Foreign Costs	Local Costs	Common Labor Costs	Residual Local Cost	Converted Value			
					Foreign x 1.0	Labor x 0.5	Residual x 0.95	Total
1. Collection Chamber	445	1,335	868	467	445	434	444	1,323
2. Reservoir	968	2,902	1,886	1,016	968	943	965	2,875
3. Pumps	1,020	680	340	340	1,020	170	323	1,513
4. Transmission	2,813	1,385	346	1,039	2,813	173	987	3,973
5. Distribution	6,564	3,234	1,294	1,940	6,564	647	1,843	9,054
6. I/G	350	1,050	525	525	350	263	499	1,112
7. Meters	5,147	1,535	307	1,228	5,147	154	1,167	6,468
8. Hydrants	354	182	73	109	354	17	104	495
9. Chlorinators	18	2	-	2	18	-	2	20
10. Vehicles	105	105	-	105	105	-	100	205
11. Engineering	1,901	1,315	-	1,315	1,901	-	1,249	3,150
12. Lands	-	143	-	143	-	-	136	136
13. Valves	315	117	23	94	315	12	89	416
14. Supervision	634	438	-	438	634	-	416	1,050
15.								
16.								
17.								

ECONOMIC TABLE 3-C

LEGASPI WATER SUPPLY PROJECT

CONVERSION OF CONSTRUCTION COST TO ECONOMIC COST

Costs as of July 1, 1981 in 1,000 Pesos

Component	Foreign Costs	Local Costs	Common Labor Costs	Residual Local Cost	Converted Value			
					Foreign x 1.25	Labor x 1.0	Residual x 1.0	Total
1. Collection Chamber	445	1,335	868	467	556	868	467	1,891
2. Reservoir	968	2,902	1,886	1,016	1,210	1,886	1,016	4,112
3. Pumps	1,020	680	340	340	1,275	340	340	1,955
4. Transmission	2,813	1,385	346	1,039	3,516	346	1,039	4,901
5. Distribution	6,564	3,234	1,294	1,940	8,205	1,294	1,940	11,439
6. I/G	350	1,050	525	525	438	525	525	1,488
7. Meters	5,147	1,535	307	1,228	6,434	307	1,228	7,969
8. Hydrants	354	182	73	109	443	73	109	625
9. Chlorinators	18	2	-	2	23	-	2	25
10. Vehicles	105	105	-	105	131	-	105	236
11. Engineering	1,901	1,315	-	1,315	2,376	-	1,315	3,691
12. Lands	-	143	-	143	-	-	143	143
13. Valves	315	117	23	94	394	23	94	511
14. Supervision	634	438	-	438	793	-	438	1,231
15.								
16.								
17.								

ECONOMIC TABLE 4-0

LEGASPI WATER SUPPLY PROJECT
ECONOMIC COSTS DISTRIBUTED TO YEARS
₱ x 1,000

I + II

Value without CONVERSION

Components	Total	1983	1984	1985	1986	1987	1988
1. Collection Chamber	1,780	-	1,780	-	-	-	-
2. Reservoirs	3,870			900	900	725	1,345
3. Pumps	1,700	-	-	-	1,156	544	-
4. Transmission	4,198	-	488	866	2,354	490	-
5. Distribution	9,798	-	4,313	2,372	2,474	482	157
6. I/G	1,400	-	-	-	700	700	-
7. Meters	6,682	-	3,371	2,397	306	306	302
8. Hydrants	536	-	134	139	176	50	37
9. Chlorinators	20			19			1
10. Vehicles	210		140	70			
11. Engineering	3,216	3,216			-		
12. Land	143		48	30	30	35	-
13. Valves	432	-	109	109	157	30	27
14. Supervision	1,072	-	216	213	213	213	217
15.							
16.							
17.							
18.							
Total	35,057	3,216	10,599	7,115	8,466	3,575	2,086

I + II

ECONOMIC TABLE 4-A

LEGASPI WATER SUPPLY PROJECT

ECONOMIC COSTS DISTRIBUTED TO YEARS

₱ x 1,000

Value with CONVERSION A

Components	Total	1983	1984	1985	1986	1987	1988
1. Collection Chamber	1,434	-	1,434	-	-	-	-
2. Reservoirs	3,118	-	-	725	725	584	1,084
3. Pumps	1,768	-	-	-	1,202	566	-
4. Transmission	4,676	-	544	964	2,622	546	-
5. Distribution	10,695	-	4,708	2,589	2,701	526	171
6. I/G	1,200	-	-	-	600	600	-
7. Meters	7,755	-	3,912	2,782	355	355	351
8. Hydrants	584	-	146	151	192	55	40
9. Chlorination	25	-	-	24	-	-	1
10. Vehicles	231	-	154	77	-	-	-
11. Engineering	3,625	3,625	-	-	-	-	-
12. Land	136	-	46	29	29	32	-
13. Valves	495	-	125	125	180	34	31
14. Supervision	1,209	-	244	240	240	240	245
15.							
16.							
17.							
18.							
Total	36,951	3,625	11,313	7,706	8,846	3,538	1,923

ECONOMIC TABLE 4-B

I + II

LEGASPI WATER SUPPLY PROJECT

ECONOMIC COSTS DISTRIBUTED TO YEARS

₱ x 1,000

Value with CONVERSION B

Components	Total	1983	1984	1985	1986	1987	1988
1. Collection Chambers	1,323		1,323	-	-	-	-
2. Reservoirs	2,875	-	-	661	661	518	1,035
3. Pumps	1,513	-	-	1,029	484	-	-
4. Transmission	3,973	-	477	795	2,225	476	-
5. Distribution	9,054	-	3,984	2,173	2,264	453	180
6. I/G	1,112	-	-	-	556	556	-
7. Meters	6,468	-	3,234	2,328	323	323	260
8. Hydrants	495	-	124	129	163	45	34
9. Chlorinators	20	-	-	19	-	-	1
10. Vehicles	205	-	137	68	-		-
11. Engineering	3,150	3,150	-	-	-	-	-
12. Land	136		46	29	29	32	-
13. Valves	416	-	104	104	150	29	29
14. Supervision	1,050	-	211	209	209	209	212
15.							
16.							
17.							
18.							
Total	31,790	3,150	9,640	7,544	7,064	2,641	1,751

Legaspi

I + II

ECONOMIC TABLE 4-C

LEGASPI WATER SUPPLY PROJECT

ECONOMIC COSTS DISTRIBUTED TO YEARS

₱ x 1,000

Value with CONVERSION C

Components	Total	1983	1984	1985	1986	1987	1988
1. Collection Chamber	1,891	-	1,891	-	-	-	-
2. Reservoir	4,112	-	-	956	956	771	1,429
3. Pumps	1,955	-	-	-	1,329	626	-
4. Transmission	4,901	-	570	1,011	2,748	572	-
5. Distribution	11,439	-	5,036	2,769	2,888	563	183
6. I/G	1,488	-	-	-	744	744	-
7. Meters	7,969	-	4,020	2,859	365	365	360
8. Hydrants	625	-	156	162	205	59	43
9. Chlorinators	25	-	-	24	-	-	1
10. Vehicles	236	-	157	79	-	-	-
11. Engineering	3,691	3,691	-	-	-	-	-
12. Land	143	-	48	30	30	35	-
13. Valves	511	-	129	128	186	36	32
14. Supervision	1,231	-	248	245	245	244	249
15.							
16.							
17.							
18.							
Total	40,217	3,691	12,255	8,263	9,696	4,015	2,297

I + II

ECONOMIC TABLE 5

LEGASPI WATER SUPPLY PROJECT

OPERATION AND MAINTENANCE EXPENSES

Costs as of July 1, 1981 in 1,000 Pesos

Year	Power	Chemicals	Others	Total	Net Costs
1981	22	34	140	196	-
1982	22	34	159	215	-
1983	22	34	179	235	20
1984	22	35	198	255	40
1985	-	68	217	285	70
1986	-	73	275	348	133
1987	-	78	343	421	206
1988	37	91	401	529	314
1989	87	108	459	654	439
1990	145	127	527	799	584
1991	210	149	594	953	738
1992	284	174	652	1,110	895
1993	369	202	710	1,281	1,066

Base Year = 1983

I + II

ECONOMIC TABLE 6-0

LEGASPI WATER SUPPLY PROJECT
LIFE EXPECTANCY AND REPLACEMENT SCHEDULES
₱ x 1,000

Value without CONVERSION

Components	Life Expectancy of Components				
	7 Years	15 Years	50 Years	Infinite	Total
1. Collection Chamber			1,780		1,780
2. Reservoir			3,870		3,870
3. Pumps		1,700			1,700
4. Transmission			4,198		4,198
5. Distribution			9,798		9,798
6. I/G			1,400		1,400
7. Meters		6,682			6,682
8. Hydrants			536		536
9. Chlorinators	20				20
10. Vehicles	210				210
11. Land				143	143
12. Valves			432		432

7 Year Items	Years of Installation					Years of Replacement				
1. Chlorinators	1985	1988				1992	1995	1999	2002	2006
						2009				
2. Vehicles	1985					1991	1992	1998	1999	2005
						2006	2012			

15 Year Items	Years of Installation					Years of Replacement				
1. Pumps	1986	1987				2001	2002			
2. Meters	1984	1985	1986	1987	1988	1999	2000	2001	2002	2003

ECONOMIC TABLE 6-A

LEGASPI WATER SUPPLY PROJECT
LIFE EXPECTANCY AND REPLACEMENT SCHEDULES
₱ x 1,000

Value with CONVERSION A

Components	Life Expectancy of Components				
	7 Years	15 Years	50 Years	Infinite	Total
1. Collection Chamber			1,434		1,434
2. Reservoir			3,118		3,118
3. Pumps		1,768			1,768
4. Transmission			4,676		4,676
5. Distribution			10,695		10,695
6. I/G			1,200		1,200
7. Meters		7,755			7,755
8. Hydrants			584		584
9. Chlorinators	25				25
10. Vehicles	231				231
11. Land				136	136
12. Valve			495		495

7 Year Items	Years of Installation					Years of Replacement				
1. Chlorinators	1985	1988				1992	1995	1999	2002	2006
						2009				
2. Vehicles	1984	1985				1991	1992	1998	1999	2005
						2006	2012			

15 Year Items	Years of Installation					Years of Replacement				
1. Pumps	1986	1987				2001	2002			
2. Meters	1984	1985	1986	1987	1988	1999	2000	2001	2002	2003

ECONOMIC TABLE 6-B

I + II

LEGASPI WATER SUPPLY PROJECT
LIFE EXPECTANCY AND REPLACEMENT SCHEDULES
₱ x 1,000

Value with CONVERSION B

Components	Life Expectancy of Components				
	7 Years	15 Years	50 Years	Infinite	Total
1. Collection Chamber			1,323		1,323
2. Reservoir			2,875		2,875
3. Pumps		1,513			1,513
4. Transmission			3,973		3,973
5. Distribution			9,054		9,054
6. I/G			1,112		1,112
7. Meters		6,468			6,468
8. Hydrants			495		495
9. Chlorinators	20				20
10. Vehicles	205				205
11. Land				136	136
12. Valves			416		416

7 Year Items	Years of Installation					Years of Replacement				
1. Chlorinators	1985	1988				1992	1995	1999	2002	2006
						2009				
2. Vehicles	1984	1985				1991	1992	1998	1999	2005
						2006	2012			

15 Year Items	Years of Installation					Years of Replacement				
1. Pumps	1986	1987				2001	2002			
2. Meters	1984	1985	1986	1987	1988	1999	2000	2001	2002	2003

I + II

ECONOMIC TABLE 6-C

LEGASPI WATER SUPPLY PROJECT

LIFE EXPECTANCY AND REPLACEMENT SCHEDULES

₱ x 1,000

Value with CONVERSION C

Components	Life Expectancy of Components				
	7 Years	15 Years	50 Years	Infinite	Total
1. Collection Chambers			1,891		1,891
2. Reservoir			4,112		4,112
3. Pumps		1,955			1,955
4. Transmission			4,901		4,901
5. Distribution			11,439		11,439
6. I/G			1,488		1,488
7. Meters		7,969			7,969
8. Hydrants			625		625
9. Chlorinators	25				25
10. Vehicles	236				236
11. Land				143	143
12. Valves			511		511

7 Year Items	Years of Installation					Years of Replacement				
1. Chlorinators	1985	1988				1992	1995	1999	2002	2006
						2009				
2. Vehicles	1984	1985				1991	1992	1998	1999	2005
						2006	2012			

15 Year Items	Years of Installation					Years of Replacement				
1. Pumps	1986	1987				2001	2002			
2. Meters	1984	1985	1986	1987	1988	1999	2000	2001	2002	2003

I + II

ECONOMIC TABLE 7-0

LEGASPI WATER SUPPLY PROJECT

CALCULATION OF SALVAGE VALUES

₱ x 1,000

Value without CONVERSION

Components	Base Year Value	Percentage of Base Year Value	31st Year Salvage Base Year Values
Infinite Life, Year Purchased			
1984	48)		
1985 1986	30 } 30) 143	75%	107
1987	35)		
50 Year Life, Year Constructed			
1 1984	6,824	42%	2,866
2 1985	4,386	44%	1,930
3 1986	6,761	46%	3,110
4 1987	2,477	48%	1,189
5 1998 6 1989	1,566	50%	783
15 Year Life, Year of Replacement			
1 1999	3,371	7%	236
2 2000	2,397	13%	312
3 2001	1,442	20%	288
4 2002	870	27%	235
5 2003	302	33%	100
7 Year Life, Years of Final Replacement			
1 2006	19	0%	0
2 2009	1	43%	0
3 2006 4 2012	70 140	0% 86%	0 120
Total			11,276

ECONOMIC TABLE 7-A

LEGASPI WATER SUPPLY PROJECT

CALCULATION OF SALVAGE VALUES

₱ x 1,000

Value with CONVERSION A

Components	Base Year Value	Percentage of Base Year Value	31st Year Salvage Base Year Values
Infinite Life, Year Purchased			
1984	46)		
1985 1986	29 29 } 136	75%	102
1987	32)		
50 Year Life, Year Constructed			
1 1984	6,957	42%	2,922
2 1985	4,554	44%	2,004
3 1986	7,020	46%	3,229
4 1987	2,345	48%	1,126
5 1988	1,326	50%	663
15 Year Life, Year of Replacement			
1 1999	3,912	7%	274
2 2000	2,782	13%	362
3 2001	1,557	20%	311
4 2002	921	27%	249
5 2003	351	33%	116
7 Year Life, Years of Final Replacement			
1 2006	24	0%	0
2 2009	1	43%	0
3 2006 4 2012	77 154	0% 86%	0 132
Total			11,490

I + II

ECONOMIC TABLE 7-B

LEGASPI WATER SUPPLY PROJECT

CALCULATION OF SALVAGE VALUES

₱ x 1,000

Value with CONVERSION B

Components	Base Year Value	Percentage of Base Year Value	31st Year Salvage Base Year Values
Infinite Life, Year Purchased			
1984	46)		
1985 1986	29 } 136 29)	75%	102
1987	32)		
50 Year Life, Year Constructed			
1 1984	6,012	42%	2,525
2 1985	3,862	44%	1,699
3 1986	6,019	46%	2,769
4 1987	2,077	48%	997
5 1988	1,278	50%	639
15 Year Life, Year of Replacement			
1 1999	3,234	7%	226
2 2000	3,357	13%	436
3 2001	807	20%	161
4 2002	323	27%	87
5 2003	260	33%	86
7 Year Life, Years of Final Replacement			
1 2006	19	0%	0
2 2009	1	43%	0
3 2006 4 2012	68 137	0% 86%	0 118
Total			9,845

I + II

ECONOMIC TABLE 7-C

LEGASPI WATER SUPPLY PROJECT

CALCULATION OF SALVAGE VALUES

₱ x 1,000

Value with CONVERSION C

Components	Base Year Value	Percentage of Base Year Value	31st Year Salvage Base Year Values
Infinite Life, Year Purchased			
1984	48)		
1985 1986	30 } 30 } 143	75%	107
1987	35)		
50 Year Life, Year Constructed			
1 1984	7,782	42%	3,268
2 1985	5,026	44%	2,211
3 1986	7,727	46%	3,554
4 1987	2,745	48%	1,318
5 1988	1,687	50%	844
15 Year Life, Year of Replacement			
1 1999	4,020	7%	281
2 2000	2,859	13%	372
3 2001	1,694	20%	339
4 2002	991	27%	268
5 2003	360	33%	119
7 Year Life, Years of Final Replacement			
1 2006	24	0%	0
2 2009	1	43%	0
3 2006 4 2012	79 157	0% 86%	0 135
Total			12,816

I + II

ECONOMIC TABLE 8-0

LEGASPI WATER SUPPLY PROJECT

SUMMARY OF ALL PROJECT COSTS

Costs as of July 1, 1981 in 1,000 Pesos

Value without CONVERSION

Year	Cost of Facilities	Net O & M	Replacement Costs	Total	Salvage	Net Cost
1982						
1983	3,216	20		3,236		
1984	10,599	40		10,639		
1985	6,249	70		6,319		
1986	6,978	133		7,111		
1987	5,439	206		5,645		
1988	2,576	314		2,890		
1989		439		439		
1990		584		584		
1991		738	140	878		
1992		895	89	984		
1993		1,066		1,066		
1994		1,066		1,066		
1995		1,066	1	1,067		
1996		1,066		1,066		
1997		1,066		1,066		
1998		1,066	140	1,206		
1999		1,066	3,460	4,526		
2000		1,066	2,397	3,463		
2001		1,066	1,462	2,528		
2002		1,066	851	1,917		
2003		1,066	302	1,368		
2004		1,066		1,066		
2005		1,066	140	1,206		
2006		1,066	89	1,155		
2007		1,066		1,066		
2008		1,066		1,066		
2009		1,066	1	1,067		
2010		1,066		1,066		
2011		1,066		1,066		
2012		1,066	70	1,136		
Total	25,057	24,759	9,142	68,958	(11,276)	57,682

I + II

ECONOMIC TABLE 8-A

LEGASPI WATER SUPPLY PROJECT

SUMMARY OF ALL PROJECT COSTS

Costs as of July 1, 1981 in 1,000 Pesos

Value with CONVERSION A

Year	Cost of Facilities	Net O & M	Replacement Costs	Total	Salvage	Net Cost
1982						
1983	3,625	20		3,645		
1984	11,313	40		11,353		
1985	6,742	70		6,812		
1986	7,188	133		7,321		
1987	5,614	206		5,820		
1988	2,469	314		2,783		
1989		439		439		
1990		584		584		
1991		738	154	892		
1992		895	101	996		
1993		1,066		1,066		
1994		1,066		1,066		
1995		1,066	1	1,067		
1996		1,066		1,066		
1997		1,066		1,066		
1998		1,066	154	1,220		
1999		1,066	4,013	5,079		
2000		1,066	2,782	3,848		
2001		1,066	1,557	2,623		
2002		1,066	922	1,988		
2003		1,066	351	1,417		
2004		1,066		1,066		
2005		1,066	154	1,220		
2006		1,066	101	1,167		
2007		1,066		1,066		
2008		1,066		1,066		
2009		1,066	1	1,067		
2010		1,066		1,066		
2011		1,066		1,066		
2012		1,066	154	1,220		
Total	36,951	24,759	10,445	72,155	(11,490)	60,665

I + II

ECONOMIC TABLE 8-B

LEGASPI WATER SUPPLY PROJECT
SUMMARY OF ALL PROJECT COSTS
Costs as of July 1, 1981 in 1,000 Pesos

Value with CONVERSION B

Year	Cost of Facilities	Net O & M	Replace-ment Costs	Total	Salvage	Net Cost
1982						
1983	3,150	20		3,170		
1984	9,640	40		9,680		
1985	6,749	70		6,819		
1986	5,634	133		5,767		
1987	4,390	206		4,596		
1988	2,227	314		2,541		
1989		439		439		
1990		584		584		
1991		738	137	875		
1992		895	87	982		
1993		1,066		1,066		
1994		1,066		1,066		
1995		1,066	1	1,067		
1996		1,066		1,066		
1997		1,066		1,066		
1998		1,066	137	1,203		
1999		1,066	3,321	4,387		
2000		1,066	2,328	3,394		
2001		1,066	1,352	2,418		
2002		1,066	808	1,874		
2003		1,066	260	1,326		
2004		1,066		1,066		
2005		1,066	137	1,203		
2006		1,066	87	1,153		
2007		1,066		1,066		
2008		1,066		1,066		
2009		1,066	1	1,067		
2010		1,066		1,066		
2011		1,066		1,066		
2012		1,066	137	1,203		
Total	31,790	24,759	8,793	65,342	(9,845)	55,497

ECONOMIC TABLE 8-C

LEGASPI WATER SUPPLY PROJECT

SUMMARY OF ALL PROJECT COSTS

Costs as of July 1, 1981 in 1,000 Pesos

Value with CONVERSION C

Year	Cost of Facilities	Net O & M	Replace-ment Costs	Total	Salvage	Net Cost
1982						
1983	3,691	20		3,711		
1984	12,255	40		12,295		
1985	7,252	70		7,322		
1986	7,959	133		8,092		
1987	6,191	206		6,397		
1988	2,869	314		3,183		
1989		439		439		
1990		584		584		
1991		738	157	895		
1992		895	103	998		
1993		1,066		1,066		
1994		1,066		1,066		
1995		1,066	1	1,067		
1996		1,066		1,066		
1997		1,066		1,066		
1998		1,066	157	1,223		
1999		1,066	4,123	5,189		
2000		1,066	2,859	3,925		
2001		1,066	1,694	2,760		
2002		1,066	992	2,058		
2003		1,066	360	1,426		
2004		1,066		1,066		
2005		1,066	157	1,223		
2006		1,066	103	1,169		
2007		1,066		1,066		
2008		1,066		1,066		
2009		1,066	1	1,067		
2010		1,066		1,066		
2011		1,066		1,066		
2012		1,066	157	1,223		
Total	40,217	24,759	10,864	75,840	(12,816)	63,024

I + II

ECONOMIC TABLE 9

LEGASPI WATER SUPPLY PROJECT
BENEFITS AT 1981 PRICES
(₱ x 1,000)

Year	Volume	Qualitative	Fire Loss Reduction	Total	National Interest Adjustment
1982					
1983					
1984	67	164	67	298	328
1985	2,161	327	89	2,577	2,835
1986	2,557	491	116	3,164	3,480
1987	3,001	491	148	3,640	4,004
1988	3,482	491	192	4,165	4,582
1989	4,044	491	252	4,787	5,266
1990	4,603	491	331	5,425	5,968
1991	5,184	491	437	6,112	6,723
1992	5,665	491	584	6,740	7,414
1993	6,072	491	801	7,364	8,100
1994	6,072	491	801	7,364	8,100
1995	6,072	491	801	7,364	8,100
1996	6,072	491	801	7,364	8,100
1997	6,072	491	801	7,364	8,100
1998	6,072	491	801	7,364	8,100
1999	6,072	491	801	7,364	8,100
2000	6,072	491	801	7,364	8,100
2001	6,072	491	801	7,364	8,100
2002	6,072	491	801	7,364	8,100
2003	6,072	491	801	7,364	8,100
2004	6,072	491	801	7,364	8,100
2005	6,072	491	801	7,364	8,100
2006	6,072	491	801	7,364	8,100
2007	6,072	491	801	7,364	8,100
2008	6,072	491	801	7,364	8,100
2009	6,072	491	801	7,364	8,100
2010	6,072	491	801	7,364	8,100
2011	6,072	491	801	7,364	8,100
2012	6,072	491	801	7,364	8,100
Total	152,204	13,748	18,236	184,188	202,600

ECONOMIC TABLE 10-0

LEGASPI WATER SUPPLY PROJECT

INTERNAL RATE OF RETURN COMPUTATION

I + II

Cost Value without CONVERSION

Year	Total Cost	Total Benefit	Net Benefit	Present Net Benefit
1982				
1983	3,236	-	-3,236	-3,236
1984	10,639	328	-10,311	-8,859
1985	6,319	2,835	-3,484	-2,572
1986	7,111	3,480	-3,631	-2,303
1987	5,645	4,004	-1,641	-894
1988	2,890	4,582	1,692	792
1989	439	5,266	4,827	1,942
1990	584	5,968	5,384	1,861
1991	878	6,723	5,845	1,736
1992	984	7,414	6,430	1,640
1993	1,066	8,100	7,034	1,542
1994	1,066	8,100	7,034	1,325
1995	1,067	8,100	7,033	1,138
1996	1,066	8,100	7,034	978
1997	1,066	8,100	7,034	840
1998	1,206	8,100	6,894	707
1999	4,526	8,100	3,574	315
2000	3,463	8,100	4,637	351
2001	2,528	8,100	5,572	363
2002	1,917	8,100	6,183	346
2003	1,368	8,100	6,732	323
2004	1,066	8,100	7,034	290
2005	1,206	8,100	6,894	245
2006	1,155	8,100	6,945	212
2007	1,066	8,100	7,034	184
2008	1,066	8,100	7,034	158
2009	1,067	8,100	7,033	136
2010	1,066	8,100	7,034	117
2011	1,066	8,100	7,034	100
2012	1,136	8,100	18,240*	224*
Salvage(-)	11,276			
Total	57,682	202,600	144,918	1

Rate of Return = 0.16

ECONOMIC TABLE 10-A

I + II

LEGASPI WATER SUPPLY PROJECT
INTERNAL RATE OF RETURN COMPUTATION

Cost Value with CONVERSION A

Year	Total Cost	Total Benefit	Net Benefit	Present Benefit
1982				
1983	3,645	-	-3,645	-3,645
1984	11,353	328	-11,025	-9,555
1985	6,812	2,835	-3,977	-2,987
1986	7,321	3,480	-3,841	-2,500
1987	5,820	4,004	-1,816	-1,024
1988	2,783	4,582	1,799	879
1989	439	5,266	4,827	2,045
1990	584	5,968	5,384	1,977
1991	892	6,723	5,831	1,855
1992	996	7,414	6,418	1,770
1993	1,066	8,100	7,034	1,681
1994	1,066	8,100	7,034	1,457
1995	1,067	8,100	7,033	1,262
1996	1,066	8,100	7,034	1,094
1997	1,066	8,100	7,034	948
1998	1,220	8,100	6,880	804
1999	5,079	8,100	3,021	306
2000	3,848	8,100	4,252	373
2001	2,623	8,100	5,477	416
2002	1,988	8,100	6,112	403
2003	1,417	8,100	6,683	382
2004	1,066	8,100	7,034	348
2005	1,220	8,100	6,880	295
2006	1,167	8,100	6,933	258
2007	1,066	8,100	7,034	227
2008	1,066	8,100	7,034	196
2009	1,067	8,100	7,033	170
2010	1,066	8,100	7,034	147
2011	1,066	8,100	7,034	128
2012	1,220	8,100	18,370*	289*
Salvage(-)	11,490			
Total	60,665	202,600	141,935	-1

* Values include salvage.

Rate of Return = 0.15

ECONOMIC TABLE 10-B

LEGASPI WATER SUPPLY PROJECT

INTERNAL RATE OF RETURN COMPUTATION

Cost Value with CONVERSION B

Year	Total Cost	Total Benefit	Net Benefit	Present Benefit
1982				
1983	3,170	-	-3,170	-3,170
1984	9,680	328	-9,352	-7,936
1985	6,819	2,835	-3,984	-2,869
1986	5,767	3,480	2,287	-1,398
1987	4,596	4,004	-592	-307
1988	2,541	4,582	2,041	898
1989	439	5,266	4,827	1,803
1990	584	5,968	5,384	1,707
1991	875	6,723	5,848	1,573
1992	982	7,414	6,432	1,468
1993	1,066	8,100	7,034	1,363
1994	1,066	8,100	7,034	1,156
1995	1,067	8,100	7,033	981
1996	1,066	8,100	7,034	833
1997	1,066	8,100	7,034	707
1998	1,203	8,100	6,897	588
1999	4,387	8,100	3,713	269
2000	3,394	8,100	4,706	289
2001	2,418	8,100	5,682	296
2002	1,874	8,100	6,226	275
2003	1,326	8,100	6,774	254
2004	1,066	8,100	7,034	224
2005	1,203	8,100	6,897	186
2006	1,153	8,100	6,947	159
2007	1,066	8,100	7,034	137
2008	1,066	8,100	7,034	116
2009	1,067	8,100	7,033	99
2010	1,066	8,100	7,034	84
2011	1,066	8,100	7,034	71
2012	1,203	8,100	16,742*	143*
Salvage(-)	9,845			
Total	55,497	202,600	147,103	-1

* Values include salvage.

Rate of Return = 0.18

Legaspi

I + II

ECONOMIC TABLE 10-C

LEGASPI WATER SUPPLY PROJECT
INTERNAL RATE OF RETURN COMPUTATION

Cost Value with CONVERSION C

Year	Total Cost	Total Benefit	Net Benefit	Present Benefit
1982				
1983	3,711	-	-3,711	-3,711
1984	12,295	328	-11,967	-10,480
1985	7,322	2,835	-4,487	-3,441
1986	8,092	3,480	-4,612	-3,098
1987	6,397	4,004	-2,393	-1,408
1988	3,183	4,582	1,399	721
1989	439	5,266	4,827	2,178
1990	584	5,968	5,384	2,127
1991	895	6,723	5,828	2,017
1992	998	7,414	6,416	1,944
1993	1,066	8,100	7,034	1,867
1994	1,066	8,100	7,034	1,635
1995	1,067	8,100	7,033	1,432
1996	1,066	8,100	7,034	1,254
1997	1,066	8,100	7,034	1,098
1998	1,223	8,100	6,877	940
1999	5,189	8,100	2,911	349
2000	3,925	8,100	4,175	438
2001	2,760	8,100	5,340	490
2002	2,058	8,100	6,042	486
2003	1,426	8,100	6,674	470
2004	1,066	8,100	7,034	434
2005	1,223	8,100	6,877	372
2006	1,169	8,100	6,931	328
2007	1,066	8,100	7,034	292
2008	1,066	8,100	7,034	255
2009	1,067	8,100	7,033	224
2010	1,066	8,100	7,034	196
2011	1,066	8,100	7,034	171
2012	1,223	8,100	19,693*	420*
Salvage(-)	12,816			
Total	63,024	202,600	139,576	0

* Values include salvage.

Rate of Return = 0.14

APPENDIXES

1. Water Quality of Water Sources
2. Findings on Transmission Pipelines
3. Water Pressure in Daraga
4. Study on Water Sources
5. Socio-Economic Study
6. Design Criteria for Planning
7. Procedure of Projection of Population and Water Demand
8. Basic Cost Data

Appendix 1 Water Quality of Water Sources

Water quality of the existing water sources and potential ones in the study area was analyzed in the present study. Results of the analyses are presented in Table 1 together with the water quality standard of the Philippines in Table 2 Major characteristics of the water quality are as follows:

1) Spring Water

a. Water of most springs has good water quality, not requiring any water treatment except for disinfection.
b. Generally the water is soft and not corrosive, and concentrations of dissolved matters, hardness and chloride, are comparatively low.
c. The Banadero spring water has a rather high concentration of sulfate, such as 600 mg/l. It is recommendable to mix the water with other source water having low sulfate concentrations for health and pipe protection.

2) Deep Well Water

a. Water of deep wells in the poblacion has high values of color and odor.
b. Value of dissolved matters is high, which is undesirable for domestic use.
c. The water is free from contamination by domestic waste water.

3) Riverbed Water

Some shallow wells dug on the riverbed and outcrops of riverbed water which are being used by inhabitants nearby have good water quality, not requiring treatment for domestic use.

Table 1 Water Quality of Existing Water Soueces in Legaspi City and Daraga

Items \ Source	Budiao Spring No. 1	Budiao Spring No. 2	Banadero Spring	Daraga Spring	Camp Ibalon Deep Well	Bogtong Spring	Salbacion Spring	Tinapian Spring	Lacag Spring	Buyoan Spring	Tinago Deep Well	Malabog Spring	Bicol Deep Well	Bitano Deep Well
Sampling date	10 Aug	10 Aug	10 Aug	11 Aug	11 Aug	11 Aug	19 Aug	14 Aug	17 Aug	11 Aug	11 Aug	11 Aug	11 Aug	11 Aug
Weather	fine	fine	fine	Clouded	Clouded	Clouded	fine	fine	fine	Clouded	Clouded	Clouded	Clouded	Clouded
Atom. Temperature (°C)	27	27	27	25	25	25	28	27	26	25	25	25	25	25
Water Temperature (°C)	25	25	26	26	27	26	26	23	24	24.5	29	26	36	27
Turbidity (mg/l)	0	0	0	0	0	0	0	0	8	0	5	0	0	20
Color (mg/l)	0	0	0	10	15	0	0	0	0	0	20	0	8	40
Conductivity (μ℧/cm)	350	380	1060	650	1000	1050		230		340	2600	320	1690	
Hardness (mg/l)	60	85	310	775	100	190	67.5	35	25	95	325	50	30	300
Calcium (mg/l)	12	16	96	20	32	64	13	8	6	22	90	12	8	64
Magnesium (mg/l)	7.3	8.5	17	6.7	4.9	7.3	9	3.6	2.4	9.7	24	5	2.4	34
Chloride (mg/l)	12	18	76	36	70	40	50	12	35	12	340	10	230	290
pH	7.2	7.1	7.2	6.9	6.8	7.4	7.0	6.6	6.9	6.8	7.6	6.6	6.5	7.6
Alkalinity (mg/l)	70	50	80	60	160	100	80	40	50	70	240	80	200	210
Sulfate (mg/l)	2	1	600	20	15	140	2.5	0	1	0	215	0	41	275
Ammonia-N (mg/l)	<0.3	<0.3	<0.3	0.3	2.5	<0.3	<0.3	<0.3	0.4	<0.3	1.0	<0.3	1.5	2.0
Iron (mg/l)	0.001	0.01	0.015	0.01	0.01	0.01	0.01	0.015	0.045	0.005	0.025	0.01	0.015	0.04
Manganese (mg/l)	0.05	nil	0.05	0.15	0.20	0.00	0.00	0.00	0.00	0.00	0.20	0.02	0.10	0.35
Odor[1/]	0	0	1	1	3	1	0	0	0	0	4	2	4	5
Total Bacteria (/ml)	negative	100	100	90	negative	20	50	50	more than 3000	negative	negative	negative	negative	negative
Coliform groups (/ml)	negative	negative	negative	50	negative	20	15	20	more than 1000	negative	negative	negative	negative	negative

Table 2 Water Quality Standard
Key Parameters of the Philippines
Standard for Drinking Water

Parameters[1/]	Permissible Level[2/]	Maximum Permissible[2/]
Coliform groups	No detecting in 100 ml	-
Total Bacteria	10/ml	-
Odor	Unobjectionable	-
Taste	Unobjectionable	-
Color	5 units	50 units
Turbidity	5 units	25 units
Total solids	500	1,500
pH	7.0 - 8.5	6.5 - 9.2
Total hardness	100	500
Calcium, as Ca	75	200
Magnesium, as Mg	50	150
Chloride, as Cl	200	600
Sulfate, as SO_4	200	400
Nitrate, as NO_3	-	30
Iron, as Fe	0.3	1.0
Manganese, as Mn	0.1	0.5

1/ The above table shows only main parameters of the Standard, which are considered essential for judging characteristics of drinking water quality.

2/ All units are in mg/l, unless otherwise stated.

Water quality of the currently-used water sources in the study area was investigated during the field survey from 9th to 21st August 1981. Remarkable characteristics of water quality except only some springs are that water of some sources has odor of hydrogen sulfide, and some others have color in addition to the odor. Findings on these two matters are briefly described below.

1) Odor of Hydrogen Sulfide

As shown in Table 1.3.1, water of deep wells in the area has strong odor of hydrogen sulfide, which is a phenomenon often seen in the volcanic area. Hydrogen sulfide (H_2S) may most probably have been caused by reduction of sulfuric acid (H_2SO_4), which is generally found in the volcanic formations. Meanwhile, water of the river, shallow wells and some springs has no or little order.

Regarding removal of the odor, a test by aeration was carried out in the field. As shown in Fig. 1, aeration is very effective in reducing the odor within a short time.

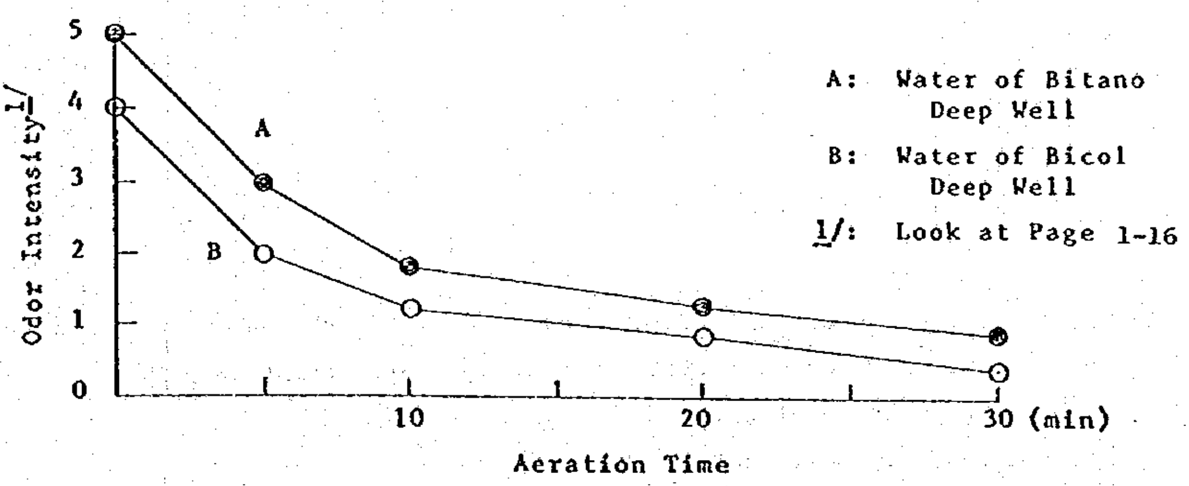


Fig 1 Test Result of Odor Removed by Aeration

2) Color

Water of deep wells and a spring surveyed in the area has high value of yellow color, exceeding the permissible value specified by the drinking water standard, as shown in the above-mentioned table. As the cause of the color was considered to be by dissolved matters, correlation between color and dissolved matters was investigated.

It was found that manganese, among others had a high correlation coefficient 0.94 with color, which is presented in Fig 2.

3) Summary

Findings and considerations on water quality are summarized as below:

a. Odor can be easily removed by aeration.
b. Color cannot be removed by aeration.
c. To oxidize and make manganese insoluble, over 10 mg/l chlorine is required.
d. To treat the water with color, a complete series of treatment processes will be needed.

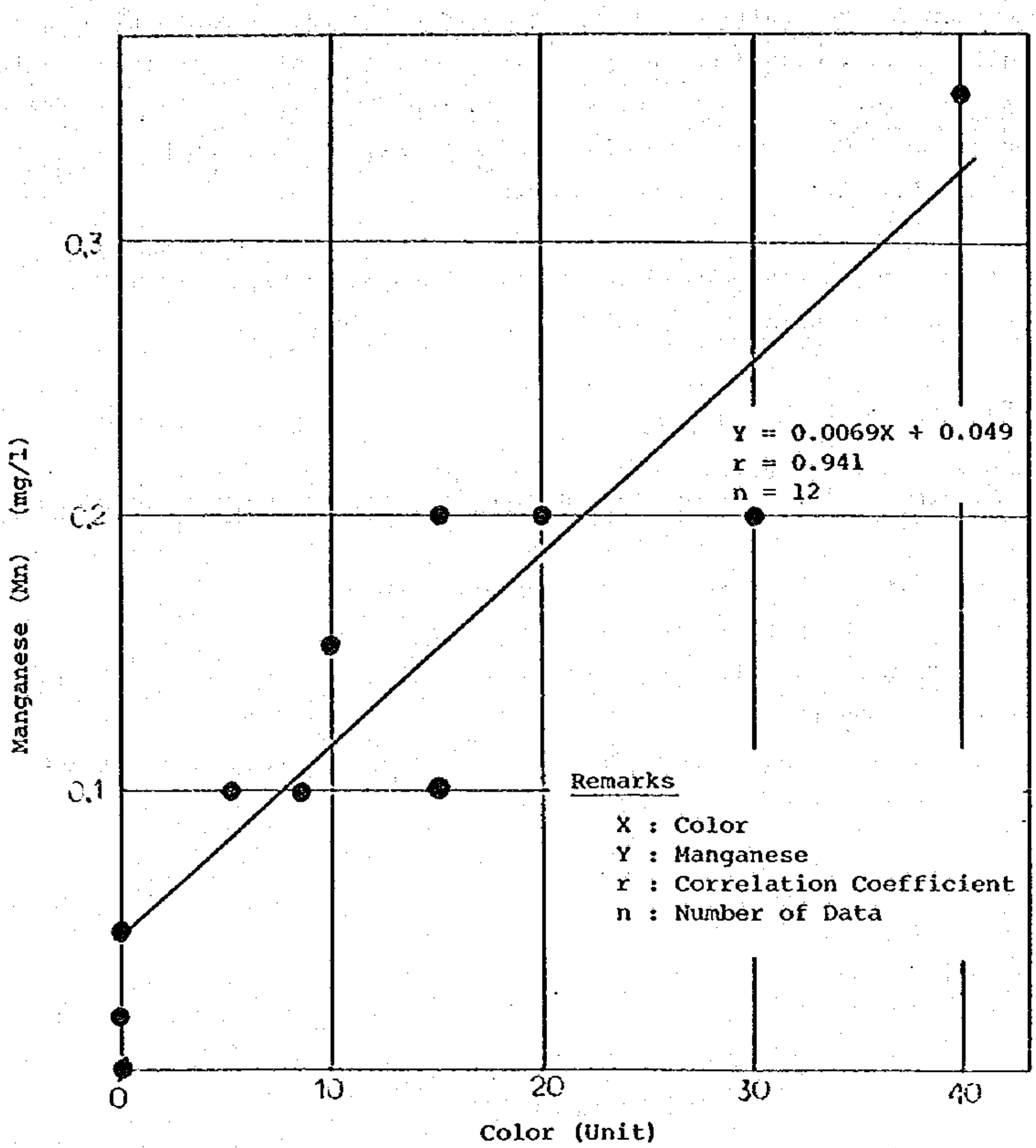


Fig 2 Correlation of Color and Manganese Concentration

Appendix 2 Findings on Transmission Pipeline

The transmission pipelines of the Albay Provincial Waterworks suffered heavy damages from the flood that occurred in June 1981. As the pipelines are located on the deposits of the volcano traversing the skirts of Mt. Mayon, they are extremely vulnerable to the mountain mud flow which contains cobbles, gravel and sand. The present field survey, therefore, was carried out to ascertain the present conditions of damaged pipelines and to find out means to be taken in rehabilitation of the pipelines and remedy of the shortcomings thereof in connection with the project planning for the water district. The survey was conducted in August 1981, about two months after the disaster. Major findings are as follows.

1. Budiao Spring System

a. The pipeline had many breakages between A and B in the attached figure. All visible breakages were temporarily repaired and presently the pipeline is in service.
b. At B, the flow in the pipe was free, not filling the pipe.
c. At the downstream of B, consumers are taking water from the pipe by hand pump.
d. At about the middle of B and C, an air pipe was blowing out air.
e. At C, water pressure was about 0.5 kg/sq cm.
f. Measured yield at A was about 7,600 cu m/day, and past records say the minimum yield is 6,540 cu m/day.
g. The carrying capacity of the pipeline is calculated as 3,900 cu m/day, assuming C = 90.

From the above observation and calculation, it is concluded that 1) there are still pipe breakage unrepaired between A and B, 2) the present actual flow may be far less than the calculated value, and 3) the spring has a big potential even when the repair is completely made.

2. Bañadero Spring System

This spring system had not been repaired at the time of the field survey. As the intake facilities were also damaged, the actual yield of the spring was not ascertained.

From the pipe size and length, the carrying capacity of the pipeline is calculated as 2,200 cu m/day assuming C = 90, against the recorded yield 2,940 cu m/day.

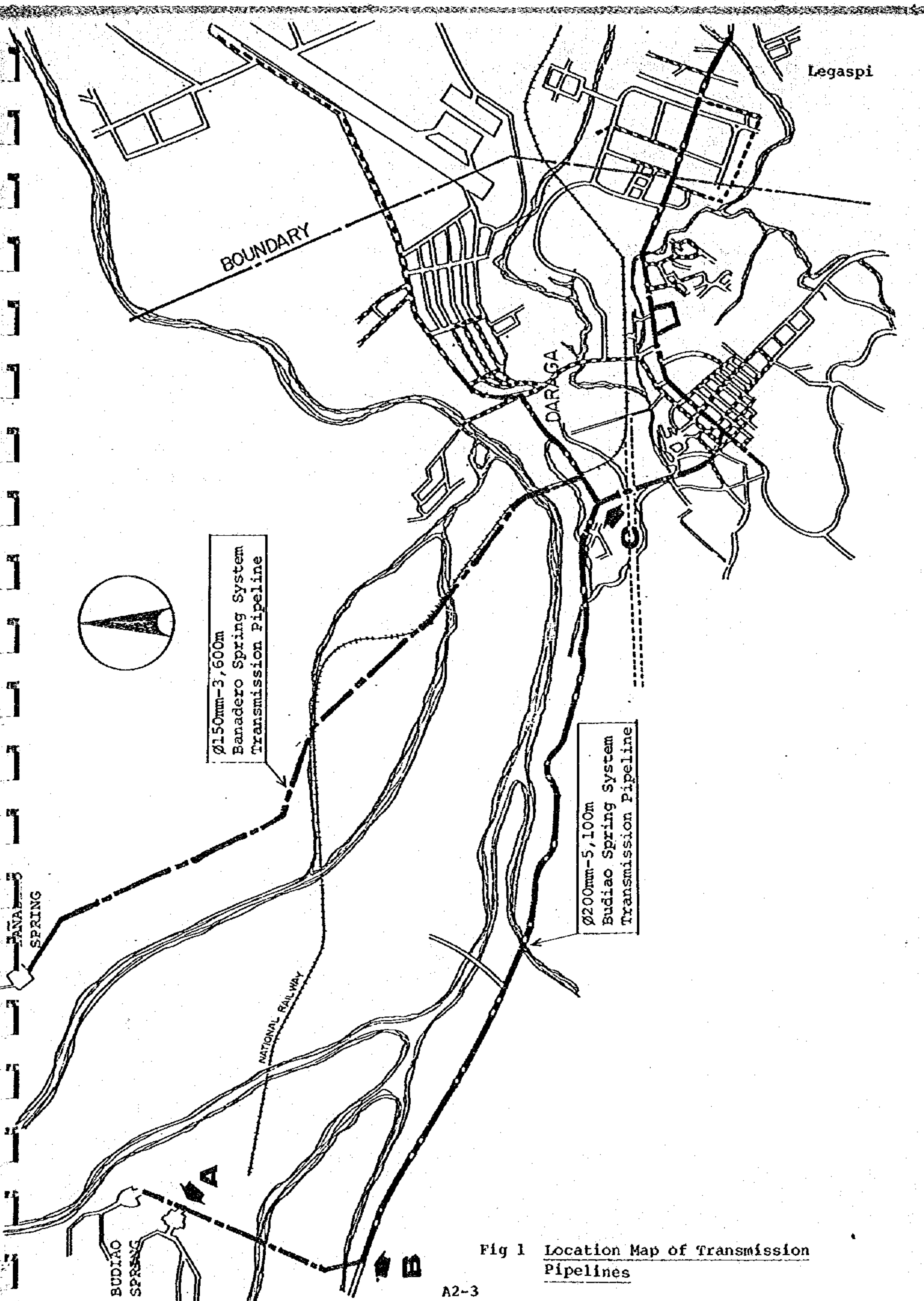


Fig 1 Location Map of Transmission Pipelines

Appendix 3 Water Pressure in Daraga

To investigate water pressure and its variation during 24 hours in the Daraga area, pressure recording was made at four strategic points on the distribution mains, as shown in Figs 1 and 2 , in August 1981.

Point R-1 on the transmission line just before forking into two distribution mains. Points R-2 and R-3 are each on the two distribution mains just after the above bifurcation. Point R-4 is at the farther end of Daraga poblacion where water supply conditions were extremely poor. The recorder for this point was placed on a service connection which is about four meters below the main.

As is clear in the figure, all pressures of the four recorded points were very low all through the day, with even the highest pressure less than 1 kg/ sq cm. Especially in the daytime from 6 A.M. to 8 P.M., the pressure was as low as 0.2 kg/sq cm.

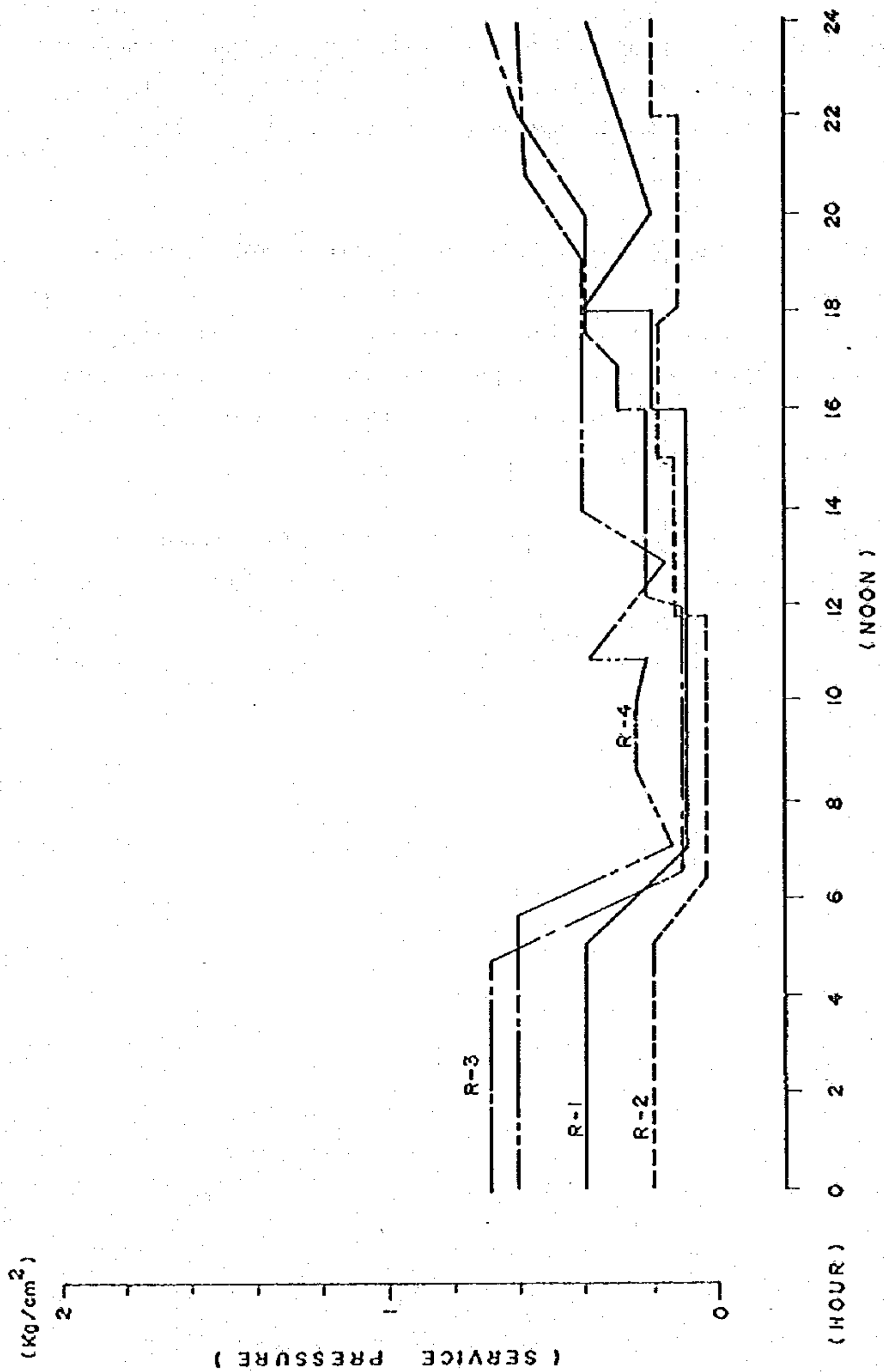


Fig 1 Variation of Water Pressure in Daraga
(Aug. 1981)

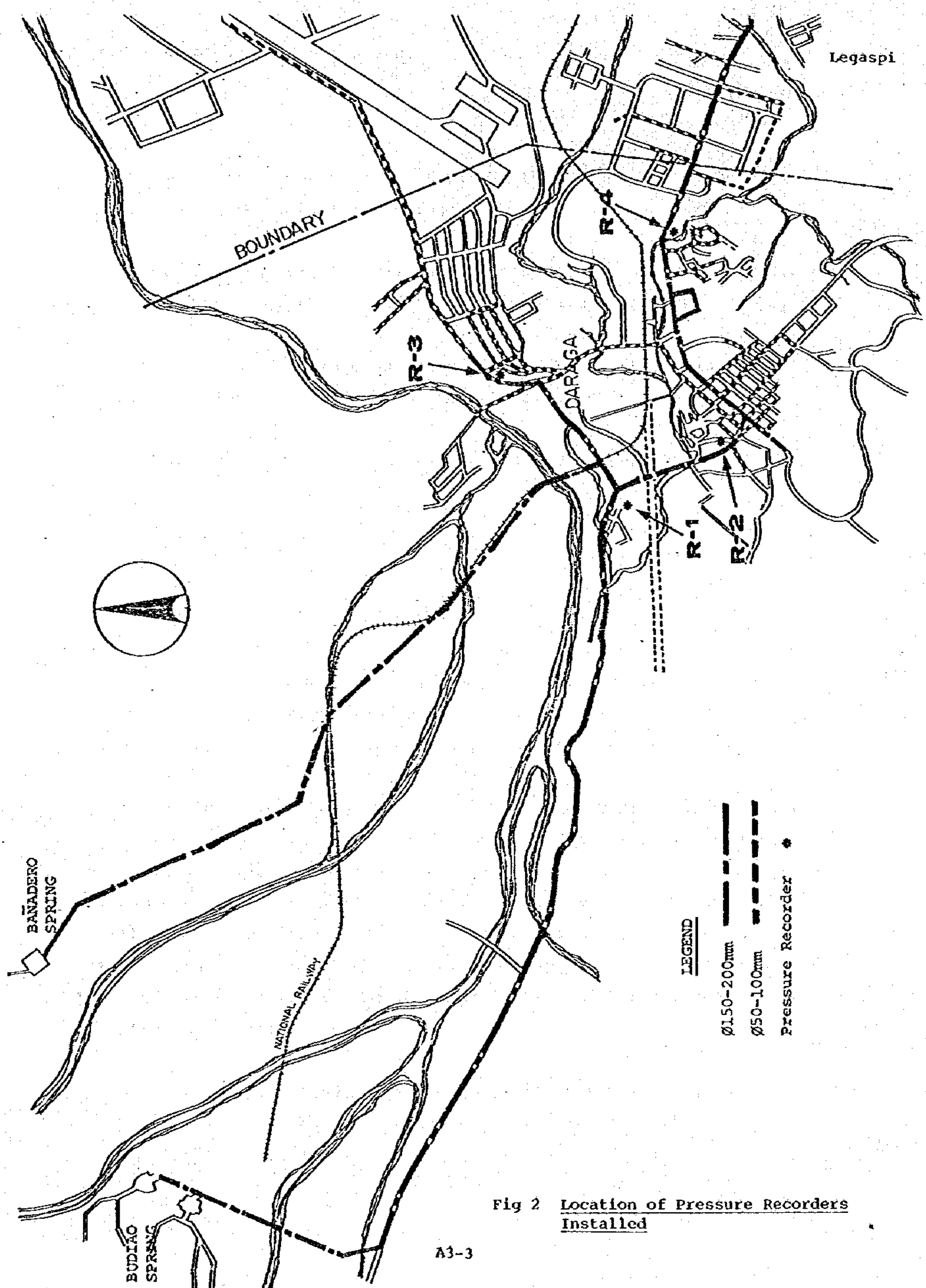


Fig 2 Location of Pressure Recorders Installed

Appendix 4. Study on Water Sources

1. General

Study Area: the city of Legaspi and the municipality of Daraga including the periphery thereof.

Purpose of Study: to examine possible sources of surface water and groundwater for the use of Legaspi and Daraga Water Districts.

Method of Study: reconnaissance in the field, flow measurement, analysis of existing data and electric resistivity survey.

Period of Field Investigation: August 10 to 20, 1981.

2. Topography

The region which includes the study area is characterized by volcanoes. Mt. Mayon is situated in the north of Daraga and Legaspi and rises to an elevation of 2,462 m with a perfect conical shape. Its volcanic activities are vigorous. As the volcano has repeatedly erupted, it has formed vast skirts, which extend as far as the seashore 10 km away from the crater in the north east of Daraga and Legaspi. The volcano has two types of topography: its upper portion, about 120 m and above, with steep slopes; its lower portion, less than that, with gentle and smooth slope. The former portion is dominated by the pyroclastic rocks; the latter portion by the mudflows. Many small streams have developed in the radial directions from the center of the volcano. Some of the streams drain directly into the sea, and some others are collected by the Yawa River, which borders the southern skirt of the volcano.

The Yawa River flows west to east, gathering tributaries from both Mt. Mayon and the lower Catabrean mountains in the south of Daraga and Legaspi, and empties into the sea.

There is a small hill, Mt. Linguion with an elevation of 156 m, located on the south of the Yawa River. Its slope is rather steep. The hill is assumed to be an old volcano.

The Yawa River has developed a small alluvial plain between the River and the above-mentioned lower mountains.

The lower mountains have an elevation of about 100 m above sea level, stretch to south with many undulations, and have a steep slope on the north end. The mountains originated from an old volcano, which has come to have many valleys and summits due to erosion.

Contour lines and classifications of the topography are shown in the map of Fig 1, and the cross section thereof in Fig 2.

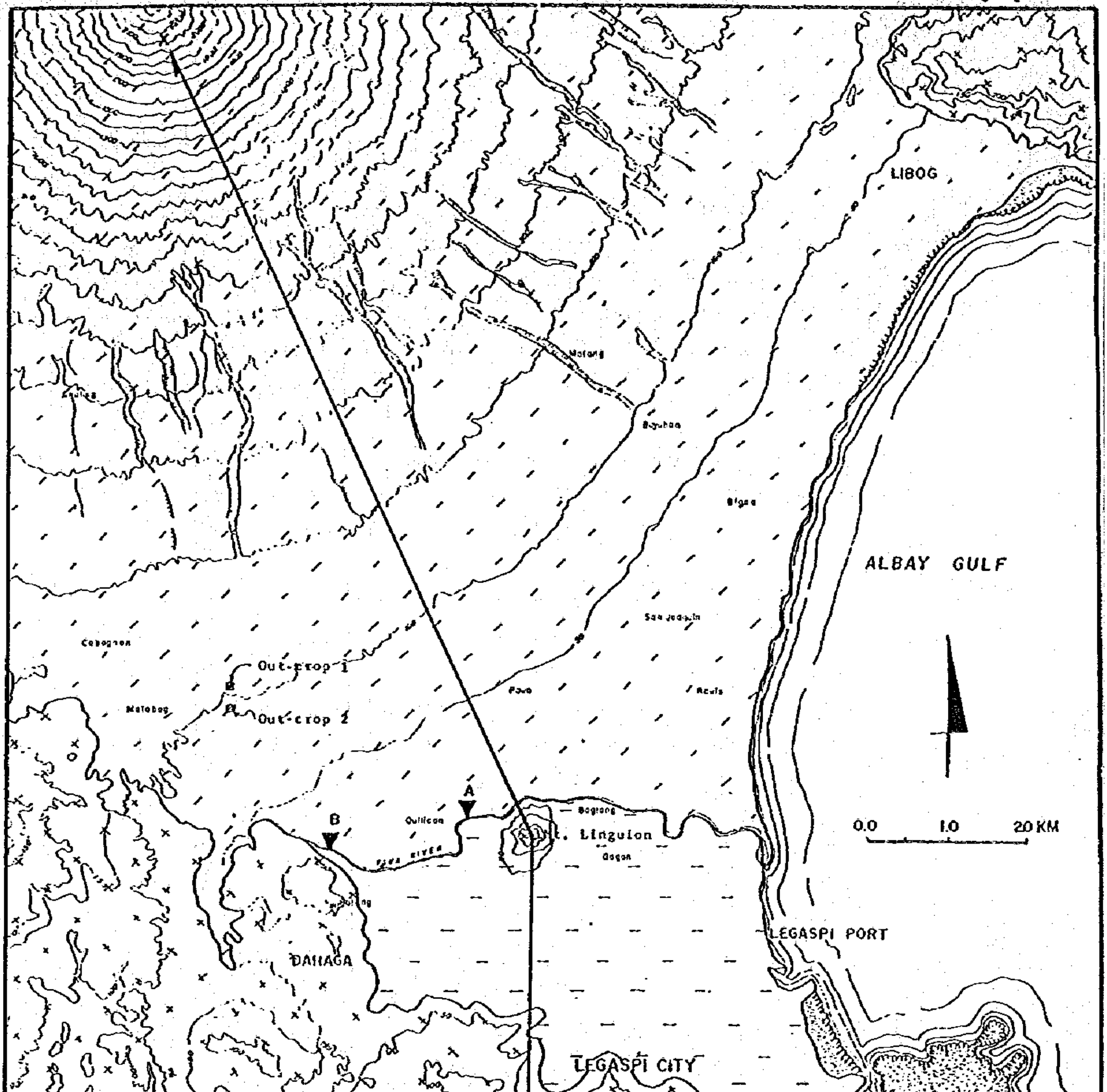


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Fig. 1 Classification Map of Topography
(Out-crops 1 and 2 are shown in Figs. 4 and 5)

LEGEND

Mayon Volcano

Plain

The Lower Mountains

A, B: The locations of river flow measurement

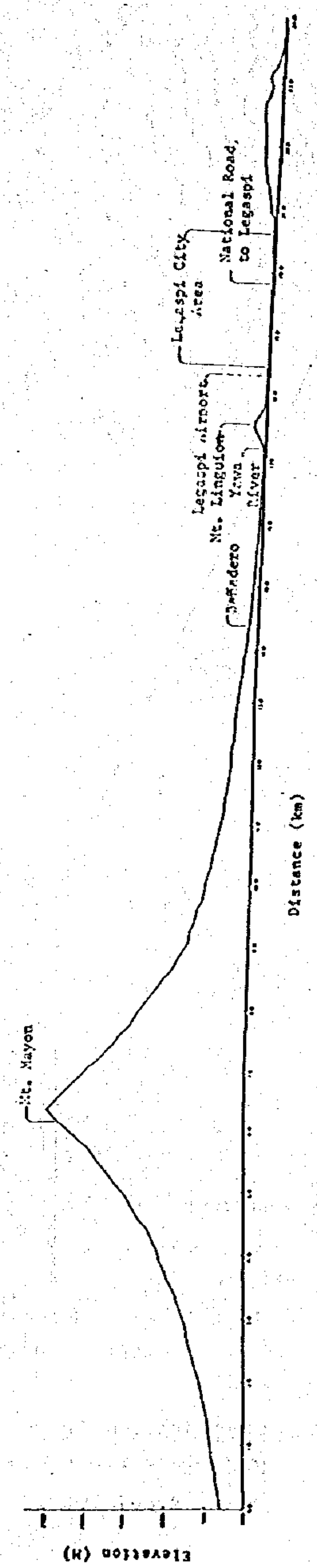


Fig 2 Topographic Profile of Section Line X-X'

3. Geology

The lower Catabrean mountains are made up of lava flows, agglomerates, volcanic breccia, tuff with interbeds of conglomerate, sandstone and shale according to the Groundwater Geology of Bicol Peninsula (1973)[1/]. The geological age is lower Miocene and the formation is called Daraga formation. Fig 3 shows the geological map in the study area.

Field evidence shows that volcanic rocks are massive and agglomeratic, and the rocks are pyroclastic rocks, tuff, volcanic rocks, and volcanic breccia, which derive from the old volcano.

Mt. Mayon is an active volcano of Konide type. The eruption debris are composed of andesitic pyroclastic rocks, scoria, volcanic ash and mudflows. Large andesites, with a longitudinal axis about 1.5 m, scatter in the volcanic ash and small scoria in the upper portion about 120 m in altitude, of the mountain. Pyroclastic rocks also exist in this portion. Fig 4 shows the outcrop of pyroclastic rocks in Budiao, Daraga.

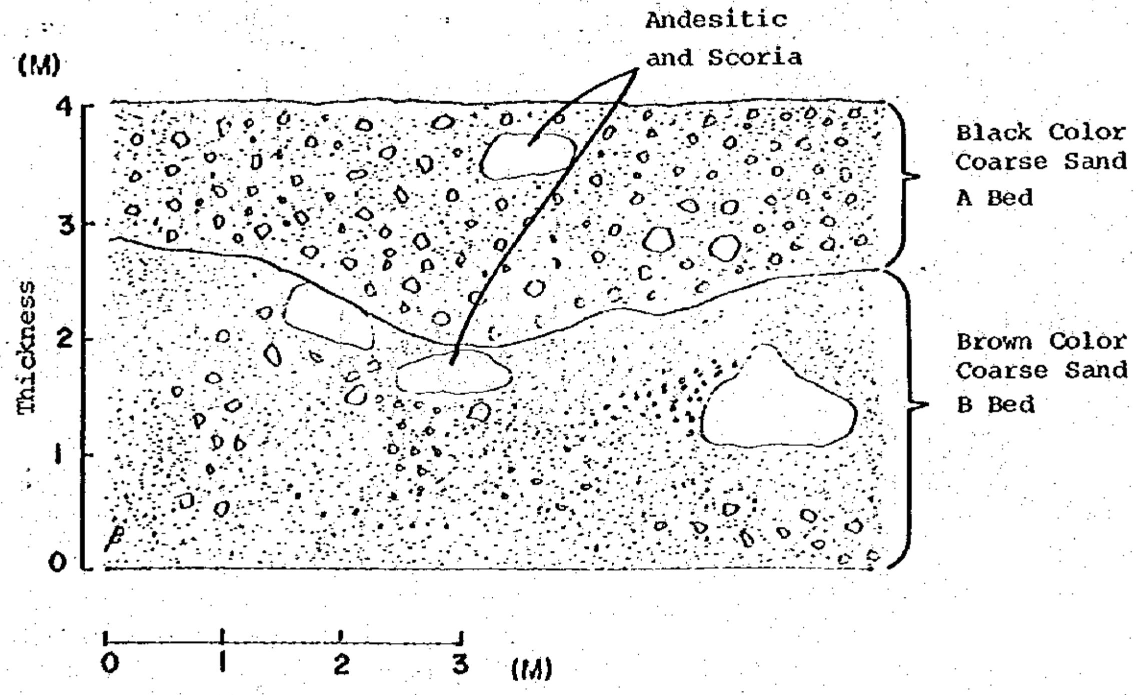
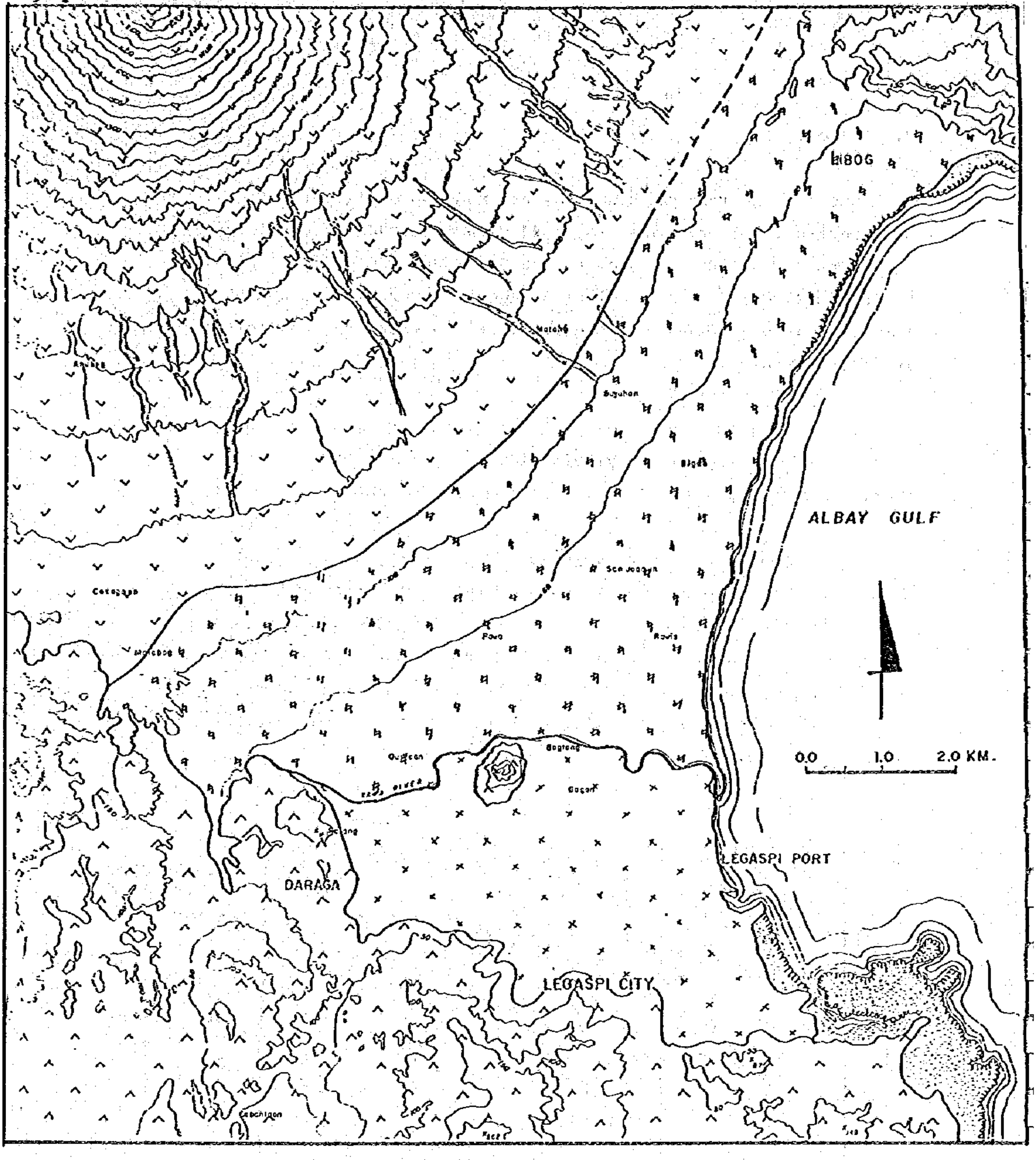


Fig 4 Outcrop of Pyroclastic Rocks
(The location is shown in the Outcrop 1 of Fig 1)

Legaspi



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LEGEND

Line of Geologic Contact

Quarternary Pyroclastic Rocks

Quarternary Mudflows

Alluvium

Lower Miocene (Daraga Formation

Fig 3 Geological Map of the Study Area

Mudflows, about one meter thick, cover the pyroclastic rocks and make the gentle and smooth slope of the lower portion of the mountain. Large andesites ejected from the volcano are sometimes found in the mudflow area. Fig 5 indicates the outcrop of the mudflow observed at Budiao, Daraga.

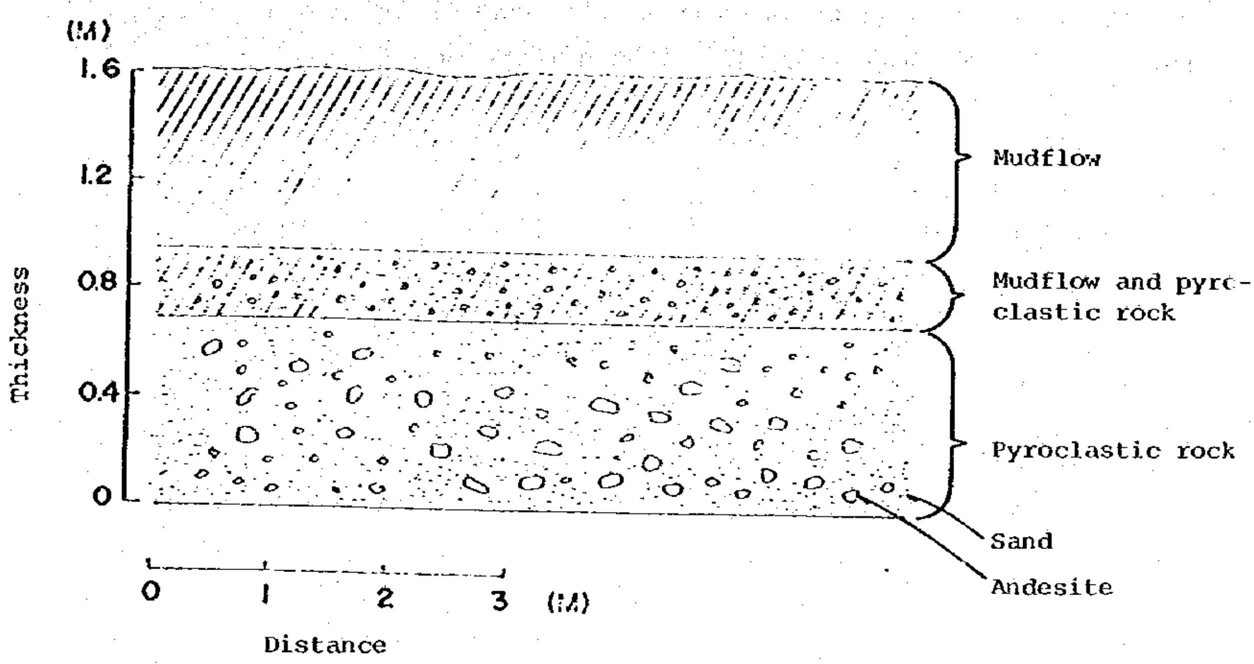

Fig 5 Outcrop of Mudflows
(The lcoation is shown in the Outcrop 2 of Fig 1)

The following Table 1 explains the stratifications of the formations in the study area.

Table 1 Geological Stratigraphy of Daraga and Legaspi Area

Sediments	Geological Period	Lithology
Alluvium	Recent	Lapilli, volcanic sand, volcanic ash, clay
Eruptions debris of Mt. Mayon	Quarternary	Andesitic pyroclastic rocks and scoria, volcanic ash, mudflows
Daraga formation	Lower Miocene	Lava flow, pyroclastic rocks, tuff, volcanic breccia

The alluvium is formed of lapilli, volcanic sand, volcanic ash and clay. These sediments derive from the eruption debris of Mt. Mayon and the formations of the lower mountains. The alluvium, it is considered, is formed of erosional material transported by the Yawa River.

Mt. Linguion consists mainly of lapilli, 3 cm to 2 mm in size, and loam. The geology explains that this mountain is an old volcano, the eruptions of which took place in the Tertiary.

4. Hydrology

4.1 Rainfall

The study area has no definite dry season with pronounced maximum rainfalls from November through January. Legaspi has an annual average rainfall 3256 mm (normal 1957-70)[2/] with a maximum monthly average 415 mm in the period from November to January and a high monthly average 223 mm from February to October. The annual rainfall of this area is fairly high composed with the average in the whole Philippines, 2500 mm.

The region is frequently hit by the typhoons during the period from October to December.

4.2 River

The Yawa River is a stream running from west to east with a drainage area about 78.3 sq km. In the present field survey, the river discharge was measured at the two points shown in Fig 1, on August 17, 1981. The instruments used for the survey were a Price current meter for flow velosity and a tape for the cross section of the stream. The weather of the day was fine. The measured discharge was Q = 3.1 cu m/sec = 267,840 cu m/d at the A point of the main stream, and Q = 1.8 cu m/sec = 155,520 cu m/d at the B point of the tributary.

The streamflow increases very rapidly when the basin has a rainfall, and the discharge is not large in the period of no rain. When the discharge is high, a great amount of volcanic ash and small breccia are carried downstream.

4.3 Groundwater

The study area has many springs scattered in the mountainous area and many wells of several types in the alluvial area. Fig 6 shows the locations of springs and wells. Table 2 indicates details of water sources.

Mt. Mayon has a number of springs at its foot, lower than 130 m in altitude, but almost no springs above that. The distribution of springs explains that the groundwater is recharged in the upper portion and flows out in the lower portion of the mountainside. These springs have generally large quantities of discharge. There are some springs along tributaries of the Yawa River, but their discharges are very small.

Rain water infiltrates in the recharge area, as mentioned above, and a part of the recharged water outflows as springs. The remaining part becomes groundwater, which is withdrawn by many wells in the alluvial area. The water withdrawn by these wells have peculiar offensive odour of hydrogen sulfide, which is derived, it is considered; from the characteristics of the volcanic sediments and the reduction of sulfides. Exceptionally there are some small areas where better quality water is found, such as Legaspi Port and Bogtong. Flowing wells are distributed in Legaspi Port, Gogon and the east portion of Old Albay. The wells scatter, with a well depth of 60 m to 80 m, in Legaspi City.

Dug wells are distributed, with a well depth of a few meters, in the study area, withdraw the unconfined water. Water level of such wells fluctuates with the intensity of rainfall.

The lower mountains also have many springs. Their discharges are very small, for example, Delapaz with Q = 0.113 l/sec = 9.8 cu m/day in contrast with the discharge of Budiao springs (No. 2) of Mt. Mayon Q = 88 l/sec = 7603.2 cu m/day. Mt.Liguion has a few springs with a small discharges. One of them has good quality without odour, and another one has an objectionable odour of hydrogen sulfide.

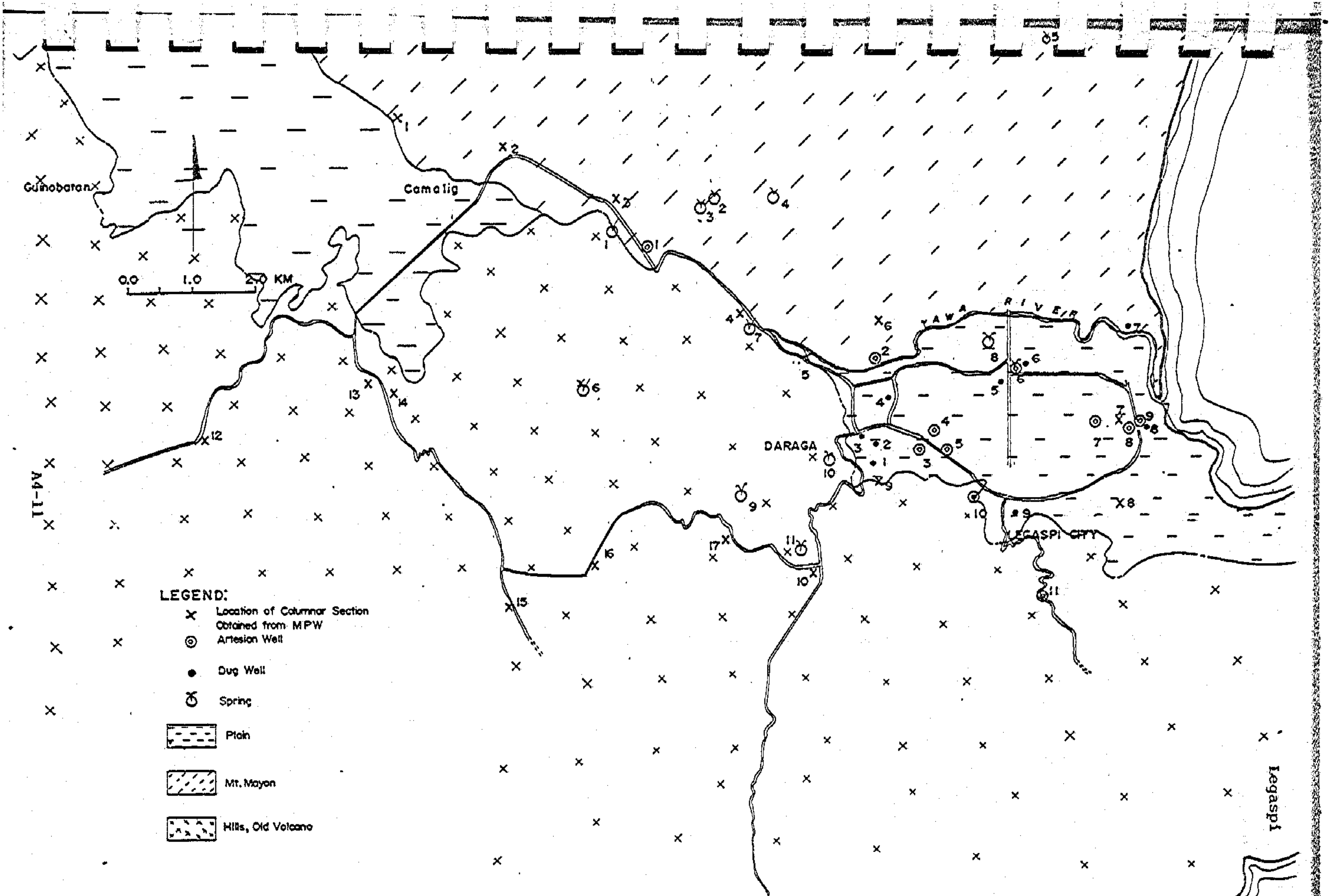

Fig 6 Location Map of Wells and Springs

Number of Springs	Surveyed Date	Locations	Elevation (m)	Discharge (lps)
1	August 11	Salvacion	140	1.6
2	August 10	Budiao I	130	88
3	August 10	Budiao II	130	
4	August 10	Banadero	120	
5	August 11	Buyoan	95	83.6
6	August 17	Lacag	160	
7	August 17	Busay	60	
8	August 11	Bogtong	30	9.8
9	August 13	Dela Paz	80	0.1
10	August 17	Daraga	80	
11	August 13	Penafrancia	90	

No. of Shallow Wells	Surveyed Date	Locations	Casing Diameter (mm)	Well Depth (m)	Static Water-Level (m)	Elevation (m)	Discharge (lps)	Remarks
1	August 13	Daraga	150	4.38	3.10	5-20		
2	August 11	Pro. Waterworks Pump Station	5.05m x 8.08m concrete box	4.20		5-20	3.81	Odor of H_2S
3	August 13	Daraga		6.10		5-20		
4	August 13	Bactol		5.49		5-20		
5	August 12	Curuzada	600	3.53	1.75	5-20		Odor of H_2S
6	August 12	Airport		2.12	1.05	5-20		Odor of H_2S
7	August 18	MPW Office		2.69	1.81	5-10		
8	August 18	Pisa Sice		3.00	1.96	5-10		
9	August 12	Legaspi		1.30	0.63	5-20		

Deep Wells

Deep Wells	Surveyed Date	Locations	Casing Diameter (mm)	Well Depth (m)	Static Water-Level (m)	Elevation (m)	Discharge (lps)	Remarks
1	August 14	Malabog Elem.				129		
2	August 13	Quilicao Elem.		15.24		20		Turbidity, Odor of H_2S
3	August 11	Bicol Univ. Campus	200	62.0	6.36	5-20		1,690 /cm
4	August 11	Bagong Ibalon	200	61.0	4.27	5-20	3.8	
5	August 13	Old Albay	100	24.0		5-20		
6	August 12	Curizada	100	63.0		5-20	0.017	High iron contents, Odor of H_2S
7	August 11	Bitano	100	64.6	-3.35	5-20		Flowing well, Odor of H_2S
8	August 18	Housing Project Well	200	13.5	0.61	5-20		Odor of H_2S
9	August 11	Tinago	100	16.8	-2.44	5-20	0.38	Flowing well, Odor of H_2S
10	August 12	Banadero	200	61.0	4.8	5-20		Odor of H_2S
11	August 12	Tognao Taysan	40	18.3	1.83	70		

Table 2 Water Source Data

5. Hydrogeology

As already stated, the lower mountains belong to Lower Miocene in geological age, which is considered to have a poor groundwater. Springs found in the mountains have small yields.

The surface sediments of Mayon Volcano consist of pyroclastic rocks in higher portion than 120 m and mudflows in lower portion. Groundwater flows out from the interface between the pyroclastic rocks and the mudflows, and from river bank of tributaries of the Yawa River. Mudflows are underlain by another formations of pyroclastic rocks, which it is considered, also include groundwater flowing from the volcano.

In this connection, detailed characteristics of geology are shown in the columnar sections of Fig 7 and are explained as follows.

(1) The eruptions of the volcano are composed of clay (mudflow and/or loam), volcanic sand, lapilli and volcanic breccia as shown in No. 1 to No. 4 and No. 6 columnar sections.

(2) The lower mountains consist of clay, tuff, sand and gravel which derived from old volcano, and limestone as indicated in No. 8 to No. 17 columnar sections.

(3) Alluvium is made up of clay, sand, and gravel as shown in the No. 5 and No. 7 columnar sections.

In order to examine the geological structure of alluvial area, the geoelectric resistivity survey was carried out. Measured points are shown in Fig 8, the analytical results in Fig 9. In A-A' cross section line along the Yawa River, geological structures are composed of three formations:

(1) Old volcanic rocks are the oldest of three formations and base rocks in the study area, which are overlain by both the younger and the older eruptions of the volcano. The volcanic rocks are more than 60 m in depth under land surface.

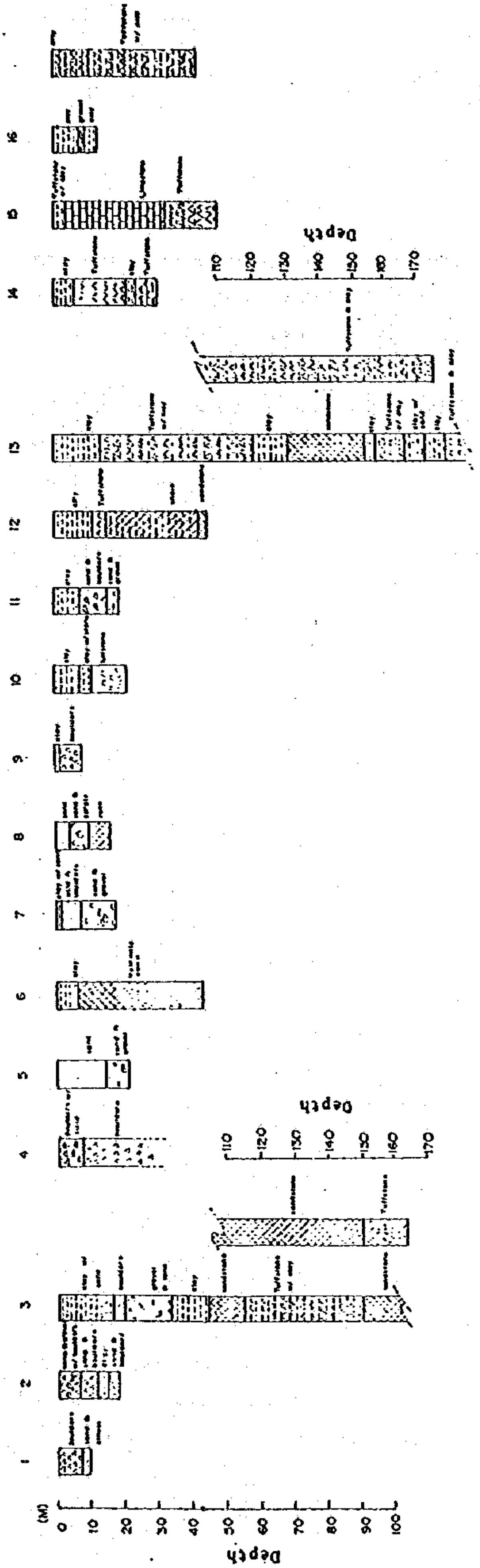

Fig 7 Columnar Sections Shown in Fig 6

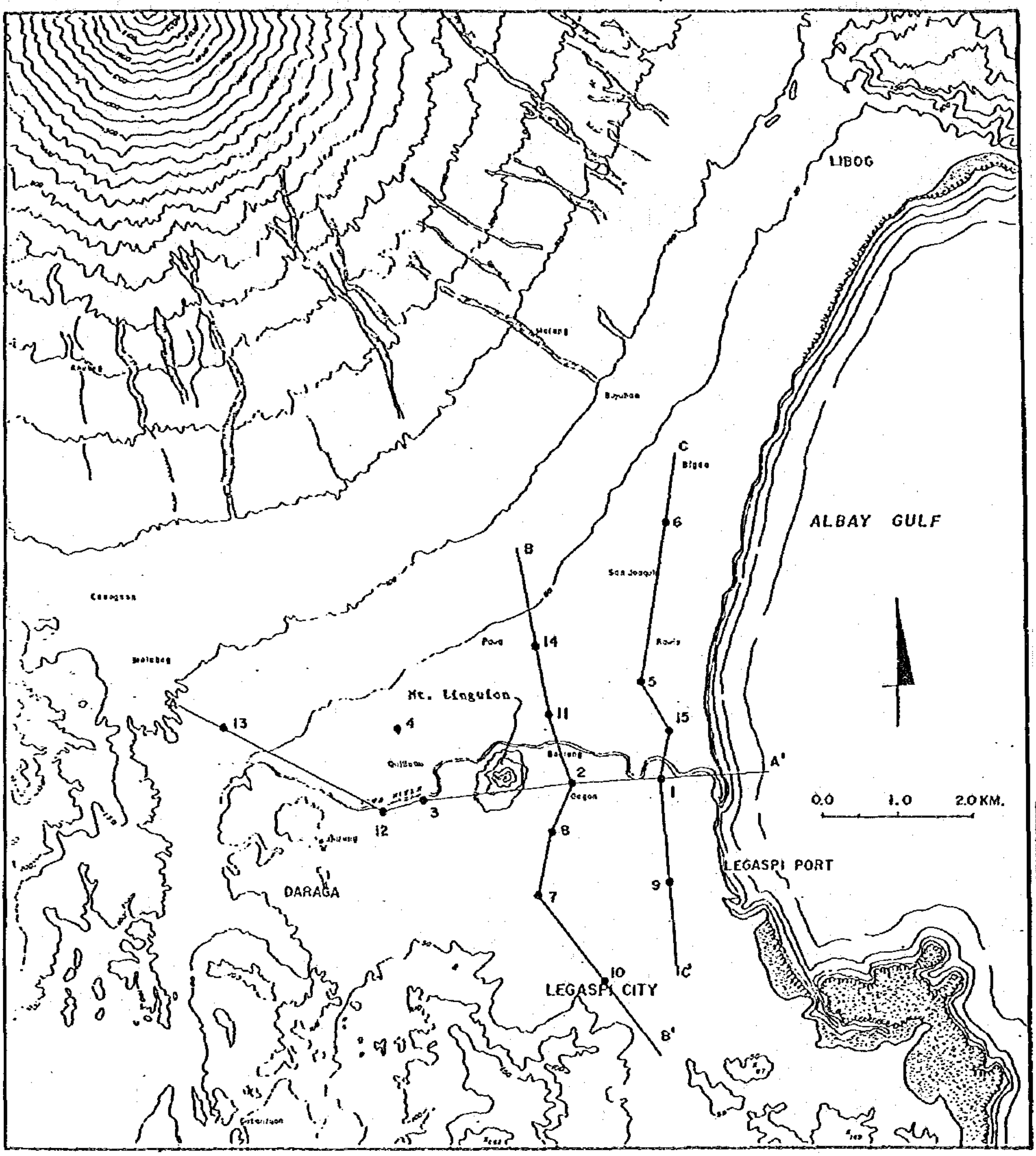

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Fig 8 Geoelectric Resistivity Survey Points

Legaspi

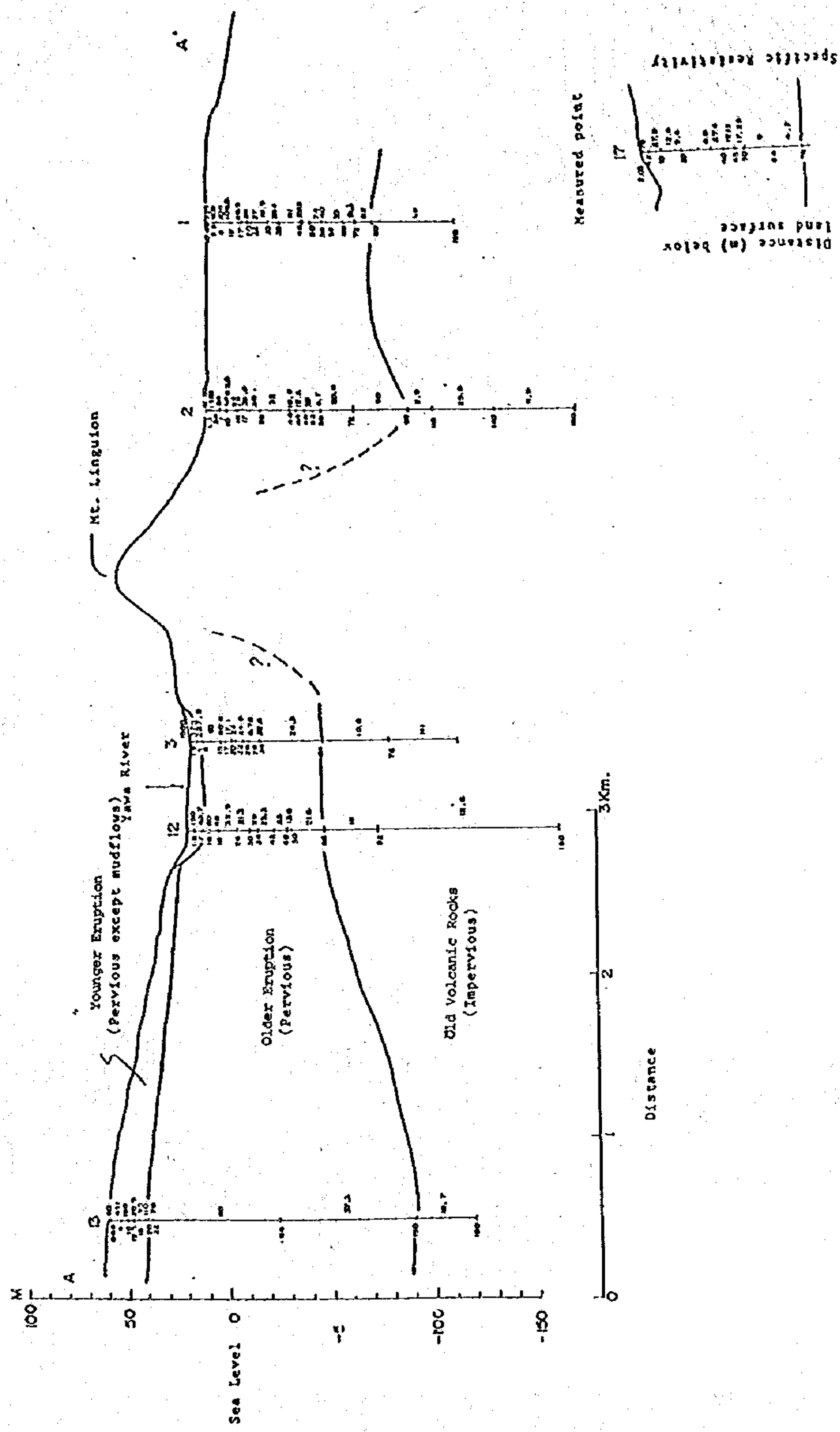

Fig 9-1 Analytical Results of Geoelectric Resistivity Survey

Legaspi

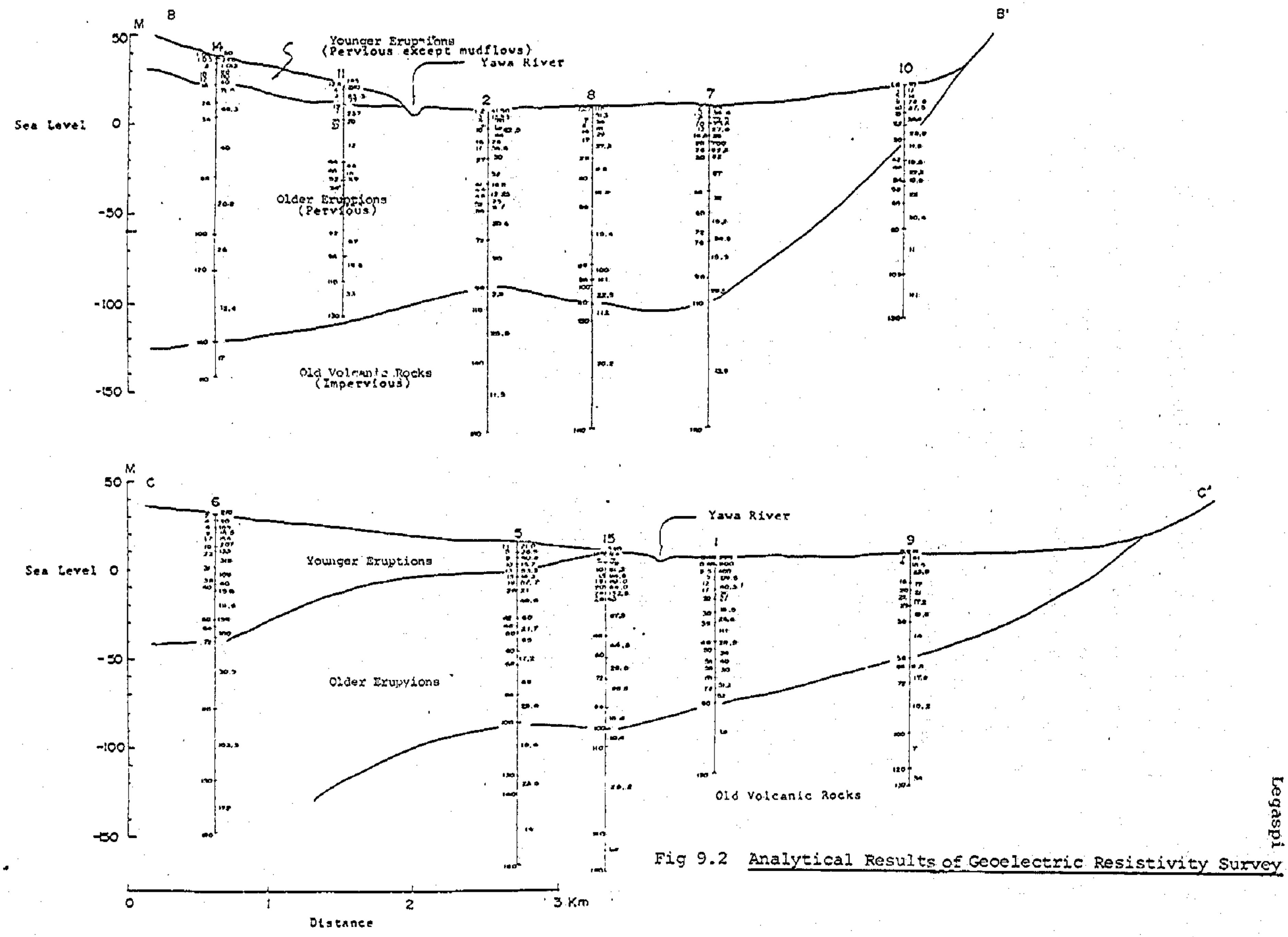

Fig 9.2 Analytical Results of Geoelectric Resistivity Survey

The volcanic rocks are estimated to be same as the geology of Mt. Linguion.

(2) The older eruptions of the volcano have a thickness over 60 m and are in the alluvium area. The older eruptions are covered by the younger eruptions in the skirts area of the volcano in the north of the river. The alluvium is formed in the surface of the old eruptions by the river in the area shown in Fig 1. The river always transports the volcanic ash and sand to the sea, and deposits sand in the river bed.

(3) The younger eruptions of the volcano are the same as observed in the field survey. The eruptions consist of pyroclastic rocks, scoria, volcanic ash and mudflow as discussed in 4.3 Geology.

In both B-B' and C-C' cross sections, old volcanic rosks rise up with a fairly steep slope to the south and reach the land surface and become the same formation as the lower mountains. Therefore, old volcanic rocks are Lower Miocene in geological age and include no good aquifer as mentioned before and are impervious.

The older and the younger eruptions (Except mudflows) have good aquifers, and especially the groundwater in the older eruptions is withdrawn by the shallow wells and flowing wells in the alluvial area. The groundwater is considered to be recharged by rainfall in the mountain.

6. Evaluation of Water Resources

6.1 River

The characteristics of the Yawa River are summarized from the description of previous sections as follows.

1) The river flows west to east, gathering tributaries from both Mt. Mayon and the lower mountains.
2) The river has a drainage area about 78.3 sq km.
3) The river always deposits the volcanic sand on the river bed.
4) The measured discharge was Q = 267,840 cu m/day at the main river.

With regard to utilization of the river surface water, its possibility is rather small. While the river has perennial flow owing to the abundant rainfall in the region, no suitable sites needed for construction of intake facilities are found along the river in the study area.

Regarding the riverbed water of the river, however, there is a rather high possibility, considering that the river has a riverbed consisting of sand together with not-scarce perennial flow. To tap the riverbed water, it is advisable to carry out further investigations to ascertain available quantity and others, necessary for detail design.

6.2 Spring

Springs in Mt. Mayon have generally large discharges and good water quality as shown in Appendix 1. Their discharges are fairly constant through the year. They are appropriate for utilization for water supply.

6.3.1 Alluvial Area

Groundwater conditions in the alluvial area are recapitulated from previous sections.

1) Geological Structures

(1) Geological structures are composed of three formations: base formation of the old volcanic rocks, lower formation of the older eruptions of Mt. Mayon, upper formation of the alluvium.

(2) The old volcanic rocks include no good aquifers.

(3) The older eruptions have a thickness over 60 m.

(4) Alluvium

a. Alluvium spreads on the surface of the older eruptions

b. Alluvium is undistinguishable from the older eruptions for its consists of same volcanic sediments.

2) Groundwater

(1) Groundwater is withdrawn by many wells in various depths in alluvium area.

(2) Groundwater is found in the older eruptions which have good aquifers.

(3) Groundwater is considered to be recharged by rainfall in the mountain.

(4) Groundwater withdrawn by wells has mostly peculiar offensive odor of hydrogen sulfide.

On the basis of above facts, the groundwater conditions are schematically shown in Fig 10.

As rainfall amount is large through all year, and moreover, most of it infiltrates into the pervious pyroclastic rocks and becomes groundwater; recharge of the groundwater is estimated to be great. For utilization of the groundwater, it will be needed to remove the odor thereof.

6.3.2 Mountain Foot of Mt. Mayon

Except springs with fairly large yields in the mountain foot area, there are the following water sources:

1) Seepage of groundwater, as described in the foregoing subsection 4.3 and section 5, which is presently used for the paddy field.
2) Fissure water flowing in lavas
3) Groundwater in water bearing layers existing in fairly deep portions, such as the older eruptions.

If such groundwater is trapped and collected in an efficient manner without impairing the existing large springs, that will be a desirable water source for water supply. Possibility of utilization of such groundwater is examined as follows:

(1) Seepage Water

1) Since groundwater seepage takes place spreading over a wide area, and such groundwater is flowing in very little depth on the impervious layer, a well, sunk vertically, cannot collect water in sufficient quantity necessary for water supply.
2) If a horizontal well is to be employed to collect such groundwater, its length will be unpractically long.

(2) Fissure Water

1) Detection of flowing paths of fissure water is very difficult, whatever survey method may be used.
2) Flowing paths often change with eruptions of the volcano.

(3) Deep Groundwater

1) Investigations required to ascertain the location, quantity and the like of such groundwater are usually very time-consuming and costly, though possible.
2) The groundwater is considered to have objectionable odor.

From the above discreet examination, seepage water and fissure water are not recommendable to develop, and development of deep groundwater is not considered advantageous at the stage of the present study.

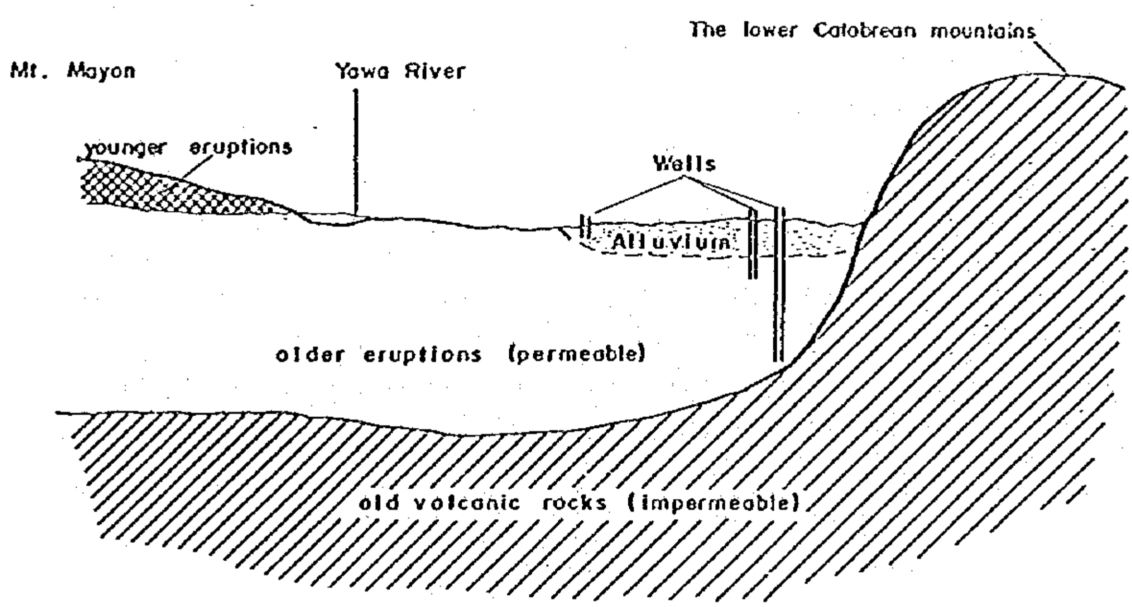

Fig. 10 Schematic Diagram of Groundwater Condition

REFERENCE

1/ Policarpio T. Dumapit (1973); Ground Water Geology of Bicol Peninsula

2/ PAGASA (1974); Annual Climatological Review