2.4 Economic Costs

The economic costs were studied on : (i) irrigation and agricultural extension services; (ii) drainage; and (iii) rural roads component in accordance with the calculation of economic benefits.

2.4.1 Capital costs

The project cost broadly comprises (1) cost for preparatory works, (2) construction cost for project facilities including contractor's overhead, profits and contract tax, (3) cost for land acquisition, (4) cost for compensation and resettlement, (5) administration expenses, (6) procurement cost of O & M equipment, (7) expenses for engineering services, (8) physical contingencies and (9) price contingencies. All these costs were estimated on a financial basis as given in APPENDIX J.

The financial costs were converted into economic costs by applying the economic factors for each cost components. The results of the calculation are summarized as follows (for details, see Table K.2.12) :

(Unit : P '000)

Cost Component	Financial Cost	Economic Cost
1. Construction Cost		
1.1 Irrigation	67,800	55,400
1.2 Drainage	38,700	32,600
1.3 Rural Roads	62,900	52,800
Sub-Total	169,400	140,800
2. O & M Equipment	3,300	3,300
3. Administration and Engineering Services	21,100	18,700
4. Physical Contingency	19,200	16,100
Total	213,000	178,900

2.4.2 Annual operation and maintenance costs

The annual O & M costs described in APPENDIX J and APPENDIX B were converted into economic costs using economic factors for each cost component. The results of calculation are summarized as fallows (for details, see Table K.2.13) :

(Unit : ₱)

Project Component	Financial Cost	Economic Cost
Irrigation	1,248,000	661,000
Agricultural Extension Services	301,000	239,000
Drainage	12,000	10,000
Rural Roads	240,000	181,000
O & M Office	185,000	145,000
Total	1,986,000 (1,685,000)*	1,236,000 (997,000)*

Note : Excluding Agricultural Extension Services

Annual operation and maintenance costs for agricultural extension services were considered from the commencement of the Project to the fifth year after completion of physical implementation.

2.4.3 Replacement costs

The replacement costs estimated in APPENDIX J were converted into economic costs using economic factors for each cost component. The results of calculation are summarized as follows (for details, see Table K.2.14) :

Project Component	Useful Life(year)	Financial Cost(₱)	Economic Cost(₱)
Irrigation	20	7,827,000	6,832,000
Drainage	30	2,400,000	2,093,000

2.4.4 Annual costs flow

The economic costs flow was prepared on the basis of the construction schedule, as shown in Table K.2.15.

2.5 Economic Internal Rate of Return (EIRR)

For the purpose of assessing the EIRR of the Project, only quantifiable benefits and concerned costs were considered. Therefore, the EIRR was calculated for : (i) irrigation; (ii) drainage; and (iii) rural roads component.

Estimation of the Project EIRR further includes the following major assumptions : (i) a Project economic life of 35 years including a three year implementation period; and (ii) achievement of full development in crop production five years after completion of physical implementation.

Based on the above, the EIRR of the Project has been estimated at about 10.2 percent. Net present value (NPV) and benefit cost ratio (B/C) have also been calculated as shown in Table K.2.15.

The EIRR of each project component has not been studied for the reasons as follows:

(1) The drainage benefit will be materialized in cooperation with irrigation and agricultural extension services;

(2) The irrigation and agricultural extension services will be assured and enhanced by the rehabilitation and new opening of rural roads; and

(3) The rural roads benefits attributable to VOC savings on agricultural transport will be assured by irrigation and agricultural extension services.

2.6 Sensitivity Analysis

In order to evaluate the soundness of the Project against the possible changes in future economic conditions, sensitivity analyses were studied for the following cases :

Case-1 : 10 percent increase in investment costs

Case-2 : 10 percent decrease in benefits

Case-3 : One-year delay in implementation

The effects on these changes on EIRR are summarized as below (for details, see Table K.2.16) :

Case	EIRR (%)
Case-1	9.4
Case-2	9.3
Case-3	9.7

3. FINANCIAL EVALUATION

3.1 Cost Recovery

Direct cost recovery from farm beneficiaries would be limited to (i) irrigation systems; (ii) domestic and drinking water supply systems; and (iii) rural community centers. Repayment requirements would be as follows :

(i) Irrigation Facilities :

All operation, maintenance and replacement cost would be borne by the communal associations responsible for irrigation system.

(ii) Domestic and Drinking Water Supply Facilities :

Barangay water associations would be responsible for all operation, maintenance and replacement costs.

(iii) Rural Community Centers :

All operation and maintenance cost would be borne by the barangay councils.

All operation, maintenance and replacement cost of other project components would be met through budgetary allocations of concerned responsible agencies which are indirectly recovered from taxes.

3.2 Farm Budget Analysis and Payment Capacity

In order to evaluate the Project from the financial aspect of the farmers, the farm budget analyses on average size farmers were studied under both with and without project conditions as shown in APPENDIX B.

The payment capacity is recognized as the ability of the project-benefited farmers to bear the expenses required for operation and maintenance of the project facilities as well as for repayment of capital cost. The payment capacity is measured by the balance which farmers can actually earn from the Project after farm expenses and living costs are deducted from the gross farm income. The payment capacity under the Project at the full develop stage was estimated as follows :

(Unit : pesos/year)

Items	Zone I		Zone II		Zone III	
	Without	With	Without	With	Without	With
Farm Size (ha)	0.87		0.70		0.91	
Net Farm Area (ha)	0.70		0.46		0.65	
Total Cultivated Area (ha)	1.32	2.39	1.02	0.99	1.35	2.13
Total Net Income	56,900	129,000	52,500	83,000	33,600	82,500
Net Farm Income	52,700	124,800	49,500	79,900	28,000	76,900
Non-Farm Income	4,200	4,200	3,100	3,100	5,600	5,600
Total Expenses*	50,200	80,600	45,900	53,200	32,600	53,300
Payment Capacity	6,700	48,400	6,600	29,800	1,000	29,200

* Including irrigation fee under with conditions.

The increased payment capacity would offer the incentives for farm re-investment and further development to the farmers, and substantial payment capacity would enable the farmers, if necessary, to make some payment for the expenses required for the project facilities.

In the calculation of payment capacity, only agricultural benefits were considered, because other monetary benefits attributable to flood control and rural roads were estimated at few percent of the payment capacity derived from agricultural benefits.

3.3 Surplus of Farm Household

3.3.1 Repayment requirement

(1) Irrigation facilities

Repayment requirement of irrigation facilities was studied on the replacement cost for pumps and valves, because operation and maintenance cost were already included in the calculation of payment capacity. To replace the pumps in 20 years will cost ₱ 990,000. Annual amount to be collected from farmers was calculated at ₱ 210 per ha, using four percent sinking fund factor (0.033582). This replacement cost would be borne by the farmers in Zone I. On the other hand, to replace the valves in 20 years will cost ₱ 6,837,000. Annual amount to be collected from farmers was calculated at ₱ 600 per ha using same sinking fund factor.

(2) Domestic and drinking water supply facilities

Total annual operation and maintenance cost of water supply systems was estimated at ₱ 461,000. This amount of cost would be shared by 900 beneficial families. Based on the above, the operation and maintenance cost was estimated at about ₱ 510 per family annually. To replace the pumps and steel pipes in 20 years will cost ₱ 18,470,000. Annual amount to be collected from beneficiaries was calculated at ₱ 690 per family using four percent sinking fund factor (0.033582).

Based on the above, monthly collection of water charges would amount to ₱ 100 per family. On the other hand, in the case of water supply from LTWD, monthly water charges after ten years would amount to about ₱ 100 per family under the assumptions of : (i) average per family consumption of 20 m^3 per month; and (ii) adopting present water rates of LTWD. This results show that domestic and drinking water supply development of the Project would be justifiable.

(3) Rural community centers

Total annual operation and maintenance cost of seven (7) rural community centers was estimated at ₱ 49,000. The total beneficiaries of rural community centers were counted at 2,710 families dwelling in the seven (7) barangays. Based on the above, the annual operation and maintenance cost was estimated at about ₱ 20 per family.

3.3.2 Surplus of farm household

Based on the above, surplus of average size farmers under with project conditions in each Zone were tentatively calculated as follows :

(Unit : pesos/year)

Items	Zone I	Zone II	Zone III
Farm Size (ha)	0.87	0.70	0.91
Net Farm Area (ha)	0.70	0.46	0.65
Total Net Income	129,000	83,000	82,500
Total Expenses *	80,600	53,200	53,300
Payment Capacity (A)	48,400	29,800	29,200
Repayment Required			
a) Irrigation	570	280	390
b) Domestic, Drinking Water	1,200	1,200	1,200
c) Rural Community Center	20	20	20
Sub-Total (B)	1,790	1,500	1,610
Surplus	46,610	28,300	27,590
(B)/(A)	0.04	0.05	0.06

* Including irrigation fee.

As for the rural electrification in Zone III, the annual electric charges were estimated at about ₱ 2,000 per family with the assumptions of : (i) monthly consumption rate of 92 kWh (Domestic Houses); and (ii) present power rate of ₱ 1.77 /kWh (Small Residence). Annual surplus in Zone III was estimated at ₱ 27,590, therefore, farm families would be able to afford electric services.

4. SOCIO-ECONOMIC IMPACT

The benefits accruing from the implementation of the Project will not only be directly measurable ones that show up in an economic evaluation. Rather, the Project is likely to result in various secondary or intangible benefits in terms of the favorable socio-economic impact which is bound to generate among the rural population and their economy. The principal spinoff effects of the Project may be described as follows.

(1) Supply of vegetables and cut-flowers

The demand to vegetables and cut-flowers in the Metro Manila, the Ilocos and the Central regions is prospected to increase by 300,000 tons in the year 2000 in comparing the year 1986. It is expected that the vegetable production in the Project area will be 13,600 tons after completion of the Project resulting in 7,200 tons increase from the present level. In those situation, the region I involving the Project area as the supply base of the said agricultural produce will play very important role in the national economy.

(2) Increased employment and training effect

During project implementation, a large number of skilled and unskilled workers would be required, totalling about 14,000 man-months. After construction, operation and maintenance of the project facilities would require a substantial permanent staff of employees. This would contribute to improve local economic condition.

Many personnel would be recruited from the local communities to manage and operate the Project and trained. Those personnel would contribute to smooth implementation of the similar kind of the development project in the region. Thus, the training effect would be of importance in terms of encouraging local participation in the development effect.

(3) Feeling of happiness and stabilization of rural society

As a result of increased farm household income and increased property value owing to the Project, a feeling of happiness of farmer will rise widely and the rural society become stabilized.

(4) Transport system

To meet the transport needs for the increased production outputs under the Project, the existing local transportation system will need to be improved and expanded.

This, in turn, would create new employment opportunities as well as permitting closer community, social, and development relations.

(5) Rural roads

The obvious tangible benefits resulting from a better or new road system will bring are likely to be complemented by intangible benefits which, while the reality is difficult to quantify. These indirect benefits can be defined in terms of better mobility, improved access to health and education facilities, improved government services, shorter commuting times for the elementary and secondary school children, etc. .

(6) Potable and household water supply

The provision of household water supply systems will have a beneficial effect on the regional conduct of life, with an assured source of water that is safe to drink and use in terms of hygienic and sanitary conditions. The result would be improved conditions of public health and safe(r) agricultural produce free from chemical or other contaminants ingested through the polluted irrigation water. The non-economic effect would be quite considerable in terms of a net reduction of adult and especially infant morbidity and mortality due to waterborne and water-related infectious and parasitic diseases.

The general improvement in public health conditions would be to the benefit of the community as a whole, and this in turn, would spin off into improved per capita productivity and economic performance as the investment and running costs for the health services would diminish with a healthier population.

(7) Rural electrification

Electrification of the barangay would entail a considerable upgrading in the amenities available to the rural communities. The major benefit due to electrification would be better lighting and access to modern communication (radio, TV, etc.). Artificial lighting could be a benefit to the farm working late at night in the peak season. In off-peak seasons, lighting could provide the farming household with an opportunity to engage in such works as cloth weaving, repair of household equipment, community activities, and meetings. The availability of proper room lighting will enrich community life in the rural areas.

Direct benefits can naturally be expected in the form of net savings in fuel and maintenance costs as a result of the use of electricity in place of kerosene and diesel.

(8) Sewage and refuse disposal trucks

The use of certain water channels within the Project area for refuse and waste disposal increases the risk of diseases spreading and poses health hazes. The proposed sewage system and the provision of a refuse/waste collection service by dump truck as well as the passing of some enforceable health ordinances would greatly improve public health and hygiene.

(9) Rural community centers

owing to the provision of rural community centers, it is expected to accelerate such activity development as expansion of health care knowledge, extension of improved farming practice, strengthening of O&M of irrigation schemes and agricultural cooperatives, and executing farmers' schoolrooms and rural cultural circles, enlightening rural woman and to contribute to activate social communication.

5. PROJECT JUSTIFICATION

5.1 General

The Government accords highest priority to the agriculture sector which is expected to play a major role in the country's economic recovery and to assist in solving the current problems of unemployment and income disparities in the rural areas. To accomplish this, the agriculture sector strategy will be directed toward upland farmers and will promote multiple cropping and productivity increases through improved technology and farm management practices, which will be supported by credit, marketing and extension services. Farmers in the highlands have been neglected in development efforts over the past decades when compared with irrigated farmers in lowlands as a result of the Government's efforts to rapidly increase rice production during the 1970s. Highland farmers also have poor access to markets and receive less extension support than their lowland counterparts.

The Project will initially produce almost immediate increases in employment and income during the construction period and would result in considerable increases in farm incomes in the areas.

The project area, covering parts of Benguet province in Northern Luzon, is a relatively low-income zone in the highlands, but exhibits considerable potential for agricultural development, principally vegetable production in view of its temperate climate. The Project will substantially increase vegetable production to meet the increasing demand in the Central Luzon and Metro Manila markets.

The Project provides for basic infrastructure for increased production of commercial vegetables, including irrigation and drainage facilities and rural roads. The Project also provides agricultural extension services through which the farmer's bargaining position would be strengthened. In addition, the social infrastructure would be provided by the Project, including domestic and drinking water supply systems, rural electrification, sewage canals and rural community centers, through which many favorable socio-economic impacts would be realized. These Project components are mutually reinforcing and together ensure maximum impact of the investment.

5.2 Projected Demand for and Supply of Vegetables

The future demand for vegetables in Metro Manila, Ilocos Region and Central Luzon Region were estimated based on the assumptions of population growth rate,

increase in per capita income and income elasticities of demand for each vegetable. Total demand for vegetables in three regions in 2000 will increase by about 300,000 tons or 35 percent of the demand in 1986. The increased production of 7,200 tons in the Project area will fall short of the projected increase in demand by about 2.4 percent in the above three regions. Therefore, it is unlikely that the Project would cause excess supply beyond future demand for vegetables.

5.3 Beneficiaries

A total of 950 farm families, most of whom are small subsistence farmers cultivating less than one ha, will share the direct Project benefits. The direct beneficiaries consist of as follows :

(Unit : family)

Project Component	Zone I	Zone II	Zone III	Total
Irrigation and Agri-Extension S.	230	330	110	670
Drainage	230	-	-	230
Rural Roads	-	480 (350)	110 (50)	590 (400)
Domestic, Drinking Water Supply	-	440 (330)	90 (40)	530 (370)
Electrification	-	-	110 (50)	110 (50)
Sewage Canals	230	-	-	230
Rural Community Centers	440 (1,090)	480 (350)	240 (110)	1,160 (1,550)
Total Direct Beneficiaries	230	480 (350)	240 (110)	950 (460)

Source : 1) 1980 Census of Agriculture and Fisheries, Province of Benguet, NCSO
2) 1980 Census of Population and Housing, NCSO
3) Family Survey 1985, Rural Health Unit

Note : Figures in parentheses indicate non-farm families.

The Project will also indirectly benefit about 4,800 other families in La Trinidad through the refuse collection truck service, and uncountable families in the external influence areas of the rehabilitated and new opened rural roads.

5.4 Economic Viability

The Project area is under very severe natural conditions that has been receiving negligible attention of rural, agricultural and social infrastructure improvement. Various kinds of constraints and problem in the rural areas are existing obstructing smooth development, prosperity and welfare of rural community so as to enable a stable economic and healthy life of rural people. The Project, therefore, aims to achieve the implementation of an urgent and fundamental improvement works of related infrastructure for one step advance of rural society, farmers income and living standard.

Under these situation, it can be seen that the required investment costs are relatively high in comparison with the tangible monetary benefits expected in the agricultural sector, etc. so that the Project can not reach an EIRR level of 15 percent required as the qualifying condition for funding by international loan agencies. The Project is estimated to yield an EIRR level many 10.2 percent, however, the Project involves many intangible benefits answering basic human needs and other social impact, particularly to the cultural community development. The Project is justified to be carried out with high priority.

5.5 Financial Viability

The financial impact of the Project on the average farm family size has been examined through farm budget analysis. Total net income would be expected to increase 1.6 to 2.5 times as compared in future without Project condition. Surplus of farm households would also substantially increase. Thus the Project would be financially viable at the farm level, would be adequate incentives for further development.

Table K.2.1 Irrigation Benefit

ZONE / CROPS	Planted Area		Net Return per ha		Annual Profit		Net Incremental Benefit
	Without	With	Without	With	Without	With	
	(ha)	(ha)	(pesos/ha)	(pesos/ha)	(pesos)	(pesos)	(pesos)
ZONE I	305	323			7,197,700	12,431,300	5,233,600
Strawberry	56	40	60,500	104,900	3,388,000	4,196,000	808,000
Vegetables*1	249	283	15,300	29,100	3,809,700	8,235,300	4,425,600
ZONE II	343	325			10,293,900	18,613,000	8,319,100
Rose	60	59	88,500	167,600	5,310,000	9,888,400	4,578,400
Vegetables*1	283	266	15,300	29,100	4,329,900	7,740,600	3,410,700
Intercropping*2	60	60	10,900	16,400	654,000	984,000	330,000
ZONE III	146	230			1,470,800	5,243,000	3,772,200
Rice	50	50	40	100	2,000	5,000	3,000
Vegetables*1	96	180	15,300	29,100	1,468,800	5,238,000	3,769,200
						Total	17,324,900

Note :

*1 Vegetables : Lettuce, Garden pea, Green onion, Chinese cabbage, Baguio bean, Celery.

*2 Intercropping : Celery, Green onion, Gladiolus.

Net return of intercrop was estimated half of the normal cropping.

Table K.2.2 Estimation of Flood Damage to Houses

Return Period (year)	High Water Level (El.m)	Max. Inundated Area (ha)	(Residential Houses) Damaged Number *1	Values *2 (₱ '000)	Damage Rate*3	Flood*4 Damage (₱ '000)	(Non-residential Houses) Damaged Number *1	Values *2 (₱ '000)	Damage Rate*3	Flood*4 Damage (₱ '000)	Total Houses Damage (₱ '000)	Other Damage *5 (₱ '000)	Total Flood Damage (₱ '000)
1.5	1,308.0	0	0	0	0	0	0	0	0	0	0	0	0
2	1,308.7	30	3	300	0.15	45	0	0	0	0	45	9	54
5	1,310.5	88	41	4,100	0.16	656	3	1,350	0.12	162	818	164	982
10	1,311.3	119	97	9,700	0.21	2,037	9	4,050	0.18	729	2,766	553	3,319
20	1,312.0	143	153	15,300	0.24	3,672	18	8,100	0.21	1,701	5,373	1,075	6,448
50	1,313.1	176	297	29,700	0.29	8,613	49	22,050	0.25	5,513	14,126	2,825	16,951
100	1,313.9	195	385	38,500	0.34	13,090	69	31,050	0.30	9,315	22,405	4,481	26,886

Note :

*1 The number of damaged residential houses was estimated with growth rate of 1.5 % p.a. based on the number of houses described on the topographical maps exposed in 1981-1982. The number of damaged non-residential houses was counted based on the same topographical maps.

*2 Values of residential house were estimated with the rate of ₱ 100,000 per house, and non-residential houses of ₱ 450,000 per house. These value rates were estimated from the data prepared by National Census and Statistics Office through some adjustment.

*3 Damage rate was culculated based on the figures below considering the distribution of houses number in each inundation depth class.

Inundation depth (cm)	Damage rate
- 50	0.124
50 - 99	0.210
100 - 199	0.308
200 - 299	0.439
300 -	0.572

*4 Flood damages to houses were calculated as the product of values and damage rate for various return periods.

*5 Other damages were estimated as 20 % of total houses damage based on the results of flood damage inventory survey. Other damages consist of personal property and real property etc..

Table K.2.3 Estimated Reduction in Flood Damage to Houses

Return Period (year)	Without		With		Damage Reduction (₱ '000)
	Inundated Area (ha) *1	Flood Damage (₱ '000) *2	Inundated Area (ha) *3	Flood Damage (₱ '000) *4	
1.5	0	0	0	0	0
2	30	54	0	0	54
5	88	982	0	0	982
10	119	3,319	31	58	3,261
20	143	6,448	55	275	6,173
50	176	16,951	88	982	15,969
100	195	26,886	107	2,200	24,686

Note :

*1 For details, see APPENDIX G.

*2 Source : Table K.2.2.

*3 Inundated area with Project conditions was calculated as inundated area without Project conditions minus 88 ha., which is present inundated area at five(5)-year return period.

*4 Flood damage with Project conditions were derived from Fig. K.2.1 in relation to the inundated area.

Table K.2.4 Estimated Average Annual Reduction in Flood Damage to Houses

Return Period (year)	Probability of Occurance *1	Damage Reduction (₱ '000) *2	Expected Reduction (₱ '000) *3
1/1.5	—	0	—
1/2	0.235	54	12.7
1/5	0.200	982	196.4
1/10	0.075	3,261	244.6
1/20	0.040	6,173	246.9
1/50	0.020	15,969	319.4
1/100	—	24,686	—
Total (Average Annual Reduction)			1,020.0

Note :

*1 Probability of occurance (Fn) is calculated as follows :

$Fn = (Pn-1 - Pn+1) / 2$,

where $Pn-1$ and $Pn+1$ are probabilities of exceedance in front and behind the Pn, which corresponds to Fn.

*2 Source : Table K.2.3.

*3 Expected reduction was calculated as the product of damage reduction and probability of occurence for various return periods.

Table K.2.5 Individual Traffic Cost

(Unit : P/km - vehicle)

		Surface Condition (Vehicle Operating Speed)	Light Car	Jeep	Jeepney (Passenger Carrying)	Small Truck	Jeepney (Crop Carrying)
Without	Zone II	Earth Very Bad (10km/hr)	5.41	5.59	7.95	8.15	5.14
	Zone III	Earth Very Bad Stones (10 km/hr)	5.52	5.70	8.05	8.29	5.23
With	Rehabili-tation	Paved Good / Fair (30 km/hr)	2.58	2.64	3.25	3.70	2.32
	New Con-struction	Gravel Fair (30 km/hr)	2.53	2.59	3.22	3.64	2.29

Note : * Running + Fixed + Time Costs

Table K.2.6 Agricultural Production in Each Influence Area of Rehabilitation Roads

Influence Area	Net Field Area (ha)	Under with Irri. Project Areas			Under w/o Irri. Project Areas		
		Rose (doz)	Veg. (kg)	Intercrop (kg)	Rose (doz)	Veg. (kg)	Intercrop (kg)
A II - 1	3.4 (F.W) 4.1 (F.WO)	51,470	83,300	11,318	39,975	74,280	9,914
A II - 2	4.2 0	63,580	102,900	13,982	—	—	—
A II - 3	14.3 3.8	216,476	350,350	47,604	37,050	68,845	9,188
A II - 4	22.4 0	339,095	548,800	74,568	—	—	—
A II - 5	12.6 0	190,741	308,700	41,945	—	—	—
A II - 6	1.9 5.0	28,762	46,550	6,325	48,750	90,585	12,090
A II - 7	0.8 1.0	12,111	19,600	2,663	9,750	18,117	2,418
A II - 8	75.1 0.2	1,136,874	1,839,950	250,004	1,950	3,623	484
A II - 9	7.6 1.1	115,050	186,200	25,300	10,725	19,929	2,660
A II - 10	0.8 2.8	12,111	19,600	2,663	27,300	50,728	6,770
A II - 11	8.9 13.1	134,730	218,050	29,628	127,725	237,333	31,676
A III - 1	8.0 (F.W) 8.9 (P)	—	531,067	—	—	—	—
A III - 2	7.9 12.6	—	560,000	—	—	—	—
A III - 3	14.1 8.5	—	868,933	—	—	—	—
Total	182.0 (F.W) 31.1 (F.WO) 30.0 (P)	2,301,000	5,684,000	506,000	303,225	563,440	75,200

Note :

1 Abbreviations are as follows :
- Upland crop field with irrigation Project conditions (F.W),
- Upland crop field without irrigation Project conditions (F.WO),
- Lowland rice field (P).

2 Intercropping are consist of Celery, G.onion and Gladiolus, and unit yield of intercrop wasestimated half of the normal cropping. The production of Gladiolus was converted intoweight with the rate of 1 doz = 1 kg.

3 Rice production is not studied in the calculation, because the farmers prefer rice cultivation only for home consumption.

Table K.2.7 VOC Savings on Agricultural Transport (1/2)

Influence Area	Project Conditions	Crop	Annual Traffic	Jeepney (1t)					Small Truck (2t)					Total VOC	VOC Savings
				Traffic	Required Transport*1	Road Length	Total Length	VOC	Traffic	Required Transport*1	Road Length	Total Length	VOC		
			(doz,ton)	(doz, t)	(Vehicle)	(km)	(km)	(P '000)	(doz, t)	(Vehicle)	(km)	(km)	(P '000)	(P '000)	(P '000)
A II - 1	W/O	Rose	91,445	91,445	183	3.30	603.9	3.10							
		Veg.	178.81	178.81	358	3.30	1,181.4	6.07						9.17	
	W	Rose	91,445	45,723	91	3.30	300.3	0.70	45,723	61	3.30	201.3	0.74		5.27
		Veg.	178.81	89.41	179	3.30	590.7	1.37	89.41	89	3.30	293.7	1.09	3.90	
A II - 2	W/O	Rose	63,580	63,580	127	3.30	419.1	2.15							
		Veg.	116.88	116.88	234	3.30	772.2	3.97						6.12	
	W	Rose	63,580	31,790	64	3.30	211.2	0.49	31,790	42	3.30	138.6	0.51		3.51
		Veg.	116.88	58.44	117	3.30	386.1	0.90	58.44	58	3.30	191.4	0.71	2.61	
A II - 3	W/O	Rose	253,526	253,526	507	3.80	1,926.6	9.90							
		Veg.	475.99	475.99	952	3.80	3,617.6	18.59						28.49	
	W	Rose	253,526	126,763	254	3.80	965.2	2.24	126,763	169	3.80	642.2	2.38		16.32
		Veg.	475.99	238.00	476	3.80	1,808.8	4.20	238.00	238	3.80	904.4	3.35	12.17	
A II - 4	W/O	Rose	339,095	339,095	678	1.90	1,288.2	6.62							
		Veg.	623.37	623.37	1,247	1.90	2,369.3	12.18						18.80	
	W	Rose	339,095	169,548	339	1.90	644.1	1.49	169,548	226	1.90	429.4	1.59		10.78
		Veg.	623.37	311.69	623	1.90	1,183.7	2.75	311.69	312	1.90	592.8	2.19	8.02	
A II - 5	W/O	Rose	190,741	190,741	381	3.10	1,181.1	6.07							
		Veg.	350.65	350.65	701	3.10	2,173.1	11.17						17.24	
	W	Rose	190,741	95,371	191	3.10	592.1	1.37	95,371	127	3.10	393.7	1.46		9.88
		Veg.	350.65	175.33	351	3.10	1,088.1	2.52	175.33	175	3.10	542.5	2.01	7.36	
A II - 6	W/O	Rose	77,512	77,512	155	1.55	240.3	1.24							
		Veg.	155.55	155.55	311	1.55	482.1	2.48						3.72	
	W	Rose	77,512	38,756	78	1.55	120.9	0.28	38,756	52	1.55	80.6	0.30		2.13
		Veg.	155.55	77.78	156	1.55	241.8	0.56	77.78	78	1.55	120.9	0.45	1.59	
A II - 7	W/O	Rose	21,861	21,861	44	1.00	44.0	0.23							
		Veg.	42.80	42.80	86	1.00	86.1	0.44						0.67	
	W	Rose	21,861	10,931	22	1.00	22.0	0.05	10,931	15	1.00	15.0	0.06		0.38
		Veg.	42.80	21.40	43	1.00	43.0	0.10	21.40	21	1.00	21.0	0.08	0.29	

Note : 1 : Requiired transport (RT) was calculated as follows : (RT) = 2 x (Traffic)/(Loading Capacity of Vehicle).
2 : Required transport of Rose was calculated as follows : Jeepney (1t) = 1,000doz/Vehicle ; Small Truck (2t) = 1,500 doz/Vehicle

Table K.2.7 VOC Savings on Agricultural Transport (2/2)

Influence Area	Project Conditions	Crop	Annual Traffic (doz,ton)	Jeepney (1t) Traffic (doz, t)	Jeepney (1t) Required Transport*1 (Vehicle)	Jeepney (1t) Road Length (km)	Jeepney (1t) Total Length (km)	Jeepney (1t) VOC (P '000)	Small Truck (2t) Traffic (doz, t)	Small Truck (2t) Required Transport*1 (Vehicle)	Small Truck (2t) Road Length (km)	Small Truck (2t) Total Length (km)	Small Truck (2t) VOC (P '000)	Total VOC (P '000)	VOC Savings (P '000)
A II - 8	W/O	Rose	1,138,824	1,138,824	2,278	2.35	5,353.3	27.52							
		Veg.	2094.06	2094.06	4,188	2.35	9,841.8	50.59						78.11	
	W	Rose	1,138,824	569,412	1,139	2.35	2,676.7	6.21	569,412	759	2.35	1,783.7	6.60		44.78
		Veg.	2094.06	1,047.03	2,094	2.35	4,920.9	11.42	1,047.03	1,047	2.35	2,460.5	9.10	33.33	
A II - 9	W/O	Rose	125,775	125,775	252	1.30	327.6	1.68							
		Veg.	234.09	234.09	468	1.30	608.4	3.13						4.81	
	W	Rose	125,775	62,888	126	1.30	163.8	0.38	62,888	84	1.30	109.2	0.40		2.76
		Veg.	234.09	117.05	234	1.30	304.2	0.71	117.05	117	1.30	152.1	0.56	2.05	
A II - 10	W/O	Rose	39,411	39,411	79	0.70	55.3	0.28							
		Veg.	79.76	79.76	160	0.70	112.0	0.58						0.86	
	W	Rose	39,411	19,706	39	0.70	27.3	0.06	19,706	26	0.70	18.2	0.07		0.50
		Veg.	79.76	39.88	80	0.70	56.0	0.13	39.88	40	0.70	28.0	0.10	0.36	
A II - 11	W/O	Rose	262,455	262,455	525	0.65	341.3	1.75							
		Veg.	516.69	516.69	1,033	0.65	671.5	3.45						5.20	
	W	Rose	262,455	131,228	262	0.65	170.3	0.40	131,228	175	0.65	113.8	0.42		2.98
		Veg.	516.69	258.35	517	0.65	336.1	0.78	258.35	258	0.65	167.7	0.62	2.22	
A III - 1	W/O	Veg.	531.07	531.07	1,062	5.40	5,734.8	29.99						29.99	
	W	Veg.	531.07	265.54	531	5.40	2,867.4	6.65	265.54	266	5.40	1,436.4	5.31	11.96	18.03
A III - 2	W/O	Veg.	560.00	560.00	1,120	5.85	6,552.0	34.27						34.27	
	W	Veg.	560.00	280.00	560	5.85	3,276.0	7.60	280.00	280	5.85	1,638.0	6.06	13.66	20.61
A III - 3	W/O	Veg.	868.93	869.93	1,738	4.60	7,994.8	41.81						41.81	
	W	Veg.	868.93	434.47	869	4.60	3,997.4	9.27	434.47	434	4.60	1,996.4	7.39	16.66	25.15
TOTAL	W/O													279.26	
	W													116.18	163.08

Table K.2.8 Estimation of Non-Agricultural Traffic Volume (1/3)

(Road Section : R III - 1, R III - 2, R III - 3)

Vehicle Type	Observed Traffic (Sta. A) *1	Entrance Ratio *2	Average Daily Traffic *3	Annual Traffic Volume *4	Designed Annual Traffic Volume *5
		0	0	0	0
Light Car	1.7	0	0	0	0
		0	0	0	0
		0.3	1.0	243.3	397
Jeep	3.3	0.2	0.7	170.3	278
		0.5	1.7	413.7	674
		0.3	4.8	1,168.0	1,904
Jeepney	15.9	0.2	3.2	778.7	1,269
		0.5	8.0	1,946.7	3,173
		0.3	0	0	0
Small Truck	0	0.2	0	0	0
		0.5	0	0	0

Note :

*1 These figures are average daily traffic observed at station (A).

*2 Entrance ratio is a estimated ratio of average daily traffic on the studied road section to average daily traffic observed at station (A).

*3 Average daily traffic volume is calculated as the product of observed average daily traffic and estimated entrance ratio.

*4 Annual traffic volume is estimated as follows :
(Annual Traffic Volume) = (Average Daily Traffic Volume) x 365 x 2/3.

*5 Designed annual traffic volume is estimated as a ten-year later traffic volume with growth rate of 5% p.a..

* Figures in the table are correspond to road section R III-1, R III-2 and R III-3 in descending order.

** As for the Traffic Survey, see APPENDIX H for details.

*** Unit : Vehicle

Table K.2.8 Estimation of Non-Agricultural Traffic Volume (2/3)

(Road Section : R II - 1, R II - 2, R II - 3, R II - 4, R II - 7)

Vehicle Type	Observed Traffic (Sta. C)	Entrance Ratio	Average Daily Traffic	Annual Traffic Volume	Designed Annual Traffic Volume
Light Car	28.3	0.5	14.2	3,455	5,632
		0	0	0	0
		0	0	0	0
		0.5	14.2	3,455	5,632
		0.5	14.2	3,455	5,632
Jeep	62.0	0.5	31.0	7,543	12,295
		0	0	0	0
		0	0	0	0
		0.5	31.0	7,543	12,295
		0.5	31.0	7,543	12,295
Jeepney	65.4	0.5	32.7	7,957	12,970
		0	0	0	0
		0	0	0	0
		0.5	32.7	7,957	12,970
		0.5	32.7	7,957	12,970
Small Truck	26.4	0.5	13.2	3,212	5,236
		0	0	0	0
		0	0	0	0
		0.5	13.2	3,212	5,236
		0.5	13.2	3,212	5,236

(Road Section : R II - 5, R II - 6)

Vehicle Type	Observed Traffic (Sta. B)	Entrance Ratio	Average Daily Traffic	Annual Traffic Volume	Designed Annual Traffic Volume
Light Car	0	1.0	0	0	0
		0.5	0	0	0
Jeep	3	1.0	3.0	730	1,190
		0.5	1.5	365	595
Jeepney	0	1.0	0	0	0
		0.5	0	0	0
Small Truck	0	1.0	0	0	0
		0.5	0	0	0

Table K.2.8 Estimation of Non-Agricultural Traffic Volume (3/3)

(Road Section : R II - 8)

Vehicle Type	Observed Traffic (Sta. D)	Entrance Ratio	Average Daily Traffic	Annual Traffic Volume	Designed Anuual Traffic Volume
Light Car	10.3	1.0	10.3	2,506	4,085
Jeep	39.0	1.0	39.0	9,490	15,469
Jeepney	0	1.0	0	0	0
Small Truck	2.1	1.0	2.1	511	833

(Road Section : R II - 9)

Vehicle Type	Observed Traffic (Sta. E)	Entrance Ratio	Average Daily Traffic	Annual Traffic Volume	Designed Anuual Traffic Volume
Light Car	7.7	1.0	7.7	1,874	3,055
Jeep	8.0	1.0	8.0	1,947	3,174
Jeepney	40.5	1.0	40.5	9,855	16,064
Small Truck	0.9	1.0	0.9	219	357

(Road Section : R II - 11)

Vehicle Type	Observed Traffic (Sta. F)	Entrance Ratio	Average Daily Traffic	Annual Traffic Volume	Designed Anuual Traffic Volume
Light Car	36.3	1.0	36.3	8,833	14,398
Jeep	47.7	1.0	47.7	11,607	18,919
Jeepney	11.1	1.0	11.1	2,701	4,403
Small Truck	3.6	1.0	3.6	876	1,428

Table K.2.9 VOC Savings on Non-Agricultural Transport

Road Section	Vehicle Type	Individual Traffic Cost (₱/km-vehicle) *1		Road Length	Designed Annual Traffic Volume *2	VOC Savings	Total VOC Savings
		Without	With	(km)		(₱'000)	(₱'000)
	L.Car	5.52	2.58	1.6	0	0	
R III-1	Jeep	5.70	2.64	1.6	397	1.94	16.56
	Jeepney	8.05	3.25	1.6	1,904	14.62	
	S.Truck	8.29	3.70	1.6	0	0	
	L.Car	5.52	2.58	2.5	0	0	
R III-2	Jeep	5.70	2.64	2.5	278	2.13	17.36
	Jeepney	8.05	3.25	2.5	1,269	15.23	
	S.Truck	8.29	3.70	2.5	0	0	
	L.Car	5.52	2.58	4.6	0	0	
R III-3	Jeep	5.70	2.64	4.6	674	9.49	79.55
	Jeepney	8.05	3.25	4.6	3,173	70.06	
	S.Truck	8.29	3.70	4.6	0	0	
	L.Car	5.41	2.58	1.0	5,632	15.94	
R II-1	Jeep	5.59	2.64	1.0	12,295	36.27	136.47
	Jeepney	7.95	3.25	1.0	12,970	60.96	
	S.Truck	8.15	3.70	1.0	5,236	23.30	
	L.Car	5.41	2.58	1.8	5,632	28.69	
R II-4	Jeep	5.59	2.64	1.8	12,295	65.29	245.65
	Jeepney	7.95	3.25	1.8	12,970	109.73	
	S.Truck	8.15	3.70	1.8	5,236	41.94	
	L.Car	5.41	2.58	2.0	0	0	
R II-5	Jeep	5.59	2.64	2.0	1,190	7.02	7.02
	Jeepney	7.95	3.25	2.0	0	0	
	S.Truck	8.15	3.70	2.0	0	0	
	L.Car	5.41	2.58	1.1	0	0	
R II-6	Jeep	5.59	2.64	1.1	595	1.93	1.93
	Jeepney	7.95	3.25	1.1	0	0	
	S.Truck	8.15	3.70	1.1	0	0	
	L.Car	5.41	2.58	1.0	5,632	15.94	
R II-7	Jeep	5.59	2.64	1.0	12,295	36.27	136.47
	Jeepney	7.95	3.25	1.0	12,970	60.96	
	S.Truck	8.15	3.70	1.0	5,236	23.30	
	L.Car	5.41	2.58	2.1	4,085	24.28	
R II-8	Jeep	5.59	2.64	2.1	15,469	95.83	127.89
	Jeepney	7.95	3.25	2.1	0	0	
	S.Truck	8.15	3.70	2.1	833	7.78	
	L.Car	5.41	2.58	1.3	3,055	11.24	
R II-9	Jeep	5.59	2.64	1.3	3,174	12.17	123.63
	Jeepney	7.95	3.25	1.3	16,064	98.15	
	S.Truck	8.15	3.70	1.3	357	2.07	
	L.Car	5.41	2.58	1.3	14,398	52.97	
R II-11	Jeep	5.59	2.64	1.3	18,919	72.55	160.68
	Jeepney	7.95	3.25	1.3	4,403	26.90	
	S.Truck	8.15	3.70	1.3	1,428	8.26	
Total							1,053.21

Note : *1 Source : Table K.2.5. *2 Source : Table K.2.8.

Table K.2.10 Agricultural Production in Each Influence Area of New Roads

Influence Area	Net Field Area	Under with Irri. Project Areas			
		Rose	Veg.	Intercrop.	Rice
	(ha)	(doz)	(kg)	(kg)	(kg)
N II - 1	7.8 (F.W)	118,078	191,100	25,966	—
N II - 2	3.2	48,442	78,400	10,653	—
N II - 3	13.0	196,796	318,500	43,276	—
N II - 4	8.7	131,702	213,150	28,962	—
N III - 1	6.8 (P) 8.2 (F.W)	—	522,667	—	28,333
Total	40.9 (F.W) 6.8 (P)	495,018	1,323,817	108,857	28,333

Note :

1 Abbreviations are as follows :

— Upland crop field with irrigation Project conditions (F.W),

— Lowland rice field (P).

2 Intercropping are consist of Celery, G.onion and Gladiolus, and unit yield of intercrop was estimated half of the normal cropping. The production of Gladiolus was converted into weight with the rate of 1 doz = 1 kg.

Table K.2.11 Transport Savings by New Roads

Influence Area	Project	Crop	Annual Traffic (doz. kg)	Head-carrying (50kg/trip, 50doz/trip) Traffic (doz.kg)	Required Trip (time)	Trip Length (km)	Total Length (km)	Cost (P '000)	Jeepney (1t) Traffic (doz.ton)	Required Trans. (Vehicle)	Road Length (km)	Total Length (km)	VOC (P '000)	Small Truck (2t) Traffic (doz.ton)	Required Trans. (Vehicle)	Road Length (km)	Total Length (km)	VOC (P '000)	Total VOC (P '000)	Cost Reduc-tion (P '000)
N II - 1	W/O	Rose	118,078	118,078	2,362	0.50	1,181.0	11.81												
		Veg.	217,066	217,066	4,341	0.50	2,170.5	21.71											33.52	
	W	Rose	118,078						59,039	118	0.50	59.0	0.14	59,039	79	0.50	39.5	0.14		32.79
		Veg.	217,066						108.53	217	0.50	108.5	0.25	108.53	109	0.50	54.5	0.20	0.73	
N II - 2	W/O	Rose	48,442	48,442	969	0.75	726.8	7.27												
		Veg.	89,053	89,053	1,781	0.75	1,335.8	13.36											20.63	
	W	Rose	48,442						24,221	48	0.75	36.0	0.08	24,221	32	0.75	24.0	0.09		20.19
		Veg.	89,053						44.53	89	0.75	66.8	0.15	44.53	45	0.75	33.8	0.12	0.44	
N II - 3	W/O	Rose	196,796	196,796	3,936	0.80	3,148.8	31.49												
		Veg.	361,776	361,776	7,236	0.80	5,788.8	57.89											89.38	
	W	Rose	196,796						98,398	197	0.80	157.6	0.36	98,398	131	0.80	104.8	0.38		87.45
		Veg.	361,776						180.89	362	0.80	289.6	0.66	180.89	181	0.80	144.8	0.53	1.93	
N II - 4	W/O	Rose	131,702	131,702	2,634	0.45	1,185.3	11.85												
		Veg.	242,112	242,112	4,842	0.45	2,178.9	21.79											33.64	
	W	Rose	131,702						65,851	132	0.45	59.4	0.14	65,851	88	0.45	39.6	0.14		32.91
		Veg.	242,112						121.06	242	0.45	108.9	0.25	121.06	121	0.45	54.4	0.20	0.73	
N III -1	W/O	Rice	28,333	28,333	567	1.40	793.8	7.94												
		Veg.	522,667	522,667	10,453	1.40	14,634.2	146.34											154.28	
	W	Rice	28,333						14.17	28	1.40	39.2	0.09	14.13	14	1.40	19.6	0.07		151.11
		Veg.	522,667						261.33	523	1.40	732.2	1.68	261.34	261	1.40	365.4	1.33	3.17	
Total	W/O																		331.45	
	W																		7.00	324.45

Note : 1. For procedures of VOC calculation, see foot note of Table K.2.7.
2. Head-carrying cost is estimated as P10/50kg(doz) - 1km trip.

Table K.2.12 Economic Capital Costs

(Unit : ₱'000)

	Cost Component	Financial Cost	Economic Cost
1.	Construction Cost		
1.1	Irrigation		
	Foreign	32,700	32,700
	Local (Labour)	7,400	4,100
	Local (Others)	21,600	18,600
	Transfer	6,100	—
	Sub-Total	67,800	55,400
1.2	Drainage		
	Foreign	20,800	20,800
	Local (Labour)	2,100	1,200
	Local (Others)	12,300	10,600
	Transfer	3,500	—
	Sub-Total	38,700	32,600
1.3	Rural Roads		
	Foreign	33,200	33,200
	Local (Labour)	3,400	1,900
	Local (Others)	20,600	17,700
	Transfer	5,700	—
	Sub-Total	62,900	52,800
	Sub-Total	169,400	140,800
2.	O & M Equipment		
2.1	O & M Equipment for Agricultural Extension Services		
	Foreign	850	850
	Local (Others)	40	30
	Transfer	0	—
	Sub-Total	890	880
2.2	Project Office Equipment for Implementation and O & M		
	Foreign	2,200	2,200
	Local (Others)	200	170
	Transfer	0	—
	Sub-Total	2,400	2,370
	Sub-Total	3,290	3,250
3.	Administration and Engineering Services		
	Foreign	15,400	15,400
	Local (Others)	3,800	3,300
	Transfer	1,900	—
	Sub-Total	21,100	18,700
4.	Phisical Contingencies		
	Foreign	10,400	10,400
	Local (Labour)	1,300	700
	Local (Others)	5,800	5,000
	Transfer	1,700	—
	Sub-Total	19,200	16,100
Total		212,990	178,850

Table K.2.13 Economic Costs of Annual Operation and Maintenance (1/2)

(Irrigation)

	Cost Component	Financial Cost (₱)	Economic Cost (₱)
a)	Pump		
	Foreign	65,300	65,300
	Local (Others)	43,500	37,400
	Transfer	10,800	0
b)	Compulsory Labour		
	Local (Labour)	1,015,200	558,400
	Transfer	112,800	0
Total		1,247,600	661,100

(Agricultural Extension Service)

	Cost Component	Financial Cost (₱)	Economic Cost (₱)
a)	Salaries and Living Allowance		
	Local (Others)	131,400	113,000
	Transfer	14,600	0
b)	Traveling Expense		
	Local (Others)	30,200	26,000
	Transfer	3,400	0
c)	Gasoline and Oil for Vehicles		
	Foreign	21,900	21,900
	Local (Others)	21,900	18,800
	Transfer	4,200	0
d)	Repair and Regular Maintenance for Vehicles		
	Local (Others)	29,100	25,000
	Transfer	2,900	0
e)	Agricultural Inputs		
	Foreign	13,600	13,400
	Transfer	1,400	0
f)	Office Supplies		
	Local (Others)	10,900	9,400
	Transfer	1,100	0
g)	Contingencies		
	Foerign	1,800	1,800
	Local (Others)	11,200	9,600
	Transfer	1,300	0
Total		300,900	238,900

Table K.2.13 Economic Costs of Annual Operation and Maintenance (2/2)

(Drainage)

	Cost Component	Financial Cost (₱)	Economic Cost (₱)
a)	Vegetation Control		
	Local (Labour)	1,440	800
	Transfer	160	0
b)	Excavation		
	Foreign	7,800	7,800
	Local (Others)	1,800	1,500
	Transfer	900	0
Total		12,100	10,100

(Rural Roads)

	Cost Component	Financial Cost (₱)	Economic Cost (₱)
a)	Vegetation Control		
	Local (Labour)	31,500	17,300
	Transfer	3,500	0
b)	Drainage Cleaning		
	Local (Labour)	15,300	8,400
	Transfer	1,700	0
c)	Shoulder Repairs		
	Local (Labour)	6,300	3,500
	Transfer	700	0
d)	Gravel Roads Grading		
	Foreign	69,200	69,200
	Local (Others)	95,500	82,100
	Transfer	16,300	0
Total		240,000	180,500

(O & M Office of HIRDP)

	Cost Component	Financial Cost (₱)	Economic Cost (₱)
a)	Office Expenses		
	Foreign	11,300	11,300
	Local (Others)	33,700	29,000
	Transfer	5,000	0
b)	Staff Salaries		
	Local (Others)	121,500	104,500
	Transfer	13,500	0
Total		185,000	144,800

Table K.2.14 Economic Costs of Replacement

(Irrigation)

Cost Component		Financial Cost (₱)	Economic Cost (₱)
a)	Pumps		
	Foreign	819,000	819,000
	Local (Labour)	81,900	45,000
	Transfer	89,100	0
	Sub-Total	990,000	864,000
b)	Valves		
	Foreign	5,656,900	5,656,900
	Local (Labour)	565,100	310,800
	Transfer	615,000	0
	Sub-Total	6,837,000	5,967,700
Total		7,827,000	6,831,700

(Drainage)

Cost Component		Financial Cost (₱)	Economic Cost (₱)
a)	Gate		
	Foreign	1,638000	1,638,000
	Local (Labour)	45,500	25,000
	Local (Others)	500,500	430,400
	Transfer	216,000	0
Total		2,400,000	2,093,400

Table K.2.15 Economic Rate of Return

(Unit : ₱ '000)

Year in Order	Costs				Benefits			
	Capital Cost	O & M Cost	Replacement Cost	Total	Irrigation	Drainage	Rural Roads	Total
1	17,000	239	-	17,239	-	-	-	0
2	76,000	239	-	76,239	-	-	-	0
3	85,900	239	-	86,139	-	-	-	0
4	-	1,236	-	1,236	3,465	2,283	212	5,960
5	-	1,236	-	1,236	6,930	3,546	425	10,901
6	-	1,236	-	1,236	10,395	4,809	637	15,841
7	-	1,236	-	1,236	13,860	6,072	849	20,781
8	-	1,236	-	1,236	17,325	7,335	1,062	25,722
9	-	997	-	997	17,325	7,335	1,167	25,827
10	-	997	-	997	17,325	7,335	1,272	25,932
11	-	997	-	997	17,325	7,335	1,377	26,037
12	-	997	-	997	17,325	7,335	1,483	26,143
13	-	997	-	997	17,325	7,335	1,588	26,248
14	-	997	-	997	17,325	7,335	1,588	26,248
15	-	997	-	997	17,325	7,335	1,588	26,248
16	-	997	-	997	17,325	7,335	1,588	26,248
17	-	997	-	997	17,325	7,335	1,588	26,248
18	-	997	-	997	17,325	7,335	1,588	26,248
19	-	997	-	997	17,325	7,335	1,588	26,248
20	-	997	-	997	17,325	7,335	1,588	26,248
21	-	997	-	997	17,325	7,335	1,588	26,248
22	-	997	-	997	17,325	7,335	1,588	26,248
23	-	997	6,832	7,829	17,325	7,335	1,588	26,248
24	-	997	-	997	17,325	7,335	1,588	26,248
25	-	997	-	997	17,325	7,335	1,588	26,248
26	-	997	-	997	17,325	7,335	1,588	26,248
27	-	997	-	997	17,325	7,335	1,588	26,248
28	-	997	-	997	17,325	7,335	1,588	26,248
29	-	997	-	997	17,325	7,335	1,588	26,248
30	-	997	-	997	17,325	7,335	1,588	26,248
31	-	997	-	997	17,325	7,335	1,588	26,248
32	-	997	-	997	17,325	7,335	1,588	26,248
33	-	997	2,093	3,090	17,325	7,335	1,588	26,248
34	-	997	-	997	17,325	7,335	1,588	26,248
35	-	997	-	997	17,325	7,335	1,588	26,248

Discount Rate (%)	Present Worth (₱ '000)		NPV	B / C
	Costs	Benefits		
0	221,641	786,848	565,207	3.55
2	199,881	532,510	332,629	2.66
4	183,773	373,636	189,863	2.03
6	171,169	270,959	99,790	1.58
8	160,841	202,386	41,545	1.25
10	152,066	155,145	3,079	1.02
12	144,404	121,646	- 22,758	0.84
14	137,577	97,256	- 40,321	0.70
15	134,418	87,523	- 46,895	0.65

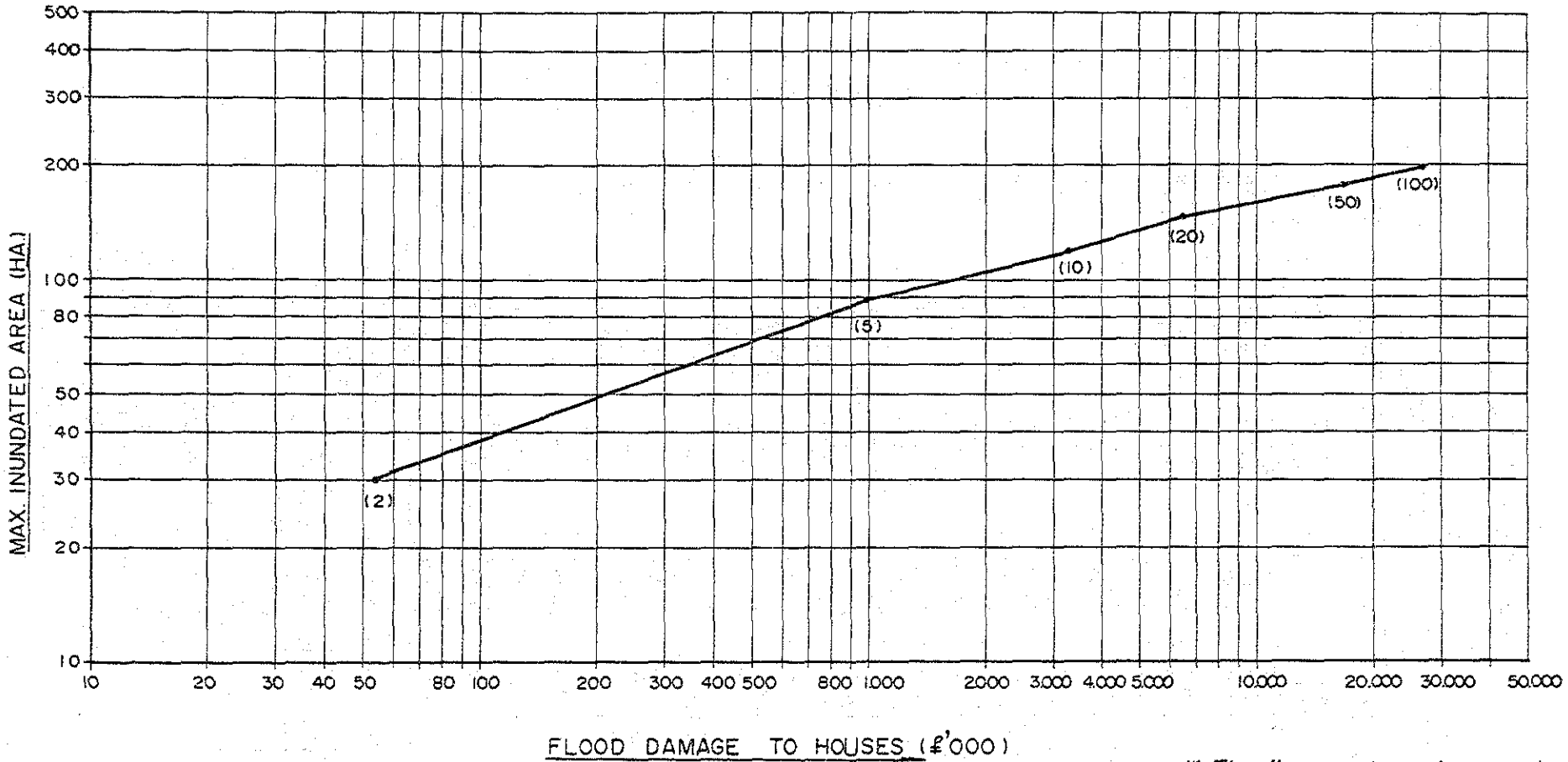
EIRR = 10.2 %

Table K.2.16 Sensitivity Analysis

(Unit : ₱'000)

Year in Order	Case-1 Costs	Case-1 Benefits	Case-2 Costs	Case-2 Benefits	Case-3 Costs	Case-3 Benefits
1	18,963	0	17,239	0	17,139	0
2	83,863	0	76,239	0	52,239	0
3	94,753	0	86,139	0	55,239	0
4	1,360	5,960	1,236	5,364	55,239	0
5	1,360	10,901	1,236	9,811	1,236	5,960
6	1,360	15,841	1,236	14,257	1,236	10,901
7	1,360	20,781	1,236	18,703	1,236	15,841
8	1,360	25,722	1,236	23,150	1,236	20,781
9	1,097	25,827	997	23,244	1,236	25,722
10	1,097	25,932	997	23,339	997	25,827
11	1,097	26,037	997	23,433	997	25,932
12	1,097	26,143	997	23,529	997	26,037
13	1,097	26,248	997	23,623	997	26,148
14	1,097	26,248	997	23,623	997	26,248
15	1,097	26,248	997	23,623	997	26,248
16	1,097	26,248	997	23,623	997	26,248
17	1,097	26,248	997	23,623	997	26,248
18	1,097	26,248	997	23,623	997	26,248
19	1,097	26,248	997	23,623	997	26,248
20	1,097	26,248	997	23,623	997	26,248
21	1,097	26,248	997	23,623	997	26,248
22	1,097	26,248	997	23,623	997	26,248
23	8,612	26,248	7,829	23,623	997	26,248
24	1,097	26,248	997	23,623	7,829	26,248
25	1,097	26,248	997	23,623	997	26,248
26	1,097	26,248	997	23,623	997	26,248
27	1,097	26,248	997	23,623	997	26,248
28	1,097	26,248	997	23,623	997	26,248
29	1,097	26,248	997	23,623	997	26,248
30	1,097	26,248	997	23,623	997	26,248
31	1,097	26,248	997	23,623	997	26,248
32	1,097	26,248	997	23,623	997	26,248
33	3,399	26,248	3,090	23,623	997	26,248
34	1,097	26,248	997	23,623	3,090	26,248
35	1,097	26,248	997	23,623	997	26,248
EIRR	9.4 %		9.3 %		9.7 %	

Note : Case - 1 : 10 % Increase in Investment Costs,
Case - 2 : 10 % Decrease in Benefits,
Case - 3 : One - Year Delay in Implementation.



※ The figures shown in parentheses indicate return period.

FIG. K.2.1 Flood Damage And Inundated Area

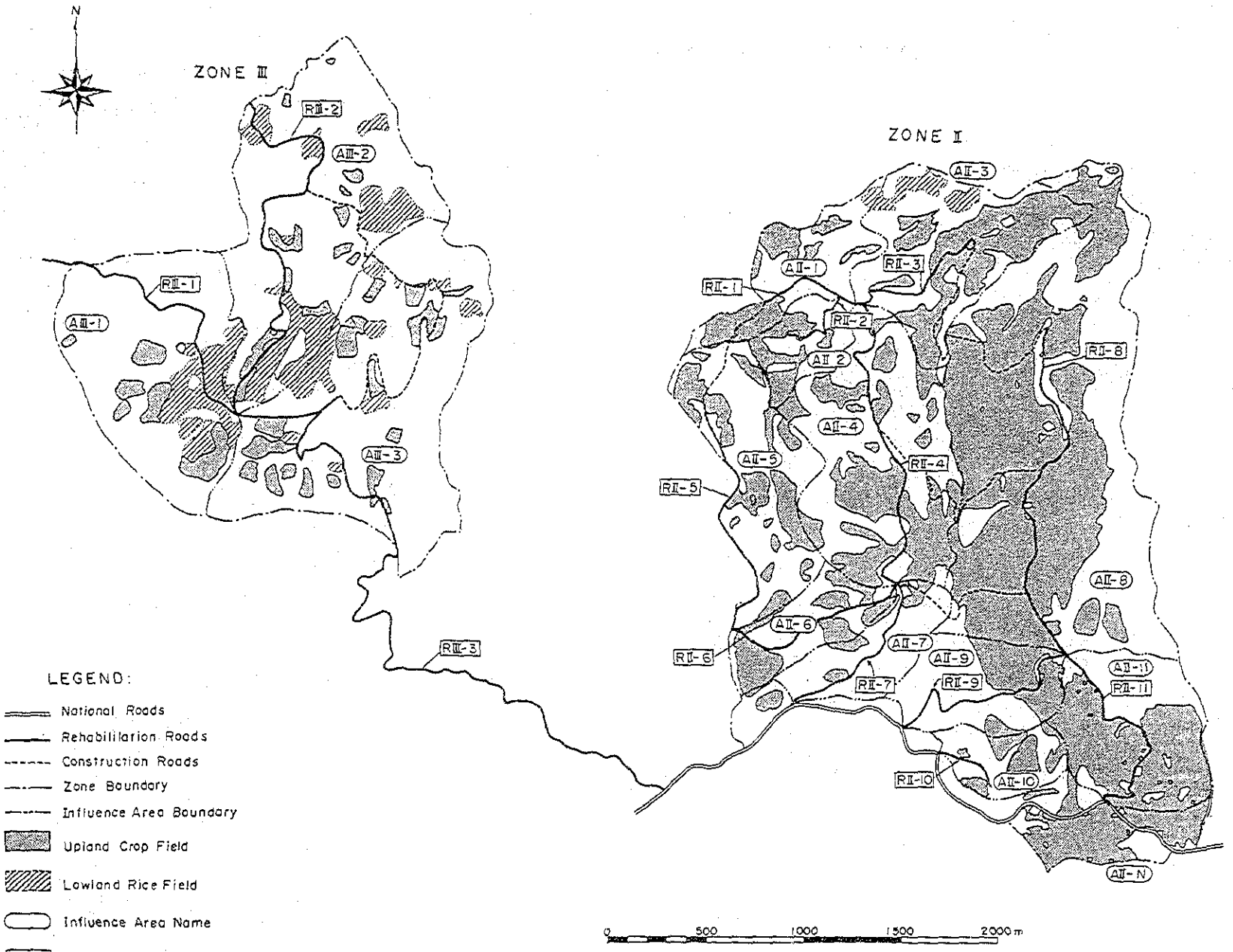


Fig. K.2.2 Zonal Division of Influene Area of Rehabilitation Roads

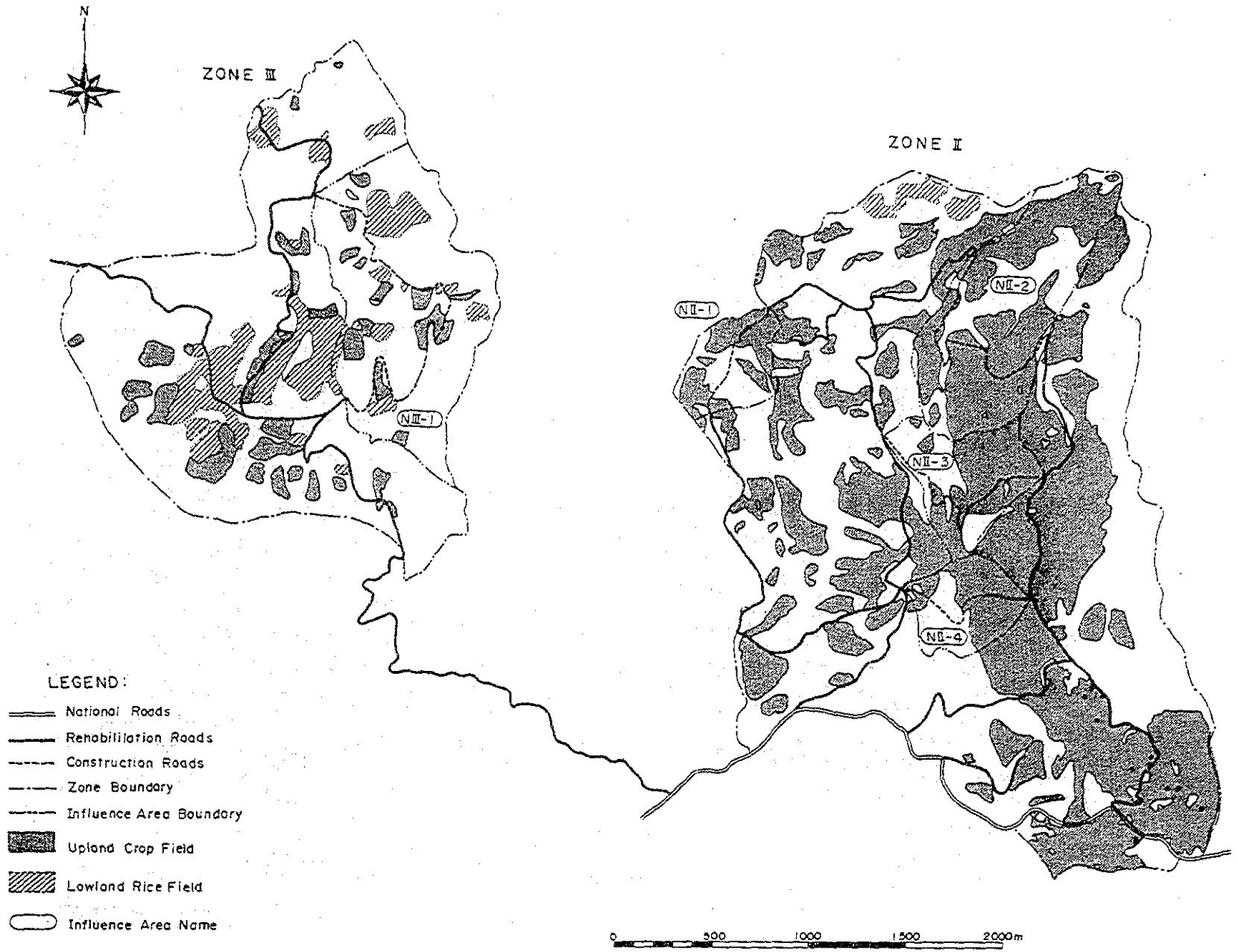


Fig. K.2.3 Zonal Division of Influence Area of New Roads

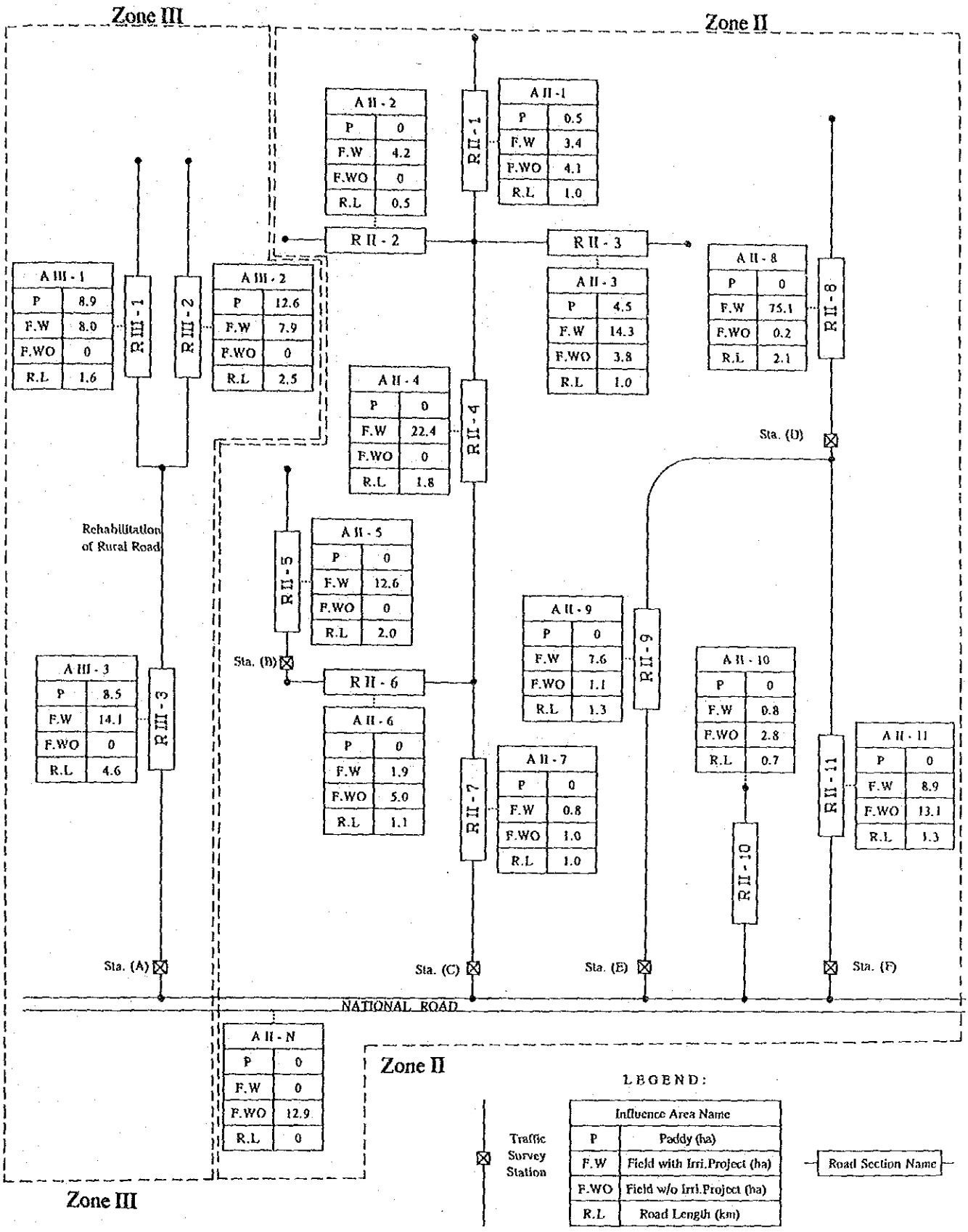


Fig. K.2.4 Schematic Diagram of Rehabilitation Roads

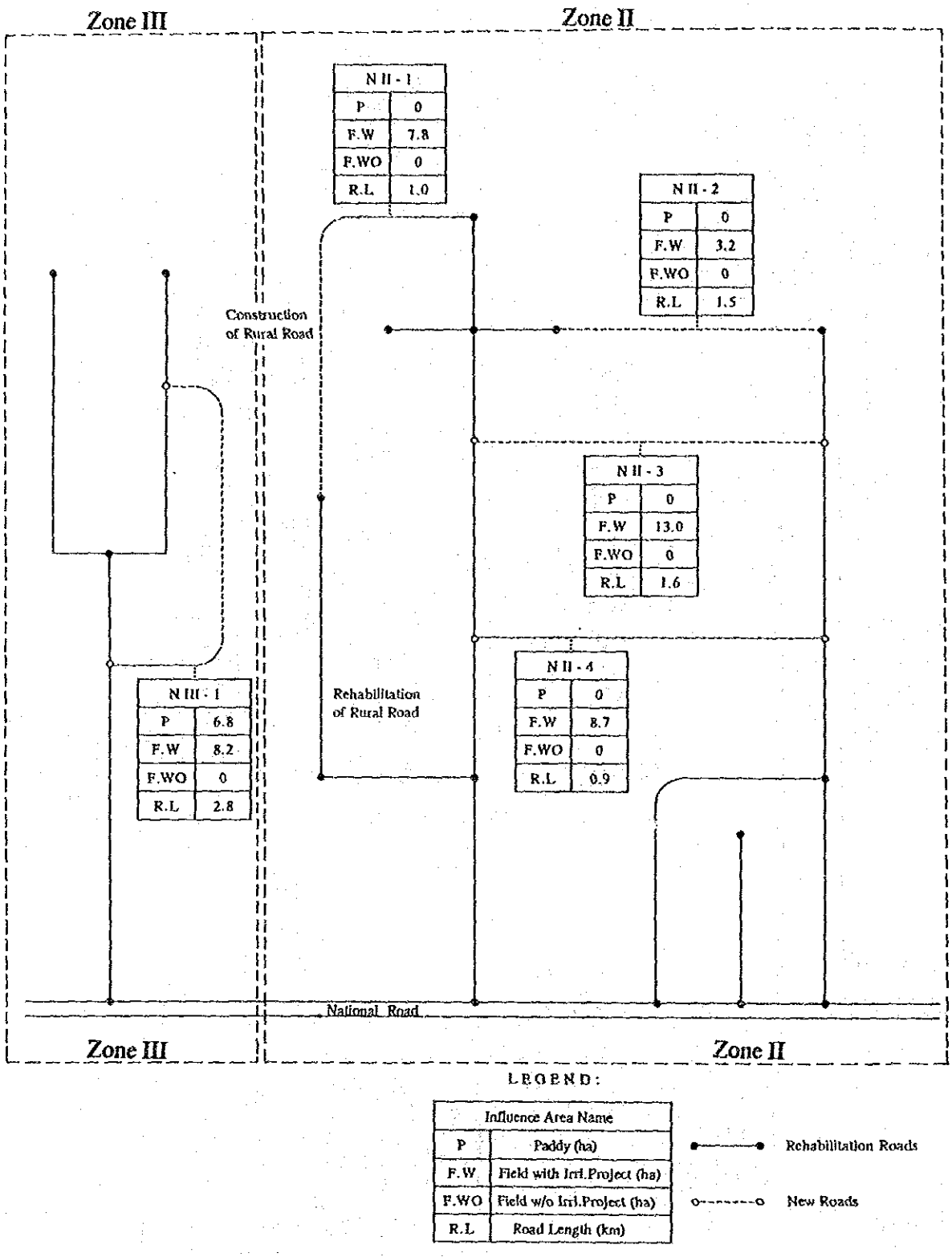


Fig. K.2.5 Schematic Diagram of New Roads

APPENDIX L

STUDY ON THE POTENTIALITY OF WATER RESOURCES DEVELOPMENT

APPENDIX L. STUDY ON THE POTENTIALITY OF WATER RESOURCES DEVELOPMENT

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APPENDIX L STUDY ON THE POTENTIALITY OF WATER RESOURCES DEVELOPMENT

1. GENERAL

Main water source in the study area can be classified into (1) rainfall, (2) runoff discharge in the form of rivers and springs and (3) groundwater in aquifer.

Rainfall in the wet season is abundant and amounts to be 3,500 mm in a period of 6 months from May to October, on the average. On the other hand, rainfall in the dry season decreases remarkably, and the records show only 250 mm in a period of 6 months from November to next April, on the average on the base of the BSU PAGASA station's data.

Since the catchment area of creeks located within the study area mostly comprises undulated rocky steep hills, rain water fallen on the hills runs fast off, with a small amount of groundwater feeding. The features of runoff is of considerably higher discharge at rainfall time and of extremely low discharge at no rain time. Therefore, huge amount of water source in the study area remains useless condition, while shortage of drinking and domestic water and irrigation water in dry season is occurs in everywhere every year.

As a reference, the monthly rainfall data of the Baguio PAGASA station are summarized as shown below:

Wet season			Dry season		
Month	Rainfall	Rainy day	Month	Rainfall	Rainy day
May	331.1	19	Nov.	152.3	9
Jun.	480.6	22	Dec.	28.8	5
Jul.	670.8	26	Jan.	12.1	4
Aug.	847.9	27	Feb.	35.8	2
Sep.	582.3	25	Mar.	55.9	4
Oct.	262.4	17	Apr.	102.9	9
Total	3,175.1	136	Total	332.0	33
Ave.	529.1	23	Ave.	64.6	6

Note: 1. Location of Baguio station: N 16°25', E 120°36', EL 1,501 m
2. Period of Records: 1951 - 1985

Thus, it can be said that the key to water resources development is to store rain water during the wet season and carry over to the dry season by means of a reservoir construction.

As for groundwater development, the study area is not blessed with topographic, geologic and hydrogeologic conditions for the groundwater basin, thus, the development potentiality of groundwater may be in a limited extent.

2. DEVELOPMENT NEEDS

2.1 Drinking and Domestic Water Demand

La Trinidad water district (LTWD) has a total water production of 330 gallons per minute (= 1,800 m^3/day) comprising of Deepwell No. 2, Lubas Spring and Ampasit Spring.

In considering update water demand of 338.8 gallons for 21,846 population which is about 60% of La Trinidad Municipality in the year 1987, shortage of water in the Municipality is a present big problem and also in future.

With efforts of the HIRDP, domestic and drinking water supply capacity in La Trinidad Municipality will be increased by 1,485 m^3/day after the implementation of the project.

The population increase in La Trinidad Municipality (LTM) has been estimated by applying a current growth rate of 3.7% on the basic population in 32,590 in the year 1985. The water demand of LTM has been estimated on the basis of the population forecast and a per capita water consumption rate. The per capita rates are assumed to be 145, 160 and 190 lit/day for years 1990, 2000 and 2010, respectively.

The necessary provisions comprised of fire provision (10%), medical, educational and public provision (10%), agricultural and commercial provision (5%), allowable losses (20%) and other contingencies (5%) have been added in the estimation.

The calculation result on water demand and shortage is as follows:

Year	(1) Total Population LTM	(2) Population: Sum of LTWD and HIRDP	(3) Per Capita Rate	(4) Water Demand: Household	(5) Water Demand: Provisions	(6) Water Demand: Total	(7) Supply Capacity	(8) Water Shortage
			lit/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day
1985	32,590	29,330	100	2,933	1,466	4,399	1,800	2,599
1990	39,100	35,190	145	5,103	2,551	7,654	1,800	5,854
2000	56,200	50,580	160	8,093	4,046	12,139	3,285	8,854
2005	67,400	60,660	180	10,919	5,459	16,378	3,285	13,093
2010	80,800	72,720	190	13,816	6,908	20,724	3,285	17,439

Note:
1. Col. (1) is La Trinidad population estimated with a gross rate 3.7%.
2. Col. (2) target population is the sum of LTWD & HIRDP population, which is 90% of Col. (1).
3. Col. (4) is the product of Col. (2) x Col. (3).
4. Col. (5) is the necessary provisions, which is obtained Col. (4) x 50%.
5. Col. (7) is the added capacity of LTWD and HIRDP.
6. Col. (8) is difference between Col. (6) and Col. (7)

From the above estimation, the value of water shortage in the year 2005 is regarded as a base of further development study. That is 13,093 m^3/day equivalent to 0.152 m^3/sec.

2.2 Irrigation Water Substitution for the Balili River

Since the water quality of the Balili river is not suitable for irrigation purpose, the need of substitution of the irrigation water may come out.

The net irrigation areas supplied by the Balili river water are identified to be 90 hectares in Zone I and 65 hectares in Zone II, with a total of 155 hectares. Owing to the implementation of HIRDP, the irrigation areas of 90 hectares in Zone I can newly receive groundwater from 3 deepwell pumps, thus the substitution requirement may be for 65 hectares in Zone II. With the unit irrigation water requirements of 3 mm/day and the combined irrigation efficiency 52%, the daily requirement is estimated at 0.00067 m^3/sec/ha. So that, the irrigation water requirement become to 65 x 0.00067 = 0.044 m^3/sec.

For study purpose, this requirement is regarded as the demand of the substitution.

3. POTENTIAL SITE OF A STORAGE DAM

It has been identified that the Wangal dam and reservoir is the only possible water storage site in the study area. From the topographic and geological conditions, the possible maximum storage capacity is estimated at about 4 million. cu.m. This amount is likely sufficient to the forecasted demands of drinking water supply and irrigation in the study area.

The location of the Wangal dam and reservoir is shown in Fig. L.1.1.

The physical feature of the location in terms of relationship between ground elevation and water area or water volume has been illustrated in Fig. L.1.2.

There are two existing irrigation areas in Zone III, which the Wangal river water is served as the main water source. One is of 10 hectares of net farmlands along the Wangal river in the Wangal Barangay, the other is of 60 hectares of net farmlands commanded by the Bineng CIS in the Bineng Barangay, comprising of 30 hectares of paddy field and 30 hectares of upland field.

The former will be completed to sacrifice its irrigated land for the Wangal reservoir. In this study, it is considered that the Local Government will provide the replaced irrigation land within a service area of the Wangal reservoir.

4. RELEASED WATER FROM THE WANGAL RESERVOIR

The above 70 hectares of irrigation land, therefore, will be given a priority to utilize the Wangal reservoir water.

The due water to be released from the Wangal reservoir has been estimated as follows:

1) Upland field irrigation water:

- Irrigation area : 40 ha
- Unit daily requirements : 0.00067 m^3/sec/ha
- Daily irrigation requirements : 0.027 m^3/sec

2) Paddy field irrigation water

- Irrigation area : 30 ha
- Land preparation : 120 mm for 30 days
- Unit daily requirements
  - Wet season : 0.00087 m^3/sec/ha
  - Dry season : 0.00101 m^3/sec/ha

3) Estimate of gross irrigation requirements and released water

The gross irrigation water requirements in which the useful rainfall for crops is not taken into consideration and the released water from the Wangal reservoir are estimated as shown in the following table.

Month	Upland	Dry Paddy		Wet Paddy		Gross Irrigation Requirement	Released Water
		L.P	G.P.	L.P.	G.P.		
	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
Jan.	0.027	0.007				0.034	0.06
Feb.	0.027	0.007	0.015			0.049	0.06
Mar.	0.027		0.030			0.057	0.06
Apr.	0.027		0.030			0.057	0.06
May	0.027		0.030			0.057	-
June	0.027		0.030	0.007		0.064	-
July	0.027		0.015	0.007	0.015	0.064	-
Aug.	0.027				0.030	0.057	-
Sep.	0.027				0.030	0.057	-
Oct.	0.027				0.030	0.057	-
Nov.	0.027				0.030	0.057	0.06
Dec.	0.027				0.015	0.042	0.06

Note: 1. L.P. means water requirements for land preparation.
2. G.P. means water requirements for vegetative growth period.
3. Released water from the Wangal reservoir has been decided on the base of the maximum requirements throughout a year.

5. PRELIMINARY ESTIMATE OF THE STORAGE REQUIREMENT OF THE WANGAL RESERVOIR

Based on the estimated specific run off given in the chapter of Hydrology (3.4.3), the Wangal river flow at the proposed dam site (watershed =5.5 km^2) has been calculated.

An examination of the storage requirement of the Wangal reservoir has been made through the following water balance calculation:

Month	Specific Runoff	Inflow to Reservoir	Released Water	Drinking & Domestic Water	Substitution of Balili W.	Total	Balance +	Balance -
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
Jan.	0.010	0.055	0.060	0.152	0.044	0.256		0.201
Feb.	0.008	0.044	0.060	0.152	0.044	0.256		0.212
Mar.	0.008	0.044	0.060	0.152	0.044	0.256		0.212
Apr.	0.014	0.077	0.060	0.152	0.044	0.256		0.179
May	0.082	0.451	-	0.152	0.044	0.196	0.255	
Jun.	0.119	0.655	-	0.152	0.044	0.196	0.459	
July	0.182	1.001	-	0.152	0.044	0.196	0.805	
Aug.	0.271	1.491	-	0.152	0.044	0.196	1.295	
Sep.	0.195	1.073	-	0.152	0.044	0.196	0.877	
Oct.	0.081	0.466	-	0.152	0.044	0.196	0.250	
Nov.	0.063	0.347	0.060	0.152	0.044	0.256	0.091	
Dec.	0.017	0.094	0.060	0.152	0.044	0.256		0.162
Total			0.360	1.824	0.528	2.712	4.032	0.966

Note: 1. Col . (7) is the sum of Col. (4), (5) and (6).

2. Col. (8) is the difference between Col. (3) and Col (7).

3. Required storage capacity (net)
   0.966 m^3/s x 86,400 s x 30.2 d = 2.52 million m^3
   Adding some allowances for sand deposit, seepage and evaporation amounting 0.3 million m^3, the storage requirement becomes 2.82 million m^3.

4. The balance between plus and minus has proved that the above storage volume can be filled sufficiently with inflow water from the Wangal watershed in the wet season.

6. PHYSICAL CONDITIONS OF THE WANGAL DAM SITE

Three alternative sites on the river bed at the elevation around El. 1,215 m in the downstream Wangal river which is also called as the Gayasey river have been studied. Their topographic and geological characteristics are summarized as shown below:

a) Damsite No.1 Upstream Site

1) Location at 2.0 km from No. 2 point, C.A. = 5.4 km^2,
2) Lowlying terrace floor in riverbed hill at the right abutment,
3) Riverbed width 30 m,
4) V-type valley, and
5) Deeply weathered conglomerates at the right abutment.

b) Damsite No. 2 Middle Site

1) Located at 1.8 km from No. 2 point, C.A. = 5.5 km^2,
2) Lowlying terrace floor in left steep slope at both abutments,
3) Riverbed width 30 m,
4) V-type valley,
5) Exposure of medium weathered conglomerates at both abutments,and
6) Medium scale fill type dam or concrete gravity dam.

c) Dam site No. 3 Downstream Site

1) Located at 1.6 km from No. 2 point, C.A. = 5.6 km^2,
2) Gentle slope in part at the middle of both abutments,
3) Riverbed width 25 m,
4) V-type valley,
5) Weathered tuff at the right abutment more than 1,250 meters in elevation, inferring fault at about 20 meters higher than riverbed at the right abutment, and
6) Medium scale of fill type dam or concrete gravity dam.

Among three alternatives, the middle site has been identified as the most promissible dam site of a concrete gravity dam. Accordingly, a test drilling with depth 50 m at the left bank abutment was conducted. Its results have been described in Chapter 7 of the Appendix.

7. LAYOUT OF THE WANGAL DAM AND RESERVOIR

Based on the topographic, geologic and hydrologic survey results, a layout of the Wangal dam and reservoir has preliminary been executed.

The major features of the Wangal dam and reservoir are summarized below:

a. Reservoir

- Catchment area : 5.5 km^2
- High water level : EL. 1,246 m
- Full water level : EL. 1,244 m
- Low water level : EL. 1,222 m
- High water surface area : 32 ha
- Total storage volume : 2.82 million m^3
- Effective storage volume : 2.52 million m^3

b. Dam

- Dam type : Concrete gravity dam
- Dam body crest length : 120 m
  - Crest width : 4 m
  - Bottom width : 34.2 m
  - Side slope upstream : Vertical
    Side slope downstream : 0.9:1
  - Height : 36 m
  - Bottom elevation : EL. 1,210 m
- Spillway
  - Type : Non gated overflow type with subdam energy dissipater
  - Design flood : 240 m3/sec
  - Overflow width : 40 m
  - Overflow depth : 2 m
- Concrete volume : 55,000 m^3

c. Related facilities

- Pump station and drinking and domestic water supply system : 1 place and 1 system
- Irrigation water intake and supply system : 1 system

8. BILL OF QUANTITIES AND COST ESTIMATE

Total concrete volume of about 55,000 m^3 is required for dam construction. and total construction cost of the Wangal reservoir, irrigation facilities, drinking water supply facilities, and rural road was estimated at 630 million pesos as shown below.

Items	Construction Cost (10^6 pesos)
1. Wangal reservoir	360
2. Irrigation facilities	135
3. Drinking water supply facilities	105
4. Rural roads	30
Total	630

The details are given in Table L.1.

9. CONSIDERATION ON THE NORTH AMBIONG CREEK

Although the North Ambiong creek and its watershed lies outside of the study area, the possibility of the water resources development has been investigated. Because the elevation of the North Ambiong area is higher than that of Zone I, so that its creek water from 1.8 km^2 watershed can be introduced to Zone I by gravity as a supplement of irrigation water in substituting for the existing water supply from the Balili River.

The water of the North Ambiong creek, however, is now mostly utilized for farm land in its basin, and quantity of its excess or waste water is very low by 7 lit/sec in the dry season.

On the other hand, the Balili CIS is located at the foot of the Ambiong hill and its irrigation water is dependent on the contaminated Balili river water.

In consideration of the needs of good quality water for the Balili CIS, the water source of the North Ambiong creek shall be reserved for he Balili CIS. Therefore, the development potentiality of the North Ambiong creek has been neglected in this study.

10. CONCLUSION

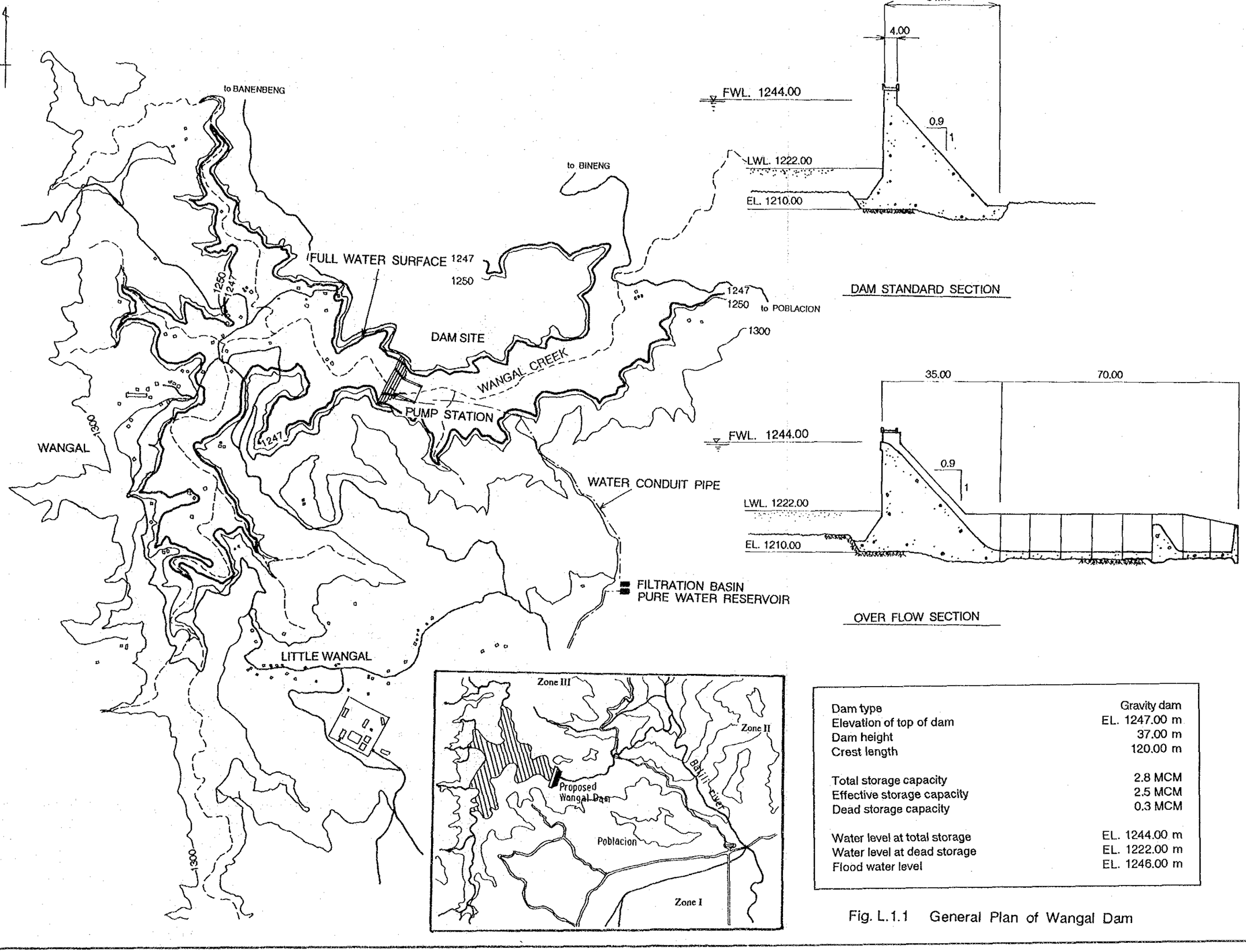
As mentioned in Chapter 5: Irrigation improvement plan of the main report, this Wangal dam & reservoir plan is not adopted to the Highland Integrated Rural Development Project from a viewpoint of the economic viability, however the Wangal dam and reservoir has a high potentiality of the rainwater storage during the wet season from the physical points of view.

Its maximum capacity being 4 million cubic meters may be sufficient enough to meet water demand amounting 2.82 million cubic meter comprising of drinking and domestic water of La Trinidad Municipality in the year 2005 and irrigation water substitution in Zone II for the Balili river source, if required in future.

It is worthy to point out that the clean water resources of the Wangal river is very valuable property for the resident population and community of La Trinidad Municipality.

Table L . 1 Construction Cost of Wangal Reservoir and Irrigation, Drinking Water Supply Facilities

Items	Unit	Quantities	Cost (10^6pesos)
1. Wangal Reservoir			
a. Right of way			
1) land acquisition	ha	35	7
2) House	houses	35	3
Sub-Total a.			10
b. Dam			
1) Temporary diversion works	set	1	20
2) Foundation treatment works	set	1	40
3) Dam body works	set	1	195
4) Intake facilities works	set	1	90
5) O/M and observation facilities	set	1	5
Sub-Total b.			350
Sub-Total 1			360
2. Irrigation Facilities			
1) Pipe line networks	km	15	120
2) Pump station at dam site	set	1	10
3) Pump station in Zone II	set	1	5
Sub-Total 2			135
3. Drinking Water Supply Facilities			
1) Pump station at dam site	set	1	20
2) Purification facilities	units	3	15
3) Service pipe line system	km	16.5	60
4) Booster pump station	units	2	10
Sub-Total 3			105
4. Rural Road (Alternatives)			
1) Access road to Wangal reservoir	km	4.8	20
2) Replacement road	km	3.3	10
Sub-Total 4			30
Total			630



Dam type	Gravity dam
Elevation of top of dam	EL. 1247.00 m
Dam height	37.00 m
Crest length	120.00 m
Total storage capacity	2.8 MCM
Effective storage capacity	2.5 MCM
Dead storage capacity	0.3 MCM
Water level at total storage	EL. 1244.00 m
Water level at dead storage	EL. 1222.00 m
Flood water level	EL. 1246.00 m

Fig. L.1.1 General Plan of Wangal Dam

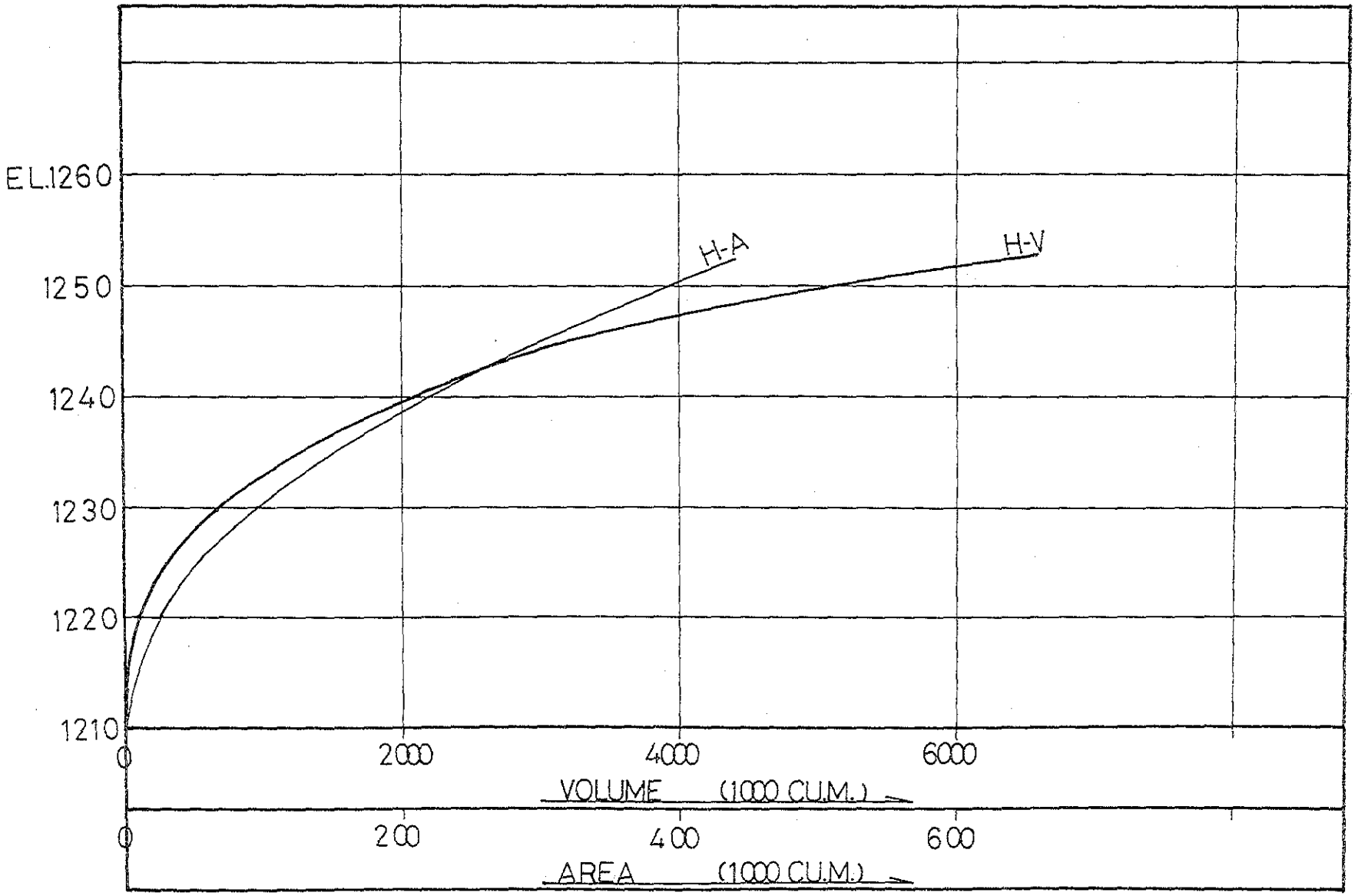


Fig. L.1.2 Height-Volume (Area) Curve of Wangal Dam