- Secondary farm road

  The secondary farm roads are required to link the cultivable areas with population centers in the area. The secondary farm roads are to be constructed on one side of all the secondary canals. These roads will have an effective width of 1.0 m and will be of earth type without any metalling.

7.2.2 Irrigation Water Requirements

(1) General

For planning of irrigation project, sufficinet information on water consumption by crops from seeding time until harvest is needed. Since field measurement of consumptive use of water by crop was not carried out in the survey period, this study is mainly depending on the study results in the report on Soil and Land Resources Appraisal and Training Project on Bicol River Basin/1 and Feasibility Studies of Quinali Integrated Development Area/2. The empirical and theoretical formulas developed in the past by various experts are also used in this study.

The calculation procedure adopted in this study is shown in the following equation:

$$IDR = (KC \times PET + P + N + LP - RE)/IE$$

where,

IDR = Irrigation diversion requirement,
KC = Crop growth stage coefficient,
PET = Potential evapotranspiration,
P = Percolation rate,
N = Nursery requirement,
LP = Land preparation requirement,
RE = Effective rainfall, and
IE = Overall irrigation efficiency.

/1: Bureau of Soil, Department of Agriculture, UNDP/FAO, 1976.

/2: Bicol River Basin Development Program, 1980.

The following terms and their abbreviations are used in this study.

a) Consumptive use (CU) : CU = KC x PET

b) Field crop requirement (FC) : FC = CU + P

c) Crop water requirement (CWR) : CWR = FC + N + LP

d) Crop irrigation requirement (CIR) : CIR = CWR - RE

e) Irrigation diversion requirement (IDR) : IDR = CIR/IE

(2) Consumptive use of water by crop

The consumptive use of water by crop can be estimated as a product of potential evapotranspiration (PET) calculated from climatic data and crop coefficients (KC) which depend on growing season and stage of the crop.

Since meteorological conditions between the Quinali (A) River basin and the Quinali (B) River basin are rather different, the potential evapotranspiration for these two areas is separately estimated. For the Quinali (A) River basin, the monthly potential evapotranspiration is estimated by using modified Penman method based on meteorological records observed at Legazpi. On the other hand, monthly class-A pan evaporation records (1972-1980) observed at Paraputo Agro-meteorological station near Malinao are used for estimation of the potential evapotranspiration for the Quinali (B) River basin. Results of calculation are shown in TABLE-VII.7.

Crop growth stage coefficients (KC) used in this study are shown in TABLE-VII.8, which were proposed in the "Soil and Land Resources Appraisal and Training Project" by FAO/UNDP in 1976.

Calculation results of the consumptive use of water by crop are shown in TABLE-VII.9 to TABLE-VII.11.

(3) Percolation rate

The rate of deep percolation loss was measured and discussed in the report on "the Feasibility Studies of Quinali Integrated Development Area" in 1980. According to the report, the results of actual field tests at 5 sites located in the Quinali (A) River basin ranged from 2 mm/day to 5 mm/day for the various soil types. During the wet season when the ground water table is high, the rate was slow and increases to a maximum of 5 mm/day during the dry season when the water table recorded to its lowest level.

Taking account of the above report, soil and topographic conditions in the project area, the following figures are adopted in this study.

Area	Name of Scheme	Percolation Rate (mm/day)
Quinali (A)		
Lower area	Agos Sta. Cruz-South Quinali Scheme	2
Upper area	Cabilogan Scheme, Quinali Scheme	4
Quinali (B)	Bantayan Scheme	4

(4) Nursery requirement

The nursery requirement is calculated by the following equation:

$$N = (LP + (KC \times PET + P) \times T) \times A$$

where,

N = Nursery requirement (mm),
LP = Land preparation requirement for nursery bed (mm),
KC = Crop growth stage coefficient,
PET = Potential evapotranspiration (mm/day),
T = Period of nursery (days), and
A = Area factor.

The area required for nursery bed and the period of nursery are assumed to be 5% of the total paddy land to be transplanted and 20 days respectively. In addition, the land preparation requirement and the crop growth stage coefficient are assumed to be 150 mm and 0.8 respectively. Results of calculation are shown in TABLE-VII.9 to TABLE-VII.11.

(5) Land preparation requirement

In general, the land preparation requirement for paddy fields can be defined as the supply of water, either by irrigation or rainfall, to a group of farms so as to wet the ground to saturation and to provide a water layer to facilitate ploughing and transplanting.

The present irrigation system in the project area relies on field-to-field flooding. In order to supply the required amount of water to each plot, it may take the period of two weeks on an average. Hence, replenishment for evaporation and percolation losses during the land preparation period is needed. Taking account of the amount of replenishment, the land preparation requirement is calculated by the following equation:

$$LP = SS + (KE \times EP + P) \times T + SP$$

where,

LP = Land preparation requirement (mm),
SS = Water depth required for land soaking (120 mm),
KE = Coefficient for evaporation from saturated soil or shallow water layer (= 0.8),
EP = Pan evaporation (mm/day),
P = Percolation rate,
T = Period for land preparation (15 days), and
ST = Water depth required for transplanting (25 mm).

Results of calculation are shown in TABLE-VII.9 to TABLE-VII.11 and summarized below.

Area		Land Preparation Requirement Wet (mm)	Land Preparation Requirement Dry (mm)
Quinali (A):	Lower area	237	221
	Upper area	268	251
Quinali (B):		257	236

(6) Effective rainfall

i) Rainfall data for the Quinali (A) River basin

In the Quinali (A) River basin, monthly rainfall data are available from three rainfall gauging stations, i.e. Guinobatan, Polangui and Libon. Among them, Libon rainfall gauging station is regarded as the key station for estimation of effective rainfall in the Quinali (A) River basin because it locates almost in the center of the proposed irrigation schemes.

Since duration of rainfall data available at Libon rainfall gauging station is insufficient for the study, rainfall data at Libon are supplemented by the long-term rainfall records available at Guinobatan rainfall gauging station. FIG.-VII.2 shows correlation of monthly rainfall between Guinobatan and Libon rainfall gauging stations. As shown in this figure, the monthly rainfall at Libon can be regarded as 75% of that observed at Guinobatan rainfall gauging station with a correlation coefficient of 0.842. Since monthly rainfall records from 1972 to 1977 are available at Libon rainfall gauging station, rainfall data for other periods, i.e. 1956-1971 and 1978-1979, are supplemented by using the above conversion ratio.

ii) Rainfall data for the Quinali (B) River basin

In the Quinali (B) River basin, monthly rainfall data are available from Malinao rainfall gauging station for 8 years from 1972 to 1979. Since duration of available rainfall record at Malinao is insufficient for the present study, it is supplemented by the rainfall records observed at Sto. Domingo rainfall gauging station. FIG.-VII.2 shows correlation of monthly rainfall between the above two stations. The monthly rainfall at Malinao can be regarded as 110% of that observed at Sto. Domingo rainfall gauging station with a correlation coefficient of 0.908 and then, monthly rainfall records at Malinao are supplemented by using the above conversion ratio.

iii) Estimation of effective rainfall

The potential effective rainfall on paddy land in the project area can be estimated by using a conversion curve shown in FIG.-VII.3 which was proposed in the report on the Upper Pampanga River Project in

1975. The monthly potential effective rainfalls thus estimated are shown in TABLE-VII.12 and TABLE-VII.13 for Libon (Quinali A) and Malinao (Quinali B) respectively.

(7) Irrigation efficiency

Irrigation efficiency is estimated by the following equation:

$$IE = Ea \times Ec$$

where,

IE = Overall irrigation efficiency,

Ea = Application efficiency, and

Ec = Conveyance and operation efficiencies.

Taking into account the soil characteristics, topography, climate, irrigation practice, etc, in the project area, the application efficiency is assumed to be 75% of the crop irrigation requirement on an average over the whole project area. In addition, the canal conveyance and operation efficiencies are estimated to be 80% of the crop irrigation requirement in total. Overall irrigation efficiency is, therefore, estimated at 60%.

(8) Irrigation diversion requirement

The irrigation diversion requirement is defined by the following equation:

$$IDR = (CWR - RE)/IE$$

where,

IDR = Irrigation diversion requirement,

CWR = Crop water requirement (Tables VII.9 to VII.11),

RE = Effective rainfall (Tables VII.12 and VII.13), and

IE = Overall irrigation efficiency (60%).

The irrigation diversion requirement for unit area is estimated on monthly basis in 24-year period of 1956-1979. Results are shown in TABLE-VII.14 to TABLE-VII.16 taking the unit of l/sec/ha.

The unit irrigation diversion requirement for the design of irrigation facilities, or the design intake discharge, for each area is determined to be equivalent to 20% probability of occurrence for the annual maximum monthly mean requirements taken from TABLE-VII.14 to TABLE-VII.16. Following figures thus estimated are adopted to the design of irrigation facilities.

Area	Design Discharge (l/sec/ha)
Quinali (A) River basin	
Lower area	1.28
Upper area	1.67
Quinali (B) River basin	1.14

7.2.3 Scale of Irrigation Area

(1) Water sources in the Quinali (A) River basin

Reliable water sources in the Quinali (A) River basin are the Cabilogan, Ogsong, Nasisi, Salog and Polangui Rivers. Except for the Quinali (A) river, stream flow records are available at 3 gauging stations as shown below.

Gauging Station	River	Drainage Area (km2)	Period of Record
Bobongsuran	Cabilogan	131	1956 - 1978
Benanuan	Ogsong	11	1956 - 1978
Nasisi	Nasisi	39	1951 - 1978

The stream runoff for the Salog and Polangui Rivers can be estimated by extrapolation from flow records observed at Nasisi gauging station. The extrapolation is carried out based on relationship between drainage area and annual mean runoff as shown in FIG.-VII.4.

A certain portion of runoff from the Ogsong, Nasisi, Salog and Polangui Rivers has been diverted by existing intake facilities of the 4 National Irrigation Systems. Available discharge for the new development should, therefore, be calculated by deducting irrigation diversion requirements of the National Irrigation Systems for river runoff. Water sources for the proposed irrigation schemes can be evaluated as follows:

i) Water source for the Cabilogan Scheme:

Cabilogan River (Drainage area = 122 km^2)

ii) Water sources for the Agos Sta. Cruz - South Quinali Scheme:

a) Remaining discharge on the Cabilogan River after diversion by the Cabilogan National Irrigation System,

b) Remaining discharge on the Ogsong River after diversion by the Ogsong National Irrigation System, and

c) Remaining discharge on the Nasisi River after diversion by the Nasisi National Irrigation System.

iii) Water sources for the Quinali Scheme:

a) Remaining discharge on the Salog River after diversion by the Mahaba National Irrigation System,

b) Remaining discharge at the Hibiga Headworks after diversion by the Hibiga National Irrigation System, and

c) Stream runoff from the drainage area of the Polangui River (excluding the drainage area at the Hibiga Headworks).

Irrigation diversion requirements for the National Irrigation System are calculated taking the future irrigable area into account as shown in TABLE-VII.17. Based on the unit irrigation diversion requirement for the upper area in the Quinali (A) area (TABLE-VII.15) and the future irrigable areas, irrigation diversion requirements are calculated as shown in TABLE-VII.18 to TABLE-VII.21.

The monthly mean discharges at the proposed Cabilogan Headworks and the existing headworks for the National Irrigation Systems and for the Polangui River are calculated by using available records and conversion ratio as shown in TABLE-VII.22. Results of calculation are shown in TABLE-VII.23 to TABLE-VII.28.

Available discharge at the proposed Agos Sta. Cruz - South Quinali Headworks and at the Quinali Headworks are calculated as shown in TABLE-VII.29 and TABLE-VII.30.

(2) Water sources in the Quinali (B) River basin

The Quinali (B) River is the most reliable water source for irrigation. Since stream flow records for this river are not available, the stream runoff at the proposed Bantayan Headworks is extrapolated from flow records observed at Bobongsuran gauging station using conversion ratio of 0.715. The result of calculation is summarized in TABLE-VII.31.

(3) Scale of irrigation area

The following criteria[1/] concerning limitations for water shortages are utilized in determining the adequancy of project water supplies.

i) Maximum annual shortages should not be greater than 50% of the annual irrigation diversion requirement.

ii) Maximum combined shortages in any two consecutive years should not be greater than 37.5% of the irrigation diversion requirements, and

iii) The average annual shortage over the 1956-1978 period should not be greater than 7%.

1/: Irrigation Development Plan for Central Luson, NIA/ECI, 1977

First, physically maximum irrigable areas by gravity irrigation are delineated on the available topographic map with a scale of 1 to 25,000 and a contour interval of 10 m as shown in TABLE-VII.36.

Irrigation diversion requirements for the delineated schemes are calculated as shown in TABLE-VII.32 to TABLE-VII.35. In order to confirm the availability of water source for irrigation, water balance calculations are carried out based on the criteria mentioned above. FIG.-VII.5 to FIG.-VII.12 shows the monthly water balance between available mean discharge and irrigation diversion requirement for 24 years from 1956 to 1979.

The amount of irrigation water shortage is calculated for each scheme as shown in TABLE-VII.37. Irrigation water for envisaged irrigation areas can be supplied by stream flow within the limitation of shortage mentioned above. Hence, the scale of irrigation area for each scheme is proposed as follows.

Name of Scheme		Net Irrigation Area (ha)
Quinali (A) River basin		
i)	Cabilogan	1,400
ii)	Agos Sta. Cruz-South Quinali	4,350
iii)	Quinali	600
	Sub-total	6,350
Quinali (B) River basin		
iv)	Bantayan	2,400
	Total	8,750

7.2.4 Drainage Requirement

(1) General

The drainage facilities are to be provided to remove the excess water in the fields taken place due to the heavy rainfall during storm and to create adequate conditions of drawdown in a harvesting period.

The unit drainage requirement is estimated referring the NIA design criteria[1/]. Surface drains are designed so as to handle flows generated from 10-year storm frequencies.

(2) Design rainfall

The 10-year, 1-day storm rainfall in the project area is calculated as follows.

Area	10-year, 1-day storm rainfall (mm/day)
Quinali (A) River basin	250
Quinali (B) River basin	300

These storm rainfall are used as a design rainfall for estimation of unit drainage requirement.

(3) Unit drainage requirement

The unit drainage requirement is calculated by the following equation.

$$R = \frac{I - 100}{T} \times 10^4$$

where,

R : Unit drainage requirement (l/sec/ha)

I : Design rainfall (mm/day) and

T : Drainage period (86,400 sec)

Using design rainfalls for both basins, unit drainage requirements for the Quinali (A) and Quinali (B) River basins are estimated at 17.4 l/sec/ha and 23.1 l/sec/ha, respectively.

1/: Design Criteria for Irrigation Canals, Drainage Channels and Appurtenant Structures, G.N. Iglesia.

CHAPTER VIII

VIII. FLOOD DAMAGE

8.1 Damage to Infrastructure

The first field inventory survey on the flood and sediment damages in the project area was carried out in 1979 as a preliminary flood damage survey, and the second field inventory for the Master Plan study which is a follow-up of the first survey was made in 1980 by using topographic maps on the scale of 1/25,000. In the latter study, the damages to infrastructures were surveyed based on the information collected by the Authorities concerned and the data on the properties obtained by the Team.

For the re-assessment and review of the Master Plan, the flood and sediment damages including mud/debris flow damage were surveyed during the past two years in 1980 and 1981 in addition to the data between 1975 to 1979 in the Master Plan study.

8.1.1 Damage to Houses

(1) Value of House

Houses in the project area are divided into three classes such as Type A, B and C considering the construction materials of roof and wall as shown in Municipal Socio-Economic and Physical Profile Document in 1979 and 1980. 'Type A' houses are made of concrete and F.I./Aluminium. 'Type B' houses are made of wood. 'Type C' houses are made of bamboo slate and nipa.

House value of each type is assessed as the average value estimated with construction cost on the basis of interview with the barangay captains in 1980. The values were estimated at P 80,000, P 20,000 and P 2,000 for 'Type A', 'Type B' and 'Type C' respectively at the price level of 1980. Each house value is re-assessed at P 115,000, P 29,000 and P 2,900 at 1982 price level on the basis of the inflation rate between 1979 and 1982; average inflation rate of 13% per annum.

(2) Flood Damage Rate to House

Since there is no flood damage rate to be applicable in the Philippines, the damage rate on the basis of Japanese standard is applied. The damage rate in relation to inundation depth is listed below.

Situation	Depth above floor level	Damage rate
Inundation below floor level	-	0.03
Inundation above floor level	0 - 0.5 m	0.053
	0.5 - 1.0 m	0.072
	1.0 - 2.0 m	0.109
	2.0 - 3.0 m	0.152
	Over 3.0 m	0.220

Source: The Ministry of Construction, Japan

(3) The Number of Houses Inundated due to Flood

In counting the number of houses inundated due to flood, the following criteria are considered:

i) Distribution of the different type houses is assessed by the proportion obtained from the Socio-Economic & Physical Profile of Municipalities in 1979 and 1980 and the field interview with the barangay captains in 1980. The proportion is estimated as follows:

(Unit: %)

Municipality	Type A	Type B	Type C
Polangi	10	20	70
Libon	10	30	60
Oas	10	30	60
Ligao	10	40	50
Guinobatan	10	20	70
Camalig	10	40	50
Daraga	20	30	50
Legazpi City	20	50	30
Sto. Domingo	10	40	50
Bacacay	10	40	50
Malilipot	10	40	50
Tabaco	10	40	50
Malinao	10	30	60

Source: Municipal Socio-Economic and Physical Profile Document in 1979 and 1980

ii) The inundation area is delineated by counterchecking the data of the field inventory surveys and the results of hydrological and hydraulic analysis, especially, in view of inundation depth and inundation period. As the result, the damaged area due to typhoon "Pepang" is approximately 113 km^2 in the project area as shown in the Master Plan.

The inundation area by the flood of typhoon "Daling" obtained from MPWH is almost the same as the area of typhoon "Pepang". For the re-assessment and review of the damage to houses, the basic data and the flood damage analysis of the Master Plan is available.

Inundated barangays are obtained from the field interview and maps on the Master Plan study. The number of inundated barangays in 1979 (typhoon "Panpang") is estimated at 49 in the Quinali (A) River basin, 4 in the Yawa River basin and 6 in the Quinali (B) River basin respectively as shown in TABLE-VIII.1. The East and North-East Area is assumed to have no inundation for the barangay area.

iii) The total number of houses in the inundated barangays is estimated as household by the Socio-Economic & Physical Profile of Municipalities in 1979 and 1980 collected by the Master Plan study.

iv) The number of houses inundated by typhoon "Pepang" in 1979 is estimated by the field survey of inundation depth, inundation area and flood damages, etc. by counterchecking the data of typhoon "Daling" in 1981. The number of houses inundated for 10-year, 20-year, 50-year and 100-year probable flood is estimated based on the results of hydrological and hydraulic analysis of the Master Plan.

(4) Damage to Houses

In this study, the damage to houses is estimated on the dwelling units excluding the damages to public buildings such as schools, charches, factories, etc. As a result of the field survey, the damages to public buildings have been caused by wind and heavy rain due to typhoon and have not been caused by flood. TABLE-VIII.2 summarizes the damage to houses.

The damage to houses by typhoon "Pepang" in 1979 is estimated at P 16.98 million at 1982 price level and the damage in each river basin is shown in TABLE-VIII.4. TABLE-VIII.3 includes the direct damage sustained by commercial establishments. This damage is estimated at about 10 percent of the amount of the damage to houses as described in the Master Plan.

The damages for 10-year, 20-year, 50-year and 100-year probable flood are estimated simultaneously as shown in TABLE-VIII.3 and TABLE-VIII.5 to TABLE-VIII.8. Those damage costs are P 35.54 million, P 46.66 million, P 63.16 million and P 75.01 million respectively.

8.1.2 Damage to Government Infrastructure

(1) Damage to Road Structures

Due to flood water and sand sedimentation brought by the flood, the various kinds of roads such as national road, provincial road, municipal road, city road and barangay road, have been damaged every year. In the extreme case, roads and bridges were washed away by rushing flood water. Besides, travel time or transportion cost are increased during the flood time, which gave adverse effect on the province economy.

Flood damages to roads are classified into the following three categories: i) Damage to bridges, culverts, pipes, ditches and reconstruction of embankment, surfacing, riprapping, etc. ii) Increase of travel cost for the detouring, iii) Decrease of regional product such as gross regional product resulting from temporary closure of major transportion arteries.

The detailed damage to road by each typhoon during the period of 1975 - 1979, on the Master Plan study and additional data during past two years in 1980 and 1981 are listed in TABLE-VIII.9 to TABLE-VIII.12.

Damage to bridges and roads can be approximately measured by the estimated damage costs, since the estimated damage cost due to each typhoon and heavy rain are submitted as the calamity fund to the Government from the Ministry of Public Works and Highways, the Provincial Engineering Office, the City Engineering Office and the Municipalities. However, the rehabilitation costs in each year are not sufficiently released to reconstruct the damaged bridges and roads.

For the damages in categories ii) and iii), these indirect damages are assumed to be 15 percent of the direct estimated damage costs as described in the Master Plan.

(2) Damage to Railway Structures

Railway located at the east area of Mayon Volcano from Legazpi City to Tabaco was destroyed and dismantled by the eruption in 1938. The railway from Daraga to Camalig was damaged by debris flow in 1969 after the eruption of 1968 and many bridges were damaged heavily in 1975 by flood and debris flow from Mayon Volcano. The railway system in Albay Province has been dismantled between Camalig and Legazpi City at present.

In estimating the damage costs, the dismantled railway from Daraga to Tabaco is excluded and the estimated damage cost from 1975 to 1979 is obtained from the Philippine National Railway on the Master Plan study. In addition to the damage data from 1975 to 1978, the data between 1980 and 1981 were collected from PNR. The railway of the project area is located only in the Quinali (A) River basin.

The detailed damage to railway trucks and bridges caused by flood is summarized in TABLE-VIII.13 and TABLE-VIII.14. The damage in 1975 from Daraga to Camalig is considered in this study.

(3) Damage to River Facilities

In the project area, flooding of the main rivers such as the Quinali (A) River, the Yawa River and the Quinali (B) river has done damage to river structures. These damages are caused by washing out and eroding dikes and scouring boulder riprap.

The detailed damage to river facilities by each typhoon during 1975 - 1981 is listed in TABLE-VIII.15 to TABLE-VIII.23. Additional data in 1980 and 1981 was collected from MPWH and is listed in TABLE-IX.15 to IX.18. These damage costs are measured by the estimated damage costs submitted as the calamity fund to the Government from the Ministry of Public Works & Highways and the City Engineering Office.

(4) Damage to Other Infrastructures

Data of the typhoon damage to other infrastructures was collected from the related Authorities concerned in the field survey in 1982.

Damage to telecommunication facilities (telegraph lines) due to typhoon in 1981 is listed in TABLE-VIII.24 and this damage data was collected from Bureau of Telecommunications.

Damage to electrical facilities (distribution lines) due to typhoon is listed in TABLE-VIII.25 and this damage data was collected from Albay Electric Cooperative, INC.

Damage to waterworks due to typhoon is listed in TABLE-VIII.26 and this damage data was collected from MPWH.

8.2 Damage to Irrigation Facilities

8.2.1 Past Damages

The flood damage to the irrigation facilities in both National and Communal Irrigation Systems had been investigated by NIA staffs just after every flood in the past 5 years from 1975 to 1979 on the stage of the Master Plan study. These damages are summarized in TABLE-VIII.30 to TABLE-VIII.35.

In addition to the above previous data, the flood damage due to typhoon "Anding, 1981" and "Aring, 1980" was collected from NIA. These damages are listed in TABLE-VIII.28 and TABLE-VIII.29, and are summarized in each river basin as shown in TABLE-VIII.27.

The damages on the temporary irrigation facilities constructed by farmers themselves are also included in the above tables, which are estimated to be around 30% of the total damages on the National and Communal Systems based on the result of field investigation.

8.2.2 Damages to Irrigation Facilities

Major floods which occurred during 7 years from 1976 to 1981 almost correspond to the probable flood with 2-year return period. The amounts of damage to irrigation facilities due to the floods are ranging from P 151,000 to P 710,000 in the said period. On the other hand, the flood due to Typhoon "Sisang" in 1975 corresponds to the probable flood with a return period of more than 20-year. However, the amount of flood damages is only P 234,000 which does not exceed the above maximum of P 710,000. This indicates that the flood damage does not increase in proportion to the magnitude of flood and therefore it is difficult to establish the relation between the flood damage and flood magnitude. For the estimation of the flood damages, the biggest damage during the said 7 years which was caused by typhoon "Pepang" in 1979 is adopted as the flood damage to be caused by the probable flood with a return period of 2-years.

The damages to be caused by the probable floods with return periods of more than 2-year are estimated by employing the damage increase rates applied for forecast of the damage to infrastructure assuming that the damage to irrigation facilities is qualitatively the same as that to infrastructure.

8.3 Damage to Crop

Flood damage to crops in the project area is estimated by the analytical method in the with- and without project conditions. Past records on the crop damage are used subsidiarily. Crop damage by floods is made mainly on palay. Damage to the upland crops such as coconut, abaca maize, sweet potato and taro is negligibly small because these crops are planted, in the most cases, on the flood-free areas. Parameters of the flood damage to palay are the area of standing crop, expected net income by the farming, production cost already spent by the date when flood occurred, growth stage of the crop (cropping pattern), inundation depth, inundation duration, flood velocity, monthly occurrence frequency of floods and sediment flows and debris flows.

Crop damage by flood can be expressed as

$$D = (I + C) \times R$$

where, D is the crop damage, I is the net income in without-flood condition, C is the production cost already spent by the date when flood occurred and R is the crop damage rate. The net income in without-flood condition and the production cost already spent by the date when flood occurred are estimated from the typical farm budget. The crop damage rate is determined by the standard table for the palay damage prepared by the Ministry of Agriculture, Forestry and Fisheries of Japan. The damage rate is the sum of the rates for the inundation damage and the lodging damage in which inundation damage rate is the product of the interaction among the growth stage, inundation depth, inundation duration and debris content, and the lodging damage rate is the product of the interaction among the growth stage, flood depth and flood velocity. The complete lodging is caused in maturing stage if the flood depth is more than around knee high and that the flood velocity becomes around 2 m/sec or more.

The area of standing crop is estimated based on the cropping pattern and is expressed reflecting the ratio of area of standing crop to the total planted area.

The monthly frequency of floods is expressed in terms of the monthly frequency of occurrence of typhoons in the project area, which is obtained from the Meteological Agency of Japan.

CHAPTER IX

IX. COST ESTIMATE

9.1 General

Construction cost of the Sabo works including nine tributaries, under the Mayon Volcano Sabo and Flood Control Project, is estimated on the basis of the preliminary engineering design and the proposed construction plan and schedule. For the cost estimate, local conditions of the Philippines, available equipment and materials, suitability of construction method, working rules, the Government estimate procedure, etc. are taken into acount.

The cost estimate is carefully prepared, using the quantities obtained from the preliminary engineering design study, so as to include all the costs incidental to the construction of this Project. Detailed cost estimate and unit price breakdown are presented on this Supporting Report and Detailed Cost Estimates.

9.2 Basic Conditions

The basic conditions applied to the cost estimates are as presented below:

(1) Price Level

Prices are based on current prices for labor, materials and equipment as of Mid-1982.

(2) Exchange Rate

Ruling exchange rate used in this estimate is as follows:

1.0 US$ = 8.0 Pesos = 240 Japanese Yen

(3) Work Quantity

Work quantities are calculated based on the preliminary design and presented on the Detailed Priced Bill of Quantity Report.

(4) Tax and Duties

For estimating the financial construction cost, unit prices are estimated on the basis of the current prices in the Philippines and these prices include tax and duties for imported materials and equipment.

(5) Material Cost

All construction materials are to be supplied by the contractor mainly from local markets. It is based on the price in Albay on Mid-1982. The costs of steel product and reinforcing bar, cement, fuel and lubricant are divided into the foreign currency portion and local currency portion.

(6) Labor Cost

Direct daily wages of local labor applied to the construction cost are estimated based on the wages in Albay on Mid-1982. The labor cost estimated dose not include any daily overtime and overtime for Sunday and Holiday.

(7) Equipment Cost

Equipment cost is estimated on the basis of depreciation cost, repair cost and administration cost against CIF price, considering daily rental rate in the Philippines. Equipment cost does not include the material cost and labor cost.

9.3 Construction Cost

Financial construction cost estimate is made based on the MPWH estimating procedures. Construction cost comprises contract cost including direct cost, general, supervision & miscellaneous, profit and contractor's tax, right of way/site acquisition, engineering cost, project management cost and contingency. The MPWH estimating procedures are as follows:

(1) Contract Cost

(a) Direct cost includes the direct cost of materials, labor and equipment expenses as shown in the unit price breakdown on the Detailed Priced Bill of Quantity Report. The cost of labor is estimated at the sum of direct labor, leaves, SSS/GSIS, medicare and state insurance.

(b) General cost for this estimate includes mobilization and demobilization, vehicles, field office, access road and other temporary works. General cost is taken as 10 percent of the direct cost.

(c) Supervision and miscellaneous items for the contractor are estimated at the rate of 5 percent and 1 percent of the sum of direct cost plus general cost.

(d) Profit is computed at 10% of the sum of direct cost plus general cost and supervision & miscellaneous according to the Memorandum for the Allowable Percentage of Contractor's Profit in the Philippines.

(e) Contractor's tax is estimate at 3 percent of the sum abovementioned.

(2) Right of Way/Site Acquisition

The cost of right of way/site acquisition is calculated based on the Schedule of Base Unit Market Value for Agricultural Lands in 1982. This cost is assumed to be 1,800 pesos per hectare.

(3) Engineering Cost

Engineering cost which is 10% of the contract cost includes topographic survey, design, soil testing prior to and during construction, construction surveys and construction management. In the construction cost estimate, the engineering cost for the overseas consultant is not included and this engineering cost is to be consultancy services of the Philippine's consultant under the Project Management Office.

(4) Project Management Cost

The operation cost of the project management office established by the MPWH is computed at 5 percent of the contract cost. The project management cost includes the salaries for the personnel services and maintenance & operating expenses during the construction period including design stage.

(5) Contingency

The contingency is provided to cope with unforeseen physical conditions and price escalation due to inflation.

(a) The rate of physical contingency varies with conditions of construction and the physical contingency is influenced by the following factors: Physical conditions of construction site; Technically unknown difficulty; Exactness of investigation and study undertaken; Exactness and base of cost estimate; Exactness of work quantity calculation; Variation in preliminary design; Occurence of unforeseen condition due to natural phenomena; Exactness of estimate of construction period.

From an assessment of factors involved, the physical contingency of 15 percent on the feasibility stage estimates is applied.

(b) The rate of price escalation contingency varies with inflation in the Philippines. The price escalation is estimated by applying the inflation rate of 7 percent per annum on foreign currency portion and 13 percent per annum on local currency portion.

9.4 Total Construction Cost

Construction cost is estimated based on the abovementioned basic conditions and MPWH cost estimate procedure.

Total construction cost of each river basin for the re-assessment and review of the Master Plan is estimated in TABLE-IX.1 to TABLE-IX.3.

Total construction cost of the Sabo Project is estimated in TABLE-IX.4. Construction cost of the Sabo Project for each river basin is listed in TABLE-IX.5 to TABLE-IX.7.

Construction cost excluding price escalation for each work component is listed in TABLE-IX.8 to TABLE-IX.22.

Construction cost disbursement schedule is presented in TABLE-IX.23 to TABLE-IX.30.

9.5 Economic Cost

For the economic evaluation of the Project for the re-study and the Sabo Project, the economic cost is estimated by adjusting the financial construction cost. The economic cost excludes taxes of materials and equipment, contractor's profit and tax, land acquisition, and price escalation.

Economic cost estimates and the economic cost disbursement schedule are listed in TABLE-IX.31 to TABLE-IX.60. Detailed economic cost estimate and that unit price breakdown are presented in the Detailed Priced Bill of Quantity Report.

CHAPTER X

X. DISASTER PREDICTION AND WARNING SYSTEM

10.1 Introduction

Albay Province located in the typhoon belt of the Pacific often incurs heavy losses attributable to tropical storms. Typhoon accompanied with a torrent heavy rainfall has brought mud/debris flow in the steep mountain slope of Mayon Volcano. Flood and inundation have been the consequents of such stormy rainfall in the flat land adjacent to the mountain skirt. The Government of Philippines has struggled to mitigate such disasters by constructing dykes along the rivers in the province. The Government's works proved their effectiveness at each typhoon season; nevertheless they have been obliged to be the emergency work level due to the economic condition of the country.

In addition to these emergent works, the Government have undertaken the study of master plan for the flood control and sabo works. Upon request by the Government, the Japanese Government extended technical cooperation in the study through JICA. JICA dispatched the study team twice in Years of 1978 and 1980. The study teams prepared MASTER PLAN FOR MAYON VOLCANO SABO AND FLOOD CONTROL PROJECT with regard to the sabo and flood control for the project area. It is concluded that various sabo facilities in the slope of Mayon Volcano and flood control facilities in and along the rivers are essential to mitigate the disasters in the project area. The Philippines Government has embarked the implementation of works proposed in the Master Plan when the Typhoon "Daling" brought the serious damages to the project area on June 30 and July 31, 1981. The Government requested again the technical assistance from the Japanese Government to re-assess and review the Master Plan to find the most effective approach taking the recent disasters into consideration. And the Japanese Government responded to the request of dispatching a study team for the Re-Study on Mayon Volcano Sabo and Flood Control Project through JICA.

The recent disasters are characterized in its devastating casualties taken place in broad areas. The casualties are attributable principally to the magnitude of the rainfall intensity. It is, however, considered that some casualties could have been avoided if the disaster had not been brought about in mid night. Peoples in danger zone slept well and disaster had taken place before the people were aware of their danger.

In this respect, the Government considered it is necessary to install a disaster prediction and warning system to mitigate disaster as a non-structural measure. And the planning for the introduction of the disaster prediction and warning system was included in the assignment program for the Re-Study.

The studies on the system were conducted mainly by the systems engineer (Senior hydrologist) and the telecommunication engineer. Since their arrival to the job site, data and records were collected and analized on hydrology, geology, disaster, disaster prevention activities, flood control facilities and existing telecommunication system.

Data and records were collected through various offices such as PAGASA Manila, Legazpi and Naga, Typhoon Committee Manila, OCD Manila and Legazpi, BUTEL Legazpi, BRBDP Naga and COMVOL Manila and Misericordia. The obtained data were examined and analysed through discussions with officials concerned and site reconnaissance surveys. The plan proposed hereunder fully reflects results of these analysis.

This report aims to backsupport the main report of the Re-Study with regard to the disaster prediction and warning system. In the next section, the present conditions of disaster and disaster preparedness are described based on the information obtained in the field works. The section 10.3 briefs the outline of the proposed plan. The major items discussed herein are the method for prediction, method for warning, the proposed telecommunication system, the configuration of equipments and their performances and construction plan. The proposed plan is phased in three stages with due regard to the socio-economic and technical conditions of the project area. The costs for the implementation are estimated and mentioned in section 10.4. The separate costs are estimated for equipments, construction and implementation, training and operation and maintenance.

In the last section, several recommendations are proposed for effective and smooth implementation of the project.

10.2 Disaster and Disaster Preparedness

10.2.1 Disaster

Disaster concerned to this Sabo and flood control project has been flood inundation, mud/debris flow and storm surge. They are brought to the project area by typhoon and monsoon accompanying torrent heavy rainfall and strong wind.

Rainfall with high intensity in the mountain slope turned to be a flood with high peak and flushed into river channels. The channel slopes are as steep as more than 5 percent in the mountain slope and 1 percent even at mountain skirt, whereas ones in flat area adjacent to mountain skirt are less than one per mil and the river channels suddenly decrease their flow capacities. In this accord, the flush flood from mountain slope tends to overflow from natural channel and the vast lands are to be submerged by inundation along rivers. Calamities have been recorded as well as damages to houses, road and other structures due to inundation.

Volcanic materials hang on the slopes and gullies of Mayon Volcano. Most of ones in gullies are silting of volcanic product once slided and concentrated thereto. A certain depth of rainfall is liable to cause land slide of the materials on the slope into gullies. It triggers secondary sliding of materials in gullies once silted therein. Mud/debris flow formed in this manner goes down scouring out the river channel bed and channel banks. It spills out from the river channel and spreads wide along the river when it comes down to the area of one to two hundreds meters above mean sea level in altitude. The mud/debris flow widely spread out has caused serious casualties and damages since the areas of these elevation are populated rather densely. Remarkable damages due to mud/debris flow have been experienced repeatedly within a few years after each eruption of the volcano since volcanic materials newly produced and deposited in loose condition.

Strong wind accompanied with tropical storm has caused storm surge. A well developed storm surge has beaten over the sea shore area of the eastern coast of the project area. Storm surge has claimed calamities and damages to fishermans houses, roads and other structures located in these areas.

According to the results of damage analysis, the magnitude of damage due to the typhoon "Daling" for each cause is as follows:

(1) Flood Inundation

Inundation has taken place some sides of most rivers in the project area. The largest area of 12,800 hectar was inundated along the Quinali (A) River. The rivers which caused major inundation damages are as follows;

Quinali (A) River	12,800 ha
Quinali (B) River	3,100 ha
Yawa River	700 ha

As shown on the inundation map, submerged area is concentrated in the downstream reach of the Quinali (A) River. Towns of Legazpi and Municipalities of Daraga, Ligao, Oas, Polangi and Libon were submerged by the inundation; nevertheless these towns are the local center of political, economic, educational and other activities. The casualty record shows that some 100 deads are to be claimed by a flood runoff of similar magnitude with one brought by "Daling" in these river basin.

(2) Mud/Debris Flow

Volcanic materials produced by the recent eruption are piled on the South-East slope of the Volcano. Gullies in this slope are filled with volcanic sand, gravel and boulder. These deposit flowed downward and brought considerable damages to habitants and infrastructures at the passage of typhoon "Daling". Summary of the reported damages are as follows;

i) Quirangay River
Earth-embanked dyke on the left bank was hit by mud/debris flow and partly broken at the upstream from the PNR bridge.

ii) Masarawag River
The old earth dyke on the left bank was attacked and breached. Mud/debris flow damaged provincial road and the barangay of Maninila.

iii) Anuling 1 River
Mud/debris flow damaged the barangay of Salvacion claiming casualties. The provincial road was also damaged.

iv) Budiao River
The provincial road was destroyed.

v) Pawa-Burabod River
The spilled out mud/debris flow hitted the barangays located along the river and casualties (dead) of 18 were reported. The damaged barangays are Mabinit, Bonga, Burabod and Buyuan.

Casualties (dead and missing) of some 60 persons are reported in barangays in the mountain slope area of Mayon Volcano attributable to the typhoon "Daling". It should be specially noted that the evacuation activities were behind time since the disasters occurred in the mid night and peoples did not acknowledge the warning disseminated through public radio broadcast.

(3) Storm surge

Storm surge has brought casualties and damages to houses, roads and other infrastructures in coastal area. People in seashore in the following towns have been subject to storm surge; Legazpi City, Sto. Domingo, Bacacay and Tabaco.

10.2.2 Disaster Preparedness

The activities to prevent and mitigate disasters are to be conducted by various authorities which organize the Disaster Coordinating Counsel (DCC) in respective level. National and Regional DCC act covering 9 fields whereas DCC of barangay level covers 11 fields of activities as shown in the Main Report. Each authority is assigned to respective field. Respective DCC is chaired by General, Governor, Mayor and barangay captain. OCD acts as the secretariat of DCC.

Members of DCC are assigned to prepare equipments, material and manpower against impending disaster to mitigate damages. It is understood that the well advanced information and accurate forecasts are extremely useful to make the activities of DCC effective.

Information on an approaching typhoon is to be sent to the OCD Central Office in Manila from the PAGASA Central Office in Manila. The same information is to be sent to the OCD Regional Office in Legazpi either from the PAGASA Legazpi Office or the OCD Central Office.

The record of route and the forecasted route of the typhoon and the wind velocity are included in the information but rainfall is not included.

Communication between the OCD Central Office and Regional Office is carried out through specific SSB system and telephone of PLDTS.

The SSB communication line tends to be disturbed after 8:00 p.m. in the evening by wave of public radio broadcasting since the frequencies are close each other and power level used by the SSB is low. Furthermore, the PLDTS stops its service at 9:00 p.m. Accordingly the communication between the OCD Central and Regional Offices encounter difficulties in the night time frequently inspite of their 24-hour services.

Warning to various offices and public are disseminated from the OCD basing on the information provided by the PAGASA or the COMVOL through existing all available media including public radio broadcasting. The Regional Offices of the PAGASA and the COMVOL are also entitled to announce warning to the public with the approval of their respective Central Offices.

The PAGASA established the Bicol River Basin Flood Forecasting System in December 1980 as shown in the Main Report. Data obtained at telemeterized observation stations located mainly in the downstream area from Lake Bato have been sent to the National Flood Forecasting Center in Manila. The observed are hourly rainfall and water level at respective station. Warning has been disseminated to the people from the regional PAGASA and OCD based on the acquired data.

Dikes have been constructed along rivers and gullies mainly by MPWH as a structural measure of disaster mitigation. The left bank dike in the Pawa Burabod River functioned well at typhoon "Daling" and protected a part of barangays Bonga and Pawa from mud/debris flow. However, the disaster at Mabinit was caused by shifting the course of the mud/debris flow upstream the existing confining dike on the right bank at the Provincial Road.

MPWH has a plan to construct the Sabo works on the Pawa Burabod, the Nasisi and other rivers. The works are planned in the emergent Sabo works level and there remain some possibilities that mud/debris flow of these rivers may cause disasters even after the completion of works.

Earth-embanked road dike and concrete-lined boulder dikes have been constructed along various rivers to protect towns and buildings by MPWH and other authorities concerned. The works are effective and considerable areas have been protected from inundation. The works have been designed based on the recorded flood water level and are considered in emergency works level. Accordingly there still remain the possibilities of inundation in some part of the project area.

Several evacuation centers have been established in each municipalities. The Ministry of Education and Culture is a member of DCC and school buildings are to be provided as evacuation centers. Buildings selected as the evacuation centers are situated in rather high land in the area. And they are conceived to be safe against mud/debris flow, flood and storm surge. The evacuation centers in the respective municipalities are as follows:

Legazpi City	:	Bonga, Mabinit and Gogon
Daraga	:	Malabog, Busay and Daraga
Camalig	:	Camalig, Ilawod and Bariw
Guinobatan	:	Guinobatan
Ligao	:	Tuburan and Ligao
Oas	:	Oas
Libon	:	Libon
Polangui	:	Polangui
Tabaco	:	Bantayan, Quinastillohan, San Antonio, Panal and Tabaco
Bacacay	:	Hindi and Bacacay
Sto. Domingo	:	San Fernando and Sto. Domingo

PAGASA, Legazpi has installed SSB system and has exchanged information with its Central Office in Manila. Thus nation-wide typhoon information have been available in Legazpi City.

COMVOL has observed the activity of the Volcano at the Rest House and Sta. Misericordia. Both observatories are facilitated with SSB and the communication network is established among both observatories and the head office in Manila.

10.3 Disaster Prediction and Warning System

10.3.1 Method of Prediction

Mud/debris flow, flood inundation and storm surge are the principal direct causes of disaster to be studied in this project area. They claim casualties of dead, missing and injury not only economic damages. Accordingly it is concluded that the planned system should serve to predict the occurrence of these causes with sufficient advanced time to avoid casualties.

The causes mentioned above are brought by a torrent and heavy rainfall and strong wind. Only tropical storm is the cause of strong wind which brings storm surge to the project area.

Heavy rainfall which causes mud/debris flow and flood inundation is brought by tropical storm and the South-West monsoon. Heaviest have been recorded when typhoon has fallen on monsoon. Rainfall as a consequence of continuous ascending current during volcanic eruption is also liable to cause mud/debris flow even if the intensity thereof is not high since the erupted volcanic materials are piled on the steep mountain slope in uncemented condition.

Most of main rivers keep high water stages in rainy season. Flood water tends to spill out from river channel if a flood of high peak from a steep sloped tributary flushed into main river which is already in bank full condition. In this connection, the water level at downstream reaches is the most important contribution factor to designate the flow capacity of river at the relevant time.

In this respect, the gathering of data and information on the following items is assigned to the planned prediction system;

- i) Rainfall in the project area, especially in the slope of Mayon Volcano.
- ii) Nation-wide rainfall information for approaching tropical storm.
- iii) River water stages at relevent sites.

iv) Velocity and direction of stormy wind for approaching tropical storm.

v) Volcanic activities during eruptive period.

The method to predict each cause is described in the next paragraph.

(1) Mud/Debris Flow

Usually there is no spare time to keep the records in good condition in disastrous period. And it is very rare that accurate data of disaster is available. However the accurate rainfall records are available because the rainfall recorders of the Legazpi weather station and the Ligao gaging station functioned well when typhoon "Daling" passed the project area. The heavy rainfall attributable to the typhoon "Daling" was received from late evening to night on June 30, 1981. Peoples in the barangays affected by mud/debris flow remember well the situation of the disaster. The mud/debris flow occurred at 8 o'clock in the evening on June 30, 1981 at first in each river almost simultaneously and continued for 2 to 3 hours with certain interruptions. The cumulative rainfall depths are 145 and 135 mm at this time at the Ligao and Legazpi observatories respectively. The hourly rainfall intensities at the antecedent two hours of 6 and 7 o'clock are 65 and 55 mm at the Ligao gaging station whereas 33 and 63 mm at the Legazpi gaging station. It should be specially noted that the figures mentioned above coincide with the critical rainfall commonly acknowledged in Japan. In Japan, rainfall with intensities of 20 mm per 10 minutes or 50 mm per hour and a rainfall depth of 150 mm are understood to be critical for mud/debris flow. With this regard mud/debris flow is planned to be forecasted through rainfall observation and the installation of telemeterized rainfall gaging stations is proposed at the following sites;

COMVOL Mayon Rest House, Quirangay, Mabinit and Tabaco (EL. 300 m), San Roque, Legazpi Golf, Micericordia, Balaigang, Masarawag, Legazpi Weather Station and Nasisi.

(2) Flood Inundation

The runoff caused by a rainfall with 2-year reccurrance interval has spilled out from some sides of river channel. If the relations between the rainfall and runoff are studied and runoff models are established, the magnitude of flood and inundation is able to be estimated applying the rainfall data to the runoff model. It should be noted that the sites subject to inundation damages are located in the downstream reaches of Quinali (A), Yawa and Quinali (B) Rivers. And accordingly there is certain lag time between the time a stormy rainfall is observed and the time an inundation takes place at the flood prone area. The total lag time can be divided into the time of concentration and the travelling time of flood wave. The available data are limited and tentative lag time is arbitrarily estimated for each major river as follows;

River	Time of Concentration at	Time of Concentration Hour	Travelling Time From	Travelling Time To	Travelling Time Hour	Total Lag Time
Quinali(A)	Nasisi	1.0	Nasisi	Libon	1.5	2.5
Yawa	Culiat	1.0	Culiat	Yawa Bridge	0.5	1.5
Quinali(B)	Bantayan	1.0	Bantayan	Balza	1.0	2.0

The inundation at the downstream reaches can be predicted by advancing at least this lag time applying the observed rainfall data at the proposed stations to the established runoff model. In other words, if a heavy rainfall, say one exceeding the 2-year rainfall, is observed at the proposed Anuling or Matanag gaging station, it can be said that an inundation will occur with respective magnitude at Legaspi city 1.5 hours later. Further, the magnitude of flood depends also on the initial water stage at the relevant site and local inflow or runoff from the remnant catchment area. Accordingly the data on water stages at relevant sites and rainfall data at remnant catchment areas are indispensable to provide an accurate prediction of flood inundation.

In this respect, following telemeterized gaging stations are proposed besides ones proposed in the previous paragraph for the disaster prediction and warning system;

Rainfall gaging station ;	(Ligao) and Libon	
Water level gaging station;	Yawa River;	Culiat dam and Yawa bridge
	Quinali A ;	Guinobatan, Polangi, Oas and (Lake Bato)
	Quinali B ;	Bantayan and Balza Bridge
Combined rainfall and water level gaging station; Nasisi		

The parenthesized stations mean the modification of the existing stations for the Bicol River Basin Flood Forecasting and Warning System.

(3) Storm Surge

Almost all storm surges are brought by the tropical storm accompanying strong wind. The location and the forecasted track of movement are obtained by the PAGASA Central Office as well as the wind velocity for each storm in the Philippines Area of Responsibility. The weather station of Legazpi can predict the future change of wind direction availing the information described above. For this purpose, the communication system between the PAGASA Manila Central Office and the PAGASA Legazpi (Weather Station) Office should be improved and up-graded from the existing simple SSB system.

According to the hydrological analysis, the location and track of eye movement and the month of occurrence of tropical storm are the comination factors for the magnitude and intensities of stormy rainfall. Typhoon which passed the project area from south-east to north-west has brought the heaviest rainfall to the area. And the highest rainfall intensity has been experienced in the project area when the eye of typhoon was located at 500 to 700 kilometers south-east of the Legazpi City. However, typhoon which took courses from south-east to north-east or south-east to south-west has brought little rainfall in and around the project area. The facts imply that the additional rainfall in the future can be predicted at respective time with certain reliability if the course of approaching typhoon is predicted. In other word, 2-year rainfall or cumulative rainfall of 100 mm is to be predicted some hours before they are actually received.

In this connection, data communication system between the PAGASA Central Office and the Legazpi City is proposed in addition to the voice communication system mentioned above. To obtain higher accuracy, it is considered to be most effective to exchange data with the Bicol River Basin Flood Forecasting System to refer the information to predict the rainfall in the project area.

10.3.2 Method of Warning

Warning for impending disaster is to be disseminated from Regional OCD to the relevant offices and inhabitants. DCC of respective level is to be organized to integrate and to make effective the disaster prevention works of various offices upon the first warning from OCD. Offices, member of DCC, act in line with the disaster preparedness plan basing on the warning. Inhabitants prepare for evacuation and flood protection. The detailed warning method for each disaster is proposed as follows;

(1) Mud/Debris Flow

With due regard to the records of rainfall and mud/debris flow, the tentative critical rainfall is designated as proposed hereunder. In this designation, the experiences in Japan were also referred. (For gaging stations specified in 10.3.1 for mud/debris flow)

(a) Cumulative rainfall depth of 60 mm.
(b) Cumulative rainfall depth of 80 mm.
(c) Hourly rainfall intensity of 50 mm.
(d) Rainfall intensity of 20 mm per 10 minutes.

Warning of respective level will be disseminated mainly based on these critical rainfall as follows;

(Level 1) A warning signal should be automatically transmitted from the supervisory control unit of the proposed system to the PAGASA weather station and Regional OCD Office in case critical rainfall (a) is observed in and around the Mayon Volcano. The PAGASA and OCD should observe rainfall in the adjacent period with care. Similar activities should be taken in case the Regional OCD or the PAGASA weather station received typhoon information that a tropical storm have entered the Philippines area of responsibility.

(Level 2) In case a critical rainfall (b) is observed, the PAGASA and OCD should disseminate the warning (level 2) to offices and inhabitants in the relevant area. In this case, actions should be taken by the offices which are assigned for the evacuation aspects. People can stay home but should prepare to evacuate. And everybody should be ready to listen the next warning with careful attention.

(Level 3) In case a critical rainfall (c) or (d) is observed after the critical rainfall (b), the OCD should disseminate the warning (level 3) to offices and inhabitants in the relevant area. In this case, all the offices concerned should take actions in line with the command from DCC. People should start to evacuate to the relevant evacuation center and should wait for the next instruction from the DCC.

(2) Flood Inundation

With due regard to the records of rainfall, flood and inundation, the following were designated as the critical conditions for inundations. (For gaging stations specified in 10.3.1)

(a) 2-year hourly rainfall.
(b) 5-year hourly rainfall.
(c) Water level corresponding to 1.5-year flood discharge.

(Level 1) In case the critical condition (c) is observed, the MPWH, the NWRC and other offices concerned should observe the fluctuation of the water level with care. The installed data processing unit carry out simulation through the runoff models for relevant sites. And if the flood magnitude is estimated to exceed one with 2-year return period, warning (level 2) should be disseminated. And if not, actions should be taken by only the offices which are assigned for the evacuation aspects. People can stay home but should prepare to evacuate. And everybody should be ready to listen the next warning with careful attention.

(Level 2) In case critical conditions (a) and (c) is observed, the OCD should disseminate the warning (level 2) to offices and inhabitants in the relevant area. All the offices concerned should take actions in line with the command from DCC. People should start to evacuate to the relevant evacuation center and should wait for the next instruction from the DCC.

(Level 3) In case critical conditions (b) and (c) is observed, the actions of offices concerned should be in full swing. People should evacuate without delay giving the first priority to protect their lives.

(3) Storm Surge

Storm surge is attributable to tropical storm which is to be observed by international organization. The OCD should be facilitated to be able to obtain the information on the approaching typhoon. The OCD should disseminate appropriate warning to the offices and public in collaboration with the PAGASA.

The critical conditions mentioned above are tentative and should be examined in the adjacent stage of study. Expecially the information on tropical storm should be amalgamated to make the warning more effective.

The warning station sites are proposed as follows;

Legazpi Area;	Legazpi OCD, Governmental offices in the Legazpi City, St. Domingo, Camalig, Daraga, Matanag, Bonga, Mi-Isi, Budiao, Quirangay and Malabog.
Mayon North East Area;	Micericordia (COMVOL), Tabaco, Malinao and Oson.
Ligao Area;	Ligao, Guinobatan, Oas, Libon, San Agustin, Polangui, Nasisi and Masarawag.

Aside from these stations, mobil warning system should be installed to reinforce the transmission of warning to the areas wherein no warning stations is to be provided.

10.3.3 Stagewise Development

It is desirable to implement the proposed system in three stages with due regard to the practical conditions of the project implementation. In this respect, following stagewise developments are proposed as hereunder;

Stage	Stations for Prediction	Stations for Warning	External Information Station
First Stage	Legaspi weather station (R) Mayon Resthouse Mabinit Quirangay Tabaco (300 m)	OCD, Legazpi Office, Matanag Ligao Libon	PAGASA Legaspi, PAGASA Manila
Second Stage	(R) Ligao, Nasisi Libon, (W) Bato	Barangays other than the above. Tabaco Micericordia	OCD Legazpi, OCD Manila PAGASA Legazpi, PAGASA Manila
Third Stage	Water level other than the above (V) Micericordia	-	-

Note; (R) Rainfall observatories
(W) Water level observatories
(V) Volcanic observatories

In addition to the stations described above, 4 warning mobil units should be prepared in Legazpi and each 2 units in Ligao and Tabaco.

10.3.4 Design of Communication System

Communication systems to be constructed by this Project are threefold as described hereunder. Route maps of these systems appear in the Main Report. Meanwhile, this study is mainly the map study so that, at the time of Project implementation, necessary field tests including the propagation test must be carried out in order to examine the degree of radio interference from the existing radio stations.

(1) 150 MHz Band Radio System (for temporary system)

The 150 MHz band radio system is to be constructed for telemeter signal transmission between the rainfall/water level observatory and the base station to be established in each area.

Hop by hop profile maps are given in the attached "Profile Maps" as shown in ANNEX. As is evident in those maps, all hops command good visibility and allows radio propagation in favorable condition. At all stations, the antenna height of less than 20 m is considered to be sufficient.

At LegaZpi radio station alone, the antenna height must be less than 10 m because the station is located close by the airport.

Noise performance in each radio hop is given in TABLE-X.1 to TABLE-X.7.

(2) 400 MHz Band Radio System (for warning system)

The 400 MHz band radio system is to be constructed for voice signal transmission between the warning station and the base station to be established in each area. All base stations are designed to permit them to be co-used as base stations of the 150 MHz band radio system.

Hop by hop profile maps appear in the attached "Profile Maps" as shown in ANNEX. All hops are free from propagational problems. The hop between Legaspi radio station and Comaring requires mountain diffraction propagation which, however, does not affect the system performance adversely.

Noise performance in each radio hop is given in TABLE-X.8 to TABLE-X.15.

(3) 800 MHz Band Radio System (for multiplex radio system)

The 800 MHz band radio system is to be constructed for voice signal and telemeter signal transmission between the base station in each area and the warning center at Legazpi.

Capacity of this radio system is for 24 telephone channels. This system, designed as a backbone system, is to be capable of high quality telephone service.

Hop by hop profile maps and noise performances appear in the attached "Profile Maps" as shown in ANNEX and TABLE-X.16, respectively. No trouble is seen in the aspect of system performance.

The telephone channel accommodation plan in this 800 MHz band radio system is illustrated in the Main Report.

The distance between Legazpi radio station as a base station in Legazpi area and Legazpi weather station where the meteorological observation center is to be established is short. Therefore, in this section, a transmission route by cable is scheduled.

For 800 MHz band radio system between Naga (camarigan) radio station constructed in the Bicol River Basin Project and Ligao radio station to be constructed by this Project, the study of system design is omitted. The reason is the lack of maps available. However, by establishing a radio repeater station newly between Naga radio station and Ligao radio station, any foreseeable propagational problem can possibly be prevented.

10.3.5 System Configuration and Function (Equipment)

Equipment required in the implementation of this Project can be classified into four major categories. They are telemetry system equipment, warning system equipment, multiplex communication system equipment and HF radio communication system equipment. Station by station equipment installation configurations are described in the Main Report and equipment lists are in TABLE-X.17 to TABLE-X.23. A summary of required equipment is as follows:

(1) Telemetry System Equipment

i) Equipment to be installed at Meteorological Observation Center

(a) Telemetering Supervisory Equipment

This equipment is to be installed for the purpose of supervising and control of equipment installed at each observatory station. The supervisory and control function of this equipment can cover 20 stations. By means of installing additional units, the equipment function can be increased to cover a maximum of 30 stations.

This equipment records basic data, such as rainfall per hour and cumulative total rainfall, as well as river water level changes. When the rainfall and water level change beyond the predetermined limit, the equipment gives alarms.

(b) Operating Console

This operating console makes each observatory station supply the required data periodically or as occasion dictates.

(c) Display Equipment

The display equipment is of wall type and digitally indicates rainfall and water level data supplied from each observatory station. Indicated data includes the time of observation (year, month, day and hour) and the name of station concerned. This equipment can make data indications covering 20 stations.

(d) CVCF Power Supply Equipment

This equipment supplies AC power to the loads without momentary interruption in the event of commercial power failure. The equipment input is AC 220 V and the output is AC 100 V. The equipment capacity is planned to be 5 kVA.

This equipment contains the built-in rectifier, storage battery, inverter, AVR, etc. The storage battery holding time is about 10 minutes, i.e., up to the time the standby motor generator starts.

ii) Equipment to be installed at Weather Station

(a) Rain Gauge

The rain gauge is planned to be the tipping bucket type. This rain gauge has the rain bucket that tips once every time the rainfall reaches 1 mm so that the rainfall can be measured by the number of bucket tippings. Messured data is sent through telemetering equipment to the meteorological observation center.

(b) Water Gauge

The well type water gauge is planned to be adopted. The water gauge of this type has its defect in that the water pipe is apt to be stopped up with silt; however, if the water pipe is well maintained, the gauge itself seldom suffers trouble.

(c) Telemetering Equipment

This equipment converts rain gauge and water gauge data into F/S signal and sends out such signal to the transmitter. The equipment also detects control signal supplied from the meteorological observation center and, at the same time, supplies necessary data to the meteorological observation center.

(d) Radio Equipment and Antenna

Radio equipment frequency is of 150 MHz band. For transmitter output, either 10 W, 3 W or 1 W is to be selected. The transmitter output must be determined, based on the propagation test result. In this study, the selection is for 10 W, allowing for some margin.

For radio frequency of 150 MHz band, a relatively large antenna element is required. When the antenna is installed on the mountain side, the wind pressure that is imposed on the antenna is supposed to be considerably heavy. Therefore, in the relatively short distance section, the use of sleeve antenna is planned.

For the selection of antenna type and radio frequency also, investigation must be made as to whether the radio frequency of 150 MHz band is already used at the site or not, in order to so arrange as to prevent radio interference.

(e) Shelter

The rainfall observation station is established in many cases on the remote mountain side or the like. For this reason, the construction of station building where to install equipment is considered to take much time. Hence, the station building is planned to be the shelter type.

(f) Solar Cell Power Supply System

For power supply system to rainfall and water level observation stations, the solar cell power supply system is planned to be adopted. This is because at those stations the power consumption is extremely limited and in many cases the commercial power supply is not available.

The solar cell capacity is set as such level that can endure for about one month without sunshine, as in the rainy season.

(2) Warning System Equipment

i) Equipment to be installed at Legazpi Warning Center

(a) MCA Control Equipment

Communication traffic between Legazpi warning center and warning stations to be established in municipalities and barangays is considered to be extremely small except during disaster prevention/relief activities in the typhoon season. Hence, for communication system, multi channel access (MCA) system is planned to be adopted.

MCA system holds noteworthy merits. Chief among them are the effective use availability for radio frequency spectrum and the system construction cost economy on account of the reduced requirement of radio equipment at base stations. For, MCA system allows warning stations in the area to co-use radio channels though, in some cases, all channels may be occupied, forcing the stations to wait until idle channel is found.

MCA control equipment is to control radio channels that are co-used.

When an emergency situation breaks out, exceptional traffic growth is anticipated between the specific warning station and the warning center. To cope with such traffic growth effectively, it is so arranged that the manual switchboard be established for priority handling of emergency communication by means of controlling other non-urgent calls.

Normally, for communication between the warning center and warning stations and between warning stations themselves, the dial system can serve.

(b) Mobil Control Equipment

Communication between warning station and mobile station and between one mobile station and another is conducted via base station to be established in the area.

The mobile control equipment is to control radio equipment of the base station.

(c) Telephone Exchange Equipment

With telephone exchange equipment installed, dial system communication between warning stations themselves and between the warning center and warning stations becomes possible.

For trunk lines, 3 channels are to be accommodated at Legazpi R/S, 3 channels at Ligao R/S and 2 channels at Mayon Rest House. Extension lines total 30.

As a means of emergency communication, the manual switchboard establishment is planned as aforementioned.

(d) Remoto Supervisory and Control Equipment

Both Legazpi R/S and Ligao R/S are unattended stations though Mayon Rest House is not. Remote supervisory and control equipment is for remote supervising of the operating condition of equipment installed at those unattended stations.

ii) Equipment to be installed at Legazpi R/S, Ligao R/S and Mayon Rest House

(a) Radio Equipment for MCA System

This equipment frequency is of 400 MHz band. The transmitter output is set at 5 W. However, as in the case of radio frequency of 150 MHz band, the study of radio interference with the existing 400 MHz band system, as well as the field propagation test, must first be carried out before final decision of frequency band, transmitter output, antenna type and so forth.

(b) Radio Equipment for Mobil System

This equipment frequency is of 150 MHz band. The communication system is the simplex system. The transmitter output is set at 10 W because the communication is with vehicles.

iii) Equipment to be installed at Warning Station

(a) Radio/Control Equipment

This equipment is composed of radio equipment and control units. Control units are for radio channel selection. For antenna, the use of Yagi antenna is planned.

(b) Power Supply Equipment

The most part of municipalities and barangays where warning stations are to be established hold access to commercial power supply. Floating system power supply equipment is planned to be adopted in order to cope with traffic growth successfully.

Each warning station is not to be equipped with standby motor generator. Instead, portable motor generator is to be transported from Legazpi, Ligao or Tabaco in case the commercial power failure continues for a long time.

(3) Multiplex Radio Communication System

This communication system is to be constructed on the warning center - Legazpi R/S - Ligao R/S - Mayon Rest House route and Ligao R/S - Naga (Camarigan) R/S route. These systems can transmit a maximum of 24 telephone channels. Channel accommodation plan for each of the abovementioned routes appears in the Main Report.

Radio equipment frequency of 800 MHz band and transmitter output of 5 W are planned to be used.

Power supply system is of floating system. This is because commercial power supply is available at all stations and because the radio system is to be operated around the clock.

(4) HF Radio Communication System

HF radio equipment is to be installed at Manila PAGASA, Manila OCD, Legazpi meteorological observation center, Legazpi OCD and Virac radar station.

i) Radio Equipment

For radio equipment, frequency range is set at 2.0 MHz - 18.0 MHz.

Transmitter output is set at 150 W (PEP) for A3J, A3A and A1 models and 40 W (carrier) for A3H model.

Input power is DC 24 V.

ii) Antenna

For Manila - Legazpi section, log periodic type antenna is to be used at both stations.

For Legaspi - Virac section, 3-band dipole type antenna is to be used at both stations.

(5) Principal Features of the Project

i) Disaster Prediction and Warning System

In this project, disaster prediction and warning system stations and radio system are as follows.

(a) Meteorological Observation Stations

First Stage

- Legazpi	Meteorological Observation Center (Legaspi Weather Station)
- Quirangay	rainfall gauging station
- Mabinit	"
- Mayon Rest House	"
- Tabaco (300 m)	"
- San Roque	"
- Legazpi Golf	"
- Micercordia	"

Second Stage

- Libon	rainfall gauging station
- Bato	water-level gauging station (Existing)

- Ligao	rainfall gauging station (")
- Nasisi	"
- Balaigarg	"
- Masarawag	"

<u>Third Stage</u>

- Culiat	water-level gauging station
- Yawa Bridge	"
- Guinobatan	"
- Oas	"
- Polangui	"
- Nasisi	"
- Bantayan	"
- Balza Bridge	"

(b) Warning Facilities

<u>First Stage</u>

- Legazpi	warning center
- Legazpi	government office warning station
- Legazpi	" "
- Matanag	warning station
- Libon	"
- Ligao	"
- Mobile	warning stations
	Four vehicles at Legazpi warning center
	Two vehicles at Ligao warning station
	Two vehicles at Tabaco "

<u>Second Stage</u>

- Darage	warning station
- Camalig	"
- Malabog	"
- Budiao	"
- Quirangay	"
- Mi-Isi	"
- Bonga	"

- Micercordia	"
- St. Domingo	"
- Malinao	"
- Oson	"
- Tabaco	"
- Guinobatan	"
- Oas	"
- San Agustin	"
- Polangui	"
- Nasisi	"
- Masarawag	"

(c) Radio System

<u>Radio System for Meteorological Observation (150 MHz Band Radio System)</u>

<u>First Stage</u>

Legazpi R/S	- Quirangay	rainfall gauging station
"	- Mabinit	"
"	- Legazpi Golf	"
"	- San Roque	"
"	- Micercodia	"
Mayon Rest House	- Tabaco (300 m)	"

<u>Second Stage</u>

Ligao R/S	- Libon	rainfall gauging station
"	- Bato	water-level gauging station
"	- Ligao	rainfall gauging station
"	- Nasisi	"
"	- Balaigarg	"
"	- Masarawag	"

<u>Third Stage</u>

Legazpi R/S	- Culiat	water-level gauging station
"	- Yawa Bridge	"
Ligao R/S	- Guinobatan	"
"	- Oas	water-level gauging station

Ligao R/S	- Polangui	"
"	- Nasisi	"
Mayon R/S	- Bantayan	"
"	- Balza Bridge	"

Radio System for Warning Facilities
(400 MHz Band Radio System)

First Stage

Legazpi R/S	- Matanag	warning station
"	- Legazpi	government office
"	- Legazpi	"
Ligao R/S	- Libon	warning station
"	- Ligao	"

Second Stage

Legazpi R/S	- Darage	warning station
"	- Camalig	"
"	- Malabog	"
"	- Quirangay	"
"	- Budiao	"
"	- Mi-Isi	"
"	- Bonga	"
"	- Micercordia	"
"	- St. Domingo	"
Mayon Rest House	- Malinao	"
"	- Oson	"
"	- Tabaco	"
Ligao R/S	- Guinobatan	"
"	- Oas	"
"	- San Agustin	"
"	- Polangui	"
"	- Nasisi	"
"	- Masarawag	"

Radio System for Warning Mobile (150 MHz Band Radio System)

First Stage

Legazpi R/S	- Four vehicles	for Legazpi area	
Ligao "	- Two	"	for Ligao area
Mayon "	- Two	"	for Tabaco area

Trunk Radio System (800 MHz Band Radio System)

First Stage

Legazpi Warning Center	- Legazpi R/S
Legazpi R/S	- Ligao R/S
Ligao R/S	- Mayon Rest House

Second Stage

Ligao R/S	- Repeater Station
Repeater Staton	- Naga (Camarigan) R/S

HF Radio System

First Stage

Manila PAGASA	- Legazpi Meteorological Center

Second Stage

Manila OCD	- Legazpi Warning Center
Legazpi Warning Center	- Virac Radar Station

10.3.6 Construction Plan

This Project is to be performed in three stages as shown in the construction time schedule (refer to the Main Report).

Participation of fully experienced Consultant in the project implementation is desirable from the viewpoint of smooth progress of construction work. Considering that this Project comprises construction not only of meteorological observation system but also of various kinds of emergency-use communication facilities, experience in the conventional meteorological observation system construction only will not be fully subservient.

As shown in the construction time schedule, detailed design and tender specifications must first be completed before the commencement of construction work. If these requirements are filled for each stage independently, the lack of consistency in overall planning may be unavoidable.

On the other hand, when such requirements are satisfied on bloc at the first stage, the station site selection can also be settled and will expedite the commencement of station building construction in and after the second stage. Especially the construction of water level observation stations is possible in the dry season only. Actually, this construction is often retarded, causing the whole project implementation to lag fatally behind schedule.

From the foregoing viewpoint, it is essential that the whole detailed design be completed at the first stage.

As stated in Section 10.3.5, investigations concerning radio routes mainly consist of the map study. Therefore, when detailed design is made, radio interference to/from the existing radio system must be carefully examined. If necessary, propagation tests must also be carried out. And, based on the findings in such examination and tests, the radio frequency band to be adopted must be determined.

10.3.7 Project Implementation Plan

The implementation plan for the disaster prediction and warning system is divided into three stages as earlier stated.

Presently in Legazpi area, the disaster prediction and warning system does not exist. Hence, for the maintenance/operation of the system to be newly established, the maintenance system must be organized without delay and, at the same time, the training of maintenance personnel must also be hastened.

To complete the disaster prediction and warning system in a specified period as a crash program is not realistic. In the first place, the maintenance system organization requires careful consideration. In the second, the construction of water level observatory buildings takes considerable time. Thus, for an alternative, the project implementation by stages in accordance with the degree of urgency of disaster prediction and warning is planned.

With regard to the system construction, the employment of consultant is scheduled, and this is for the purpose of smooth progress of construction work.

The execution of construction is on international competitive contract base. The construction of station buildings for other than shelter type stations is to be undertaken by the Filipino authority in charge of this Project.

Work schedule at each implementation stage appears in the Main Report.

(1) First stage

Construction in the first stage is the facilities most urgently required for disaster prediction and warning. Those facilities are the necessary minimum number of rainfall observatories, meteorological observation center, warning stations and warning center. In the first stage work schedule, the HF communication system between the Legazpi PAGASA and Manila RAGASA will be upgrade.

i) Meteorological Observation Center

The meteorological observation center is to be established at Legazpi. This center analyzes data supplied from observatories in different places and, when danger is anticipated, gives alarm to the warning center which is described in item iii) below. The optimum place where to locate the center is Legazpi weather station. However, for want of floor space in the station, the station building extension is necessary.

ii) Rainfall Observatory

Rainfall observatories, one each in the first to fourth quadrants, are to be established, centering upon Mayon Volcano, for the purpose of silt discharge forecast. All observatory buildings are to be the shelter type because, in this case, the construction period can be reduced.

iii) Warning Center

The warning center is to be established at Legazpi. This center is to issue evacuation advice to municipalities and barangays where disaster is anticipated and to instruct countermeasures when disaster actually takes place.

The optimum location of the center is in Legazpi OCD building. In this building, however, necessary floor space for the center is not available. Furthermore, building strength is not appropriate for the center. Thus the center must be located at another site.

iv) Warning Stations

Warning stations are to be established in municipalities and barangays where disasters are foreseen. The stations are to relay disaster warning to inhabitants.

At the first stage, warning stations are scheduled to be constructed at Matanag, Ligao and Libon where disaster potential is especially great.

Other warning stations than the above are also to be established in government organizations in Legazpi. These warning stations are to maintain contact between the warning center and those governmental organizations when disaster takes place. Such warning stations are to be established at two out of all governmental organizations in Legazpi.

v) Warning Mobile

Forwarding of alerts, including evacuation advice, from the warning station to inhabitants in the area concerned is difficult because inhabitants are widely scattered. For this reason, vehicles with announcement speaker and radio equipment mounted aboard are to be assigned on duty in Legaspi City, Ligao and Tabaco.

Those Vehicles are used for forwarding alerts to inhabitants and for reporting damage and casualties to the warning center. Four vehicles are to be provided at Legazpi and two each at Ligao and Tabaco.

vi) HF Radio Equipment Renewal

Presently, at Legazpi weather station and Manila PAGASA, HF radio equipment is installed for exchange of information. However, that equipment is obsolete; furthermore, outside radio interference is frequent. Service is far from being satisfactory.

To save such situation, radio equipment and antenna facilities are to be renewed.

vii) UHF/VHF Radio Stations

To connect each observatory and meteorological observation center and to connect each warning station and warning center, UHF/VHF radio stations are to be established.

(2) Second Stage

Constructions in the second stage are rainfall observatories and water level observatories whose main purpose is to make flood forecasts, and warning stations to watch for silt discharge and tidal waves. Upgrading of HF radio system is also included in the second stage work schedule.

i) Rainfall Observatory

Rainfall observatories mainly for flood forecasting are to be established at Ligao, Nasisi and Libon.

ii) Water Level Observatory

Presently, at Lake Bato, water level observatory exists. This observatory was constructed as part of the Bicol River Basin Flood Forecasting and Warning System. Data collected at this observatory is transmitted to Manila PAGASA via UHF radio route.

Lake Bato water level observation is important for flood forecasting in Lake Bato environs. Therefore, it is so planned, this time, that Lake Bato water level observation data is supplied not only to Manila PAGASA but to meteorological observation center at Legazpi also.

iii) Warning Stations

Warning stations scheduled to be constructed at the second stage are as follows:

(a) Legazpi Area: Daraga, Camaling, Malabog, Quirangay, Mi-Isi, Bonga and St. Domingo

(b) Ligao Area: Guinobatan, Oas, San Agustin, Polangui, Nasisi and Masarawag

(c) Mayon North East Area: Malinao, Oson and Tabaco

iv) HF Radio Equipment Renewal

Presently, at Manila OCD, Legazpi OCD and Virac radar station, HF radio equipment is installed for exchange of information among these points. However, all the equipment is obsolete. Therefore, the renewal of radio equipment and antenna facilities is scheduled.

v) UHF Radio Station

Construction of telecommunication system by UHF radio system is scheduled. This is to connect to the system to be constructed by this Project and the existing Bicol River Project System so as to realize more extensive flood forecasting and warning system.

The scheduled UHF radio system is to connect Ligao radio station to be constructed by this Project and the existing Naga (Camarigan) radio station constructed by Bicol River Project. When this UHF radio system is completed, Manila PAGASA and Legazpi meteorological observation center can partake of stable communication service at all times.

(3) Third Stage

Construction in the third stage is planned to be the water level observatories.

(a) Legazpi Area: Culiat and Yawa Bridge

(b) Ligao Area: Guinobatan, Oas, Polangui and Nasisi

(c) Mayon North East Area: Bantayan and Balza Bridge

10.3.8 Project Cost

Project cost for the dasaster prediction and warning system at each construction stage and the cost estimates appear in TABLE-X.17 to TABLE-X.19.

The disaster prediction and warning system project cost of each stage is summarized as follows:

	Foreign Currency Portion (Yen)	Local Currency Portion (Peso)
Stage I	1,335,497,000	2,186,000
Stage II	455,436,000	1,260,000
Stage III	190,273,000	502,000
Total	1,981,206,000	3,948,000

This project cost is calculated by the following conditions:

(a) Construction of disaster prediction and warning system is to be carried out on international competitive bidding. The undermentioned work items are to be taken care of by the Philippines authority in charge of this Project.

- Station site land procurement, ground leveling and fencing
- Access road, land procurement and road construction
- Station building extension and construction, except shelter type station buildings
- Legazpi R/S - communication cable installation
- Commercial power drop-in to station site

(b) Project cost is to be quoted at the price level as of mid-1982.

(c) Construction of disaster prediction and warning system is to be divided into three stages in consideration of the degree of urgency of countermeasure, as well as the maintenance and operation system.

(d) For work cost of local currency portion, the following exchange rates are to be used:

US$1 : P8.0

US$1 : ¥240

(e) All equipments and materials are to be exempt from domestic tax and duty of the Philippines.

(f) Project cost breakdown by foreign currency portion and local currency portion follows:

Foreign currency portion:

- Radio equipment, carrier terminal equipment, power supply equipment, tower, antenna, telemetering equipment, rain gauge, water gauge, publicity car, other equipment

- Equipment shelter
- Construction materials cost and work cost
- Sea transportation and insurance cost
- Training and operation/maintenance guidance
- Consultant fee

Local currency portion:
- Cost of inland transportation to station site
- Work cost