(3) Spur dike and Jetty

Spur dike and jetty are defined as masonry levees constructed obliquely to the direction of the river course. Arrangement of them can not only increase natural sand retarding capacity, but also control the direction of mud/debris flows.

The proposed Sabo facilities are designed as a massive types. These facilities are able to withstand or resist the forces induced by heavy mud/debris flow and the maintenance cost will not be high against the mud/debris flow. While, the flexible type structures such as gabions and mattresses will be applicable only to selected sites where the mud/debris flow will not affect directly.

The typical engineering designs of each kind of Sabo facility mentioned above is shown in FIG.-7.3.3 to FIG.-7.3.11. In this study dimensions of typical design of these faclities are given. However, the actual dimensions should be determined considering the change in river bed conditions before the constructions, since fluctuation of rivers originating in Mayon Volcano is very notable.

7.3.7 Sediment Control Plan and Sabo Facilities Arrangement Plan

Sediment control plan is made to reduce sediment yield and to check or retard sediment runoff by the proper arrangement of Sabo facilities. And it finally aims at reducing the amount of sediment runoff to the allowable sediment volume at base points as much as possible. The sediment control plan and Sabo facilities arrangement plan for the respective rivers are described as follows.

(1) Quinali (A) River Basin

Six (6) rivers are selected the same as the Master Plan in the Quinali (A) River basin.

i) Quirangay River

One (1) slit type Sabo dam fixes the unstable sediment and checks sediment runoff in the upper reaches, and training levee is constructed to protect Camalig from mud/debris flows and sediment flows. The capacity of natural sand retarding basin is increased with four (4) spur dikes (Type A). These Sabo facilities are arranged as shown in FIG.-7.3.12 and the sediment runoff at the base point is reduced from 260,100 m^3 to 39,900 m^3. The sediment runoff volume at the base point with the facilities becomes less than the allowable sediment volume of 82,600 m^3. The river profile is shown in FIG.-7.3.20.

ii) Tumpa River

The consolidation works with coconut trunk fence are planned at sixteen (16) sites as shown in FIG.-7.3.13 to mitigate the river bed and side erosion. The sediment runoff is reduced from 43,700 m^3 to 26,900 m^3 with the works, and it becomes less than the allowable sediment volume of 35,200 m^3.

iii) Maninila River

As shown in FIG.-7.3.14, the consolidation works with ground sills are planned at nine (9) sites to mitigate secondary river bed erosion. The sediment runoff volume at the base point is reduced from 94,000 m^3 to 42,600 m^3 with the works, which is more than the allowable sediment volume of 36,700 m^3. However, as the excess of 5,900 m^3 is regulated by sand retarding function of consolidation works.

iv) Masarawag River.

In the upper reaches, the sediment runoff and yield is reduced by one slit type Sabo dam. Four (4) spur dikes (Type A) are arranged to increase the sand retarding capacity and to help to form the main course along the east course as shown in FIG.-7.3.15. The river profile is shown in FIG.-7.3.21.

The sediment runoff is consequently changed the form into bed load from mud/debris flow, and the amount of the sediment runoff is reduced to 59,500 m^3. It becomes less than the allowable sediment volume of 77,600 m^3.

v) Ogsong River (Nabonton Creek)

As shown in FIG.-7.3.16, six (6) spur dikes (Type A) and seven (7) jetties are arranged in the upstream reaches to increase the function of natural sand retarding and seven (7) ground sills with cribs are arranged downstream of Provincial Road. The sediment runoff volume is reduced from 140,500 m^3 to 31,300 m^3. It is less than the allowable sediment volume of 32,700 m^3. The river profile is shown in FIG.-7.3.22.

vi) Nasisi River

Considering the conditions of before and after typhoon "Daling", it is found to be important for the Nasisi River to reduce and retard the sediment runoff and yield in the upper reaches. Therefore, two (2) consolidation dams and three (3) ground sills are arranged in the upper reaches in order that sediment runoff as mud/debris flow may be changed into bed load condition. In the downstream river, the intake weir of NIA functions as a consolidation dam. Consequently, the sediment runoff volume at the base point is reduced from 992,100 m^3 to 278,400 m^3, which is slightly over the allowable sediment volume of 270,900 m^3. However, the excess is regulated by the natural retarding function just downstream the base point. These Sabo facilities arranged are shown in FIG.-7.3.17. The river profile is shown in FIG.-7.3.23.

PRINCIPAL FEATURES OF PROPOSED SABO FACILITIES
FOR THE QUINALI (A) RIVER

Name of River	Proposed Works	Scale of Works	Remarks
Quirangay	Sabo Dam (Slit type)	Height: 10.0m Length: 30.0m	
	Training Levee	Length: 310m	On the left bank
	Spur Dike (Type B)	At four (4) sites Total length: 990m	On the left bank
Tumpa	Consolidation (with coconut fence)	At sixteen (16) sites Total length: 160m	Drop: 1.0~2.0m
Maninila	Ground sill (Type B)	At nine (9) sites Total length: 450m	
Masarawag	Sabo Dam (Slit type)	Height: 10.0m Length: 120m	
	Spur Dike (Type A)	At four (4) sites Total length: 910m	
Ogsong	Spur Dike (Type A)	At six (6) sites Total length: 1,200m	
	Jetty	At seven (7) sites Total length: 560m	
	Ground Sill (with crib)	At seven (7) sites Total length: 260m	Drop: 2.0~3.0m
Nasisi	Consolidation Dam	At two (2) sites Total length: 430m	with spur dike
	Ground Sill (Type A)	At three (3) sites Total length: 690 m	with spur dike

(2) Yawa River Basin

Four (4) rivers are selected in the Yawa River basin, namely, the Anuling 1, the Anuling 2, the Budiao and the Pawa-Burabod Rivers. Since the Anuling 1 River and the Anuling 2 River have the same base point in common, the Sabo plan for these two rivers is described together.

i) Anuling River

One (1) Sabo dam and two (2) ground sills and training levee are arranged to protect Anuling from mud/debris flow coming from the upper reaches of the Anuling 1 River.

In the upper reaches of the Anuling 2 River, one (1) Sabo dam and two (2) spur dikes (Type A) are arranged. Four (4) spur dikes (Type A) and one (1) spur dike (Type B) are arranged downstream the confluence of these two rivers. Finally, the sediment runoff volume at the base point is reduced to 17,200 m^3 by the above Sabo facilities arranged as shown in FIG.-7.3.18. It becomes less than the allowable sediment volume of 85,800 m^3. The river profile is shown in FIG.-7.3.24 and FIG.-7.3.25.

ii) Budiao River

As shown in FIG.-7.3.18, one (1) Sabo dam, training levee, three (3) spur dikes (Type A) and one spur dike (Type B) are arranged to reduce the sediment runoff and to control the direction of mud/debris flows, from the upper reaches to the down reaches. The river profile is shown in FIG.-7.3.26.

Consequently, the sediment runoff volume at the base point is reduced from 234,600 m^3 to 54,400 m^3 which is less than the allowable sediment volume of 58,100 m^3.

iii) Pawa-Burabod River

One (1) Sabo dam and one (1) consolidation dam are arranged in the upper reaches. Four (4) spur dikes (Type A) and three (3) spur dikes (Type B) are arranged in series from the middle to the down reaches to retard the sediment and to control the direction of mud/debris flows. These facilities are arranged as shown in FIG.-7.3.19. The river profile is shown in FIG.-7.3.27.

Consequently, the sediment runoff at the base point becomes the only bed load of 69,500 m^3 in volume.

PRINCIPAL FEATURES OF PROPOSED SABO FACILITIES FOR THE YAWA RIVERS

Name of River	Proposed Works	Scale of Works	Remarks
Anuling	Sabo Dam (Slit type)	Height: 10.0m Length: 60.0m	Anuling 1
	Ground Sill (A)	At two (2) sites Total length: 210m	One is attached with spur dike
	Training Levee	Length: 600m	On the right bank Anuling 1
	Sabo Dam (Slit type)	Height: 10.0m Length: 70.0m	Anuling 2
	Spur Dike (A)	At two (2) sites Total length: 540m	"
	Spur Dike (A)	At four (4) sites Total length: 860m	Downstream of the confluence
	Spur Dike (B)	At one (1) site Total length: 480m	"
Budiao	Sabo Dam (Slit type)	Height: 10.0m Length: 90.0m	
	Training Levee	Length: 400m	On the left bank
	Spur Dike (A)	At three (3) sites Total length: 760m	
	Spur Dike (B)	At one (1) site Total length: 400m	
Pawa-Burabod	Sabo Dam (Slit type)	Height: 10.0 m Length: 80.0 m	
	Consolidation Dam	Height: 4.0 m Length: 120 m	
	Spur Dike (A)	At four (4) sites Total length: 1,000 m	
	Spur Dike (B)	At three (3) sites Total length: 750 m	

7.3.8 Construction Plan and Schedule

To provide the construction plan and schedule of the Sabo Project, local conditions, available equipment and materials, construction method in Albay, working rules, etc. are taken into consideration. The Sabo Project will be performed by selected Philippine contractors through a competitive bidding, since the Sabo facilities are planned and designed as a simple structure. The Sabo works will be conducted by yearly program according to the Philippine's budget, and re-assessment and review of the Sabo planning due to the devastation and fluctuation of river bed in future.

(1) Construction Schedule

i) Engineering Services and Tendering Time

Engineering services consist of the works of services for the detailed survey and design, tendering and contract awarding, and the construction supervision.

The detailed survey and design for the first year program (1983) are conducted by the JICA Study Team by the end of March 1983. However, the technical specifications and tender documents will be provided by the MPWH. Tendering time which comprises advertisement for tender and prequalification is scheduled to be started from the beginning of April 1983. After the tender closing, the tender evaluation, negotiation and contract awarding will be done by the end of June 1983.

Prior to the construction of Sabo facilities planned on each yearly program, the detailed survey and design, tendering and contract will be made in the preceding year.

ii) Construction Period and Target

The construction period required for the proposed implementation program of the Sabo Project is estimated at 8 years, of which early 5 years are Stage-I construction period and later 3 years are Stage-II construction period. The construction is scheduled to be commenced at the beginning of July 1983. The construction schedule is shown in FIG.-7.3.28 and the major construction works involved in each yearly program is stated below.

iii) Construction Time Schedule

The construction works are divided into eight (8) yearly programs considering the priority, effectiveness and urgency of the Sabo facilities in the tributaries, and the Philippine's budget schedule.

(a) First Year (1983)

The detailed design conducted by the JICA Study Team and the preparation of tender documents prepared by the Philippine Government will be completed by the end of March 1983.

The compensation and land acquisition for the first year construction works will be executed by the MPWH in advance of the commencement of the contract.

Upon completion of contract awarding, the construction works will be commenced immediately.

The Sabo facilities of the first year program are as follows: Anuling River (No.1 Sabo dam, No.1 ground sill, No.3 spur dike and No.4 spur dike); Pawa-Burabod River (No.5 spur dike and No.6 spur dike).

The detailed survey and design and preparation of tender document for the second year program will be made by the end of 1983 in parallel with the construction of the first year.

(b) Second Year (1984)

Upon completion of contract awarding for the second year construction works at the beginning of 1984, the construction of No.2 spur dike in the Quirangay River, No.3, No.4 and No.7 spur dikes in the Pawa-Burabod River, will be commenced. No.1 Sabo dam and No.3 spur dike in the Anuling River, No.5 spur dike in the Pawa-Burabod River will be constructed continuously.

The detailed design, preparation of tender documents and contract awarding for the third year program will be finished by the end of 1984.

(c) Third Year (1985)

After completion of the construction of the first and second year program and contract awarding for the third year construction works, the construction of No.3 and No.4 spur dikes in the Quirangay River, No.2 consolidation dam in the Nasisi River, No.1 training levee, No.1, No.2 and No.5 spur dikes in the Anuling River, No.1 consolidation dam in the Pawa-Burabod River, will be commenced.

The engineering services and contract awarding for the fourth year program will be completed by the end of 1985.

(d) Fourth Year (1986)

The construction of No.1 spur dike in the Quirangay River, No.2-No.4 spur dikes in the Masarawag River, No.2 ground sill in the Anuling River, No.4 spur dike in the Budiao River, No.1 Sabo dam in the Pawa-Burabod River, will be commenced.

No.2 consolidation dam in the Nasisi River, No.1 training levee in the Anuling River, No.1 consolidation dam in the Pawa-Burabod River will be constructed subsequent to the third year construction.

The engineering services and contract awarding for the fifth year program will be completed by the end of 1986.

(e) Fifth year (1987)

The construction of No.1 training levee in the Quirangay River, No.1-No.3 ground sills, No.1 Sabo dam and No.1 and No.2 spur dikes in the Anuling 2 River, No.3 spur dike in the Budiao River, No.1 and No.2 spur dikes in the Pawa-Burabod River, will be commenced.

No.2-No.4 spur dikes in the Masarawag River, No.1 Sabo dam in the Pawa-Burabod River will be constructed subsequent to the fourth year construction.

The engineering services and contract awarding for the sixth year program will be completed by the end of 1987.

(f) Sixth Year (1988)

The construction of No.1 Sabo dam in the Quirangay River, No.1 spur dike in the Masarawag River, No.1 consolidation dam in the Nasisi River, No.1 Sabo dam, No.1 and No.2 spur dikes in the Budiao River, will be commenced.

No.1-No.3 ground sills in the Nasisi River, No.1 Sabo dam in the Anuling 2 River, No.3 spur dike in the Budiao River will be constructed subsequent to the fifth year construction.

The engineering services and contract awarding for the seventh year program will be completed by the end of 1988.

(g) Seventh Year (1989)

The construction of No.1 Sabo dam in the Masarawag River, No.1-No.6 spur dikes and No.1-No.7 jetties in the Ogsong River, No.1 training levee in the Budiao River, will be commenced.

No.1 Sabo dam in the Quirangay River, No.1 consolidation dam in the Nasisi River, No.1 Sabo dam in the Budiao River will be constructed subsequent to the sixth year construction.

The engineering services and contract awarding for the eighth year program will be completed by the end of 1989.

(h) Eighth Year (1990)

The construction of the remaining Sabo facilities which comprise consolidation fence in the Tumpa River, ground sill in the Maninila River, ground sill in the Ogsong River, will be made in 1990. No.1 Sabo dam in the Masarawag River and No.1-No.6 spur dikes in the Ogsong River will be constructed simultaneously.

(2) Construction Plan and Method

The construction works of the Sabo Project are planned on the basis of the mode of construction and construction schedule abovementioned. Taking into consideration, in addition to the above, the local conditions such as availability of local construction forces, weather condition, site geological and topographic conditions, construction method in the Philippines is applied in principal.

With regard to the workable day, it is assumed to be 220 days per year and one 8 hours shift per day is applied, considering the working rules in the Philippines.

Prior to the construction works of the Sabo facilities, the preparatory works such as access roads, temporary buildings, temporary facilities, etc. will be made.

The concrete works for the Sabo dam and consolidation dam will be executed through the rainy season and dry season considering the weather condition. Constructing the Sabo dam and consolidation dam, special river diversion and care of river are not required and flood discharge in rainy season will overflow the dam during construction. The dam is designed to be a rubble concrete and will be placed at 0.50 m/lift, in consideration of the capacity of available portable batching and mixing plant.

Spur dike, jetty, ground sill and training levee are to be constructed as an embankment protected by wet masonry. The embankment materials and rubble stone of wet masonry are to be supplied from river deposit. The concrete of foot protection will be placed by a light concrete mixer.

7.4 Disaster Prediction and Warning System Plan

7.4.1 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 injured not only economic damages. Accordingly it is concluded that the planned system should serves to predict the occurrence of these causes well in advance to avoid casualties.

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

Heavy rainfall which causes mud/debris flow and flood inundation is brought by tropical storm and the South-West monsoon. Heaviest has been recorded when typhoon has fallen on monsoon. Rainfall as a consequent 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 one of the most important contribution factors to designate the flow capacity of river at the relevant time.

In this respect, the gathering data and information on the following items are 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 relevant 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 are 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. People 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 are planned to be forecasted through rainfall observation, and the installation of telemeterized rainfall gaging stations are 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 reccurrence interval spilled out from some sides of river cannel. 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		Travelling Time			Total Lag Time
	at	Hour	From	To	Hour	(hr)
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 Bridge	1.0	2.0

The inundation at the downstream reaches can be predicted 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 Legazpi 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 gauging station;	Yawa River; Culiat dam and Yawa bridge
	Quinali (A); Guinobatan, Polangui, 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 surge are brought by the tropical storm accompanied by 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 hydrologic analysis, the location and track of eye movement and the month of occurrence of tropical storm are the dominating factors for the magnitude and intensities of stormy rainfall. Typhoon which passed the project area from south-east to north-west has brought heaviest rainfall to the project. 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. Whereas, 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 predict at respective time with certain reliability, if the course of approaching typhoon is predicted. In other words, 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.

7.4.2 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 Section 7.4.1 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 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 has 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 is assigned the evacuation aspects. People can stay home but should prepare to evacuate. And everybody should be ready to listen to the next warning with careful attention.

(Level 3) In case a critical rainfall (c) or (d) is observed after 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 the area to proceed 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 Section 7.4.1.)

(a) 2-year hourly rainfall
(b) 5-year hourly rainfall
(c) Water level corresponds 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 carries 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 is assigned the evacuation aspects. People can stay home but should prepare to evacuate. And everybody should be ready to listen to 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 the area without delay giving the first priority to protect ones life.

(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. Especially 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 station is to be provided.

7.4.3 Design of Communication System

Communication systems to be constructed by this Project are threefold as described hereunder. Route maps of these systems appear in FIG.-7.4.1 and FIG.-7.4.2. Meanwhile, this study is mainly the map study. 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 is to be established in each area.

Hop by hop profile maps are given in the Supporting Report II. As is evident in those maps, all hops command good visibility and allow radio propagation in favorable condition. At all stations, the antenna height of less than 20 m is considered to be sufficient.

As for Legazpi radio station, the antenna height must be less than 10 m because station is located close to the airport.

Noise performance in each radio hop is given in the Supporting Report II.

(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 Supporting Report. All hops are free from propagational problems. The hop between Legazpi radio station and Camalig requires mountain diffraction propagation which, however, does not affect the system performance adversely.

Noise performance in each radio hop is given in the Supporting Report.

(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 Supporting Report. 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 FIG.-7.4.1.

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. Howerver, by establishing a radio repeater station newly between Naga radio station and Ligao radio station, any foreseeable propagational problem can possibly be prevented.

7.4.4 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 in FIG.-7.4.2 to FIG.-7.4.5. Detailed equipment List is presented in the Supporting Report II. 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 15 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 hourly rainfall and cumulative total rainfall, as well as river water level changes. When the rainfall and water level changes beyond the predetermined limit, the equipment issues alarms.

(b) Operating console

This operating console makes each observatory station supply 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 include 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. Measured data are 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 and works effectively.

This water gauge uses the float to detect the water level variation and makes variation data processing by means of analog/digital converter, and sends processed data through telemetering equipment to the meteorological observation center.

(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 1W 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 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 at 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, letting the stations to wait until an 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 is 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) Remote 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 FIG.-7.4.5.

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 Legazpi - 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 (Legazpi Weather Station)
- Quirangay	rainfall gauging station
- Mabinit	"
- Mayon Rest House	"
- Tabaco (300 m)	"
- San Roque	"
- Legazpi Golf	"
- Micericordia	"

Second Stage

- Libon	rainfall gauging station
- Bato	water-level gauging station (Existing)
- Ligao	rainfall gauging station (")
- Nasisi	"
- Balaigang	"
- Masarawag	"

Third Stage

- Culiat	water-level gauging station
- Yawa Bridge	"

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

(b) Warning Facilities

First Stage

- 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 warning station

Second Stage

- Daraga	warning station	- Guinobatan	warning station
- Camalig	"	- Oas	"
- Malabog	"	- San Agustin	"
- Budiao	"	- Polangui	"
- Quirangay	"	- Nasisi	"
- Mi-Isi	"	- Masarawag	"
- Bonga	"		
- Micericordia	"		
- Sto. Domingo	"		
- Malinao	"		
- Oson	"		
- Tabaco	"		

(c) Radio System

Radio System for Meteorological Observation (150 MHz Band Radio System)

First Stage

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

Second Stage

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

Third Stage

Legazpi R/S	- Culiat	water-level gauging station
"	- Yawa Bridge	"
Ligao R/S	- Guinobatan	"
"	- Oas	"
"	- 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	- Daraga	warning station
"	- Camalig	"
"	- Malabog	"
"	- Quirangay	"
"	- Budiao	"
"	- Mi-Isi	"
"	- Bonga	"
"	- Micericordia	"
"	- Sto. 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 Station	- 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

7.4.5 Construction Plan

This Project is to be performed in three stages as shown in the construction time schedule (FIG.-7.4.6 to FIG.-7.4.8.)

Participation of fully experienced Consultant in the project implementation is desirable from the viewpoint of smooth progress of construction work. Because, 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 only at each stage independently, the lack of consistency in overall planning may be unavoidable.

On the other hand, when such requirements are satisfied en 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 is completed at the first stage.

As stated in Section 7.4.4, 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 adopt must be determined.

7.5 Cost Estimate

7.5.1 Sabo Project

(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 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 account.

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

The basic conditions applied for the cost estimates are presented below:

(a) Price level: Prices are based on current prices for labor, materials and equipment as of Mid-1982.

(b) Exchange Rate: Ruling exchange rate used in this estimate is 1.0 US Dollar = 8.0 Pesos = 240 Japanese Yen.

(c) Work Quantity: Work quantities are calculated from the preliminary design and presented on the Detailed Cost Estimates.

(d) Tax and Duties: On the financial construction cost, unit prices are estimated on the basis of the current prices in the Philippines adding tax and duties for imported materials and equipment.

(e) Material Cost: All construction materials are to be supplied by the contractor mainly from local markets. It is based on the price in Albay in 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.

(f) Labor Cost: Direct daily wages of local labor applied to the construction cost are estimated based on the wages in Albay in Mid-1982. The labor cost estimated does not include any daily overtime and overtime for Sunday and Holiday.

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

(2) Construction Cost

Financial construction cost estimate is made based on the MPWH estimate 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 estimate procedures are as follows:

i) Contract Cost

- Direct cost includes the direct cost of materials, labor and equipment expences as shown in the unit price breakdown on the Detailed Cost Estimates. The cost of labor is estimated at the sum of direct labor, leaves, SSS/GSIS, medicare and state insurance.

- General cost for this estimate includes mobilization and demobilization, vehicles, field office, access road and other temporary works. General cost is taken as 10 per cent of the direct cost.

- Supervision and miscellaneous items for the contractor are estimated at the rate of 5 per cent and 1 per cent of the sum of direct cost plus general cost respectively.

- 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.

- Contractor's tax is estimate at 3 per cent of the amount abovementioned.

ii) 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 P 1,800 per hectare.

iii) Engineering Cost

- Engineering cost which is 10% of the contract cost includes topographic surveys, 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 servces of the Philippine's consultant under the Project Management Office. The consultancy services of the overseas consultant engineer is described in Section 7.6 and this cost is also estimated tentatively.

iv) Project Management Cost

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

v) Contingency

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

- 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; Occurrence of unforeseen condition due to natural phenomena; Exactness of estimate of construction period.

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

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

vi) Total Construction Cost

The total construction cost of the Sabo Project is estimated at P305.9 million, of which P78.8 million is the foreign currency portion and P227.1 is the local currency portion as shown in TABLE-7.5.1. The cost of price escalation over the 8-year construction period (1983 to 1990) is taken into account in the cost estimate and is calculated based on the construction cost disbursement schedule. The construction cost for each construction stage is summarized below.

	Foreign Currency Portion (1,000 Pesos)	Local Currency Portion (1,000 Pesos)
Stage-I	43,964	117,532
Stage-II	34,809	109,549
Total	78,773	227,081

The construction cost disbursement schedule is estimated based on the Philippine's budget (Investment Requirement, CY 1983-1987, Flood control and Drainage). The disbursement schedule is listed in TABLE-7.5.2. The construction period will require 8 years in this study. The disbursement schedule from 1988 to 1990 is calculated based on the Philippine's 1987-budget. In addition, the economic cost and the disbursement schedule are presented in TABLE-7.5.3 and TABLE-7.5.4. Detailed cost estimates is listed in the Supporting Report II.

(3) Operation and Maintenance Cost

The annual operation and maintenance cost of the Sabo Project is estimated at P950 thousand on the basis of mid-1982 prices and 0.5 per cent of the construction cost excluding the price escalation.

7.5.2 Disaster Prediction and Warning System

Project cost for the disaster prediction and warning system at each construction stage and the cost estimates appear in TABLE-7.5.5 to TABLE-7.5.7.

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

This project cost is calculated by the following conditions.

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

- Station site land procurement, ground levelling 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. The exchange rate used is 1.0 US Dollar = 8.0 Pesos = 240 Japanese Yen. All equipments and materials are to be exempted from domestic tax and duty of the Philippines.

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

Foreign currency portion:
- Radio equipment, carrier terminal equipment, power supply equipment, tower, antenna, telemetering equipment, rain gauge, water-level 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

7.6 Project Implementation

7.6.1 Sabo Works

(1) Executing Agencies

The Ministry of Public Works and Highways (MPWH) will have overall responsibility for the implementation of the Sabo Project. Prior to the commencement of the implementation activities, the MPWH will create and/or establish an adequately staffed and well-equipped Project Management Office under the Office of the Minister, with the MPWH Regional Office in assisting capacity. The Project Management Office will be responsible for all designs and construction of the Project. It will be headed by a Project Manager, to be appointed by the MPWH, who will be assisted by a Project Engineer, who will also be the MPWH staff member, and full-time experienced staff engaged by the MPWH.

FIG.-7.6.1 presents overall project organization chart.

(2) Implementation Schedule

The construction of whole Sabo Project will take 8 years, including detailed survey and design, tendering and contract awarding, and the necessary preparatory works. The construction of the Project will be made by two stages, since early 5-years Sabo works will be implemented in view point of the importance and urgency of the Sabo facilities for preventing the direct disaster due to mud/debris flow, and later 3-years Sabo works will be implemented as a river basin management. The construction of the Project will be commenced in middle-1983 and will be completed by the end of 1990 as shown in FIG.-7.3.28, Construction Time Schedule. The construction schedule will be prepared based on the following consideration; the annual cash flow as stipulated in the Philippine's budget for the Sabo Project, the importance and urgency of each Sabo facility.

Detailed construction schedule and annual Sabo facilities to be constructed is presented in Section 7.3.8.

(3) Land Acquisition

The Ministry of Public Works and Highways has given the assurance that it will acquire all lands, right-of-way, easement, licences and other rights and privileges including water rights, all of which are required for implementation of the Project and operation of the Project facilities, well in advance to avoid delay in the implementation of the Project.

(4) Mode of Construction

Taking into account the Philippine's contracts for civil works, the similar flood control projects, local contractors, availability of materials and equipment, the construction works will be carried out by the contract basis with local contractors under the supervision of the Project Management Office.

(5) Operation and Maintenance

After the completion of the construction of the Project, the operation and maintenance will be transferred to and managed by the MPWH Regional Office, V.

(6) Consulting Services

Consulting services will be required to assist MPWH and the PMO for effective implementation of the Project. Consultants will be engaged by MPWH in the Philippines, to provide the following services: technical assistance and consultative services in the interpretations of detailed design including topographic survey, plans, specifications, tender documents and construction supervision of the project.

Except the above consulting services conducted by Philippine consultant, a few foreign consulting engineer of expatriate Sabo engineering services is desirable to assist the MPWH and the PMO and to advice the Philippine consultant during implementation stage. If the consultant engineers can be engaged by MPWH, they assist in: formulation of a detailed plan for the Sabo facilities arrangement; advice on a detailed design for each Sabo facilities; review of a detailed implementation schedule; the training of the PMO personnel. Engaging the foreign consultant engineers, the cost of engineering service will be added in the financial construction cost. The cost for the foreign consultant engineer is estimated as follows, on the assumption that required man-month is 48 man-months (2 men x 12 months x 2 years) in early implementation stage.

COST OF ENGINEERING SERVICES (YEN)

1. Remuneration	
(1) Field services (48 M/M)	105,600,000
2. Direct Cost	
(1) International Travel Cost	
i) Air Fare (¥220,000 x 8 trips)	1,760,000
ii) Excess Baggage Charge	
(¥1,400 x 20 kg x 8 trips x 2 times)	448,000
(2) Perdiem and Subsistence Allowance	
(¥16,000 x 30 days x 48 M/M)	23,040,000
3. Contingency (10% of 1 & 2)	13,085,000
Total	143,933,000

7.6.2 Disaster Prediction and Warning System

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

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 completed in time.

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 will be required, 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 Philippine's authority in charge of this Project.

Work schedule at each implementation stage appears in FIG.-7.4.6 to FIG.-7.4.8.

(1) First stage

Construction in the first stage consists of 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 PAGASA will be upgraded.

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, issues alarm to the warning center (which is described in item iii). 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, more than 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 governmental 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 Legazpi city, Ligao and Tabaco.

Those vehicles are used to forward alerts to inhabitants and to report 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

Construction in the second stage consists of 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, Camalig, Malabog, Quirangay, Mi-Ishi, Bonga and Sto. 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 planned.

v) UHF Radio Station

Construction of telecommunication system by UHF radio system is scheduled. This connects the system to be constructed by this Project with 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 with the existing Naga (Camarigan) radio station of Bicol River Basin Flood Forecasting and Warning System. When this UHF radio system is completed, Manila PAGASA and Legazpi meteorological observation center can partake 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

7.7 Project Evaluation

7.7.1 General

Economic evaluation is made on the basis of "with and without project principle" as well as the evaluation on the re-study of master plan. The direct and indirect benefits attributable to the project is defined as the change of the economic and socio-economic conditions with and without the project. "Without project" condition in this study is assumed as the condition that no improvement works are undertaken. All the benefits and costs are valued as of 1982 and exchange rate of US$1 = P8.0 is used in this study.

Financial evaluation is also conducted to the assessment for repayment of the project construction cost. In succession, construction fund requirement is estimated for the implementation of the project, taking into account the price escalation to be expected during the construction period. Repayment analysis is made on the basis of the expected direct revenue and the estimated fund requirement with the assumed terms of the finance.

In addition, project evaluation is made taking into consideration the intangible benefit and social impact induced through the implementation of the project.

7.7.2 Economic Evaluation

Project benefits in the project area are the expected reduction of damage to houses, rehabilitation cost of palay field covered by mud/debris, re-transplanting cost and production loss of coconut damaged by mud/debris flow and cost of relief goods and medical assistance. These benefits are presented in TABLE-4.3.1 and TABLE-5.6.10 and summarized in TABLE-7.7.2. In addition, the reduction of sediment runoff volume as mentioned in section 7.3.7 can be evaluated for project benefit. Owing to sediment runoff from the foot of Mayon Volcano, unexpected river improvement works for flood control such as river dredging will be required under future condition without the flood control and Sabo projects. The sediment runoff reduction benefit is presented in TABLE-7.7.1.

The annual project benefit under full development stage is estimated at P 5.06 million and most of this project benefit is produced from the first construction stage.

Economic construction cost for the project is estimated taking into consideration tax to be deducted and contractor's profit for the construction cost. The total economic construction cost is estimated at P 152 million and annual O&M cost is P 949 thousand as shown in TABLE-7.7.2. As for the first construction stage, the total economic construction cost and annual O&M cost are estimated at P 93 million and P 580 thousand, respectively.

In order to estimate the economic internal rate of return, the benefit and cost stream is prepared as shown in TABLE-7.7.3, and a result of estimation is given in FIG.-7.7.1. As shown in this figure, economic internal rate of return for the full construction stage of the Sabo project is estimated at 0.9%. In case of the only first construction stage, on the other hand, it is estimated at 3.5%. As a result of economic evaluation based on the tangible benefit, economic viability of this Sabo project is not so attractive, though it is technically sound. However, this project will be justified by the intangible and social benefits described in section 7.7.4.

7.7.3 Financial Evaluation

Fund requirement for the project construction is estimated on the basis of the disbursement schedule of the project cost and expected cost escalation. The rate of cost escalation is estimated at 7.0% per annum for foreign currency portion and 13% per annum for local currency portion during the construction period.

Estimated fund requirement is P305.9 million as shown in TABLE-7.5.1. Based on this estimated fund requirement, cash flow statement are prepared under assumption of the following financial conditions.

Foreign currency portion:

Financed by bilateral or international organization with interest rate of 3.5% per annum and repayment period of 25 years including grace period of 6 years.

Local currency portion:

Financed by the budget allocated of the Government with no interest and no repayment.

In the cash flow statement as shown in TABLE-7.7.4, the operation and maintenance cost and loan repayment will be subsidized by the Government.

7.7.4 Project Assessment

The need of this project will be justified through the assessment of intangible and social benefits as mentioned below. Furthermore, the Sabo project at the foot of Mayon Volcano will be important for the implementation of the flood control plan at the middle and lower reaches of the Quinali (A) and the Yawa Rivers.

1) Stabilization of People's Livelihood

According to the information from the DCC and COMBOL, people at the foot of Mayon Volcano has suffered large damage from mud/debris flows. In recent damage, 1,428 houses and 264 ha of agricultural land were damaged due to mud/debris flow caused by typhoon "Daling" in 1981. The implementation of the Sabo project will contribute to stabilization of the people's livelihood.

2) Protection of Human Life

The mud/debris flow in 1981 also caused serious damage to invaluable human lives which are estimated at 52 persons as shown in TABLE-7.7.5. The injured by this flow reached more than 100 persons. These casualties will be largely reduced by the implementation of the project.

3) Social and Mental Stabilization

The mud/debris flow occurs suddenly and presents a disastrous scene after its damage. The people's living at the foot of Mayon Volcano has been exposed to a menace of such mud/debris flow and this situation will produce a bad effect on their social and mental stabilization.

In addition to the above intangible and social benefits, it became clear, through the field interview survey in 1982, that there is a strong request for the Sabo project from the people exposed to a menace of mud/debris flow.

7.7.5 Evaluation of Warning system

Although project benefits induced through the implementation of warning system include a few direct and indirect benefits, the major part consists of intangible benefits such as protection against loss of life, social stabilization, etc. which are difficult to be quantified. The project benefit produced by the warning system will be considered as follows.

1) The wind damage to houses will be reduced by the warning to people.

2) If large floods come, the safe and smooth evacuation of people will be carried out by the warning system.

3) The warning of typhoons before coming to the area will produce a good result to social and mental stabilization of people.

4) The effective relief activities by the authorities concerned will be expected by the communication line of warning system.

5) The damages due to flood and mud/debris flow will occur during the construction period of flood control and Sabo facilities. However, these damages will be minimized by the effective warning activities.

TABLES

TABLE-3.2.1 LIST OF TYPHOONS AFFECTING THE PROJECT AREA

Year	Name of Typhoon	Occurrence Date
1970	Atang	Feb. 23 - Feb. 27
	Yoning	Nov. 17 - Nov. 20
1971	Herming	May 25 - May 27
1972	Konsing	Jan. 23 - Jan. 26
1973	Luming	Oct. 2 - Oct. 9
1974	Bising	Jan. 8 - Jan. 11
	Iling	Jun. 22 - Jul. 2
	Tening	Oct. 14 - Oct. 17
	Aning	Nov. 4 - Nov. 7
1976	Huaning	Jun. 22 - Jul. 2
1977	Unding	Nov. 10 - Nov. 17
1978	Atang	Apr. 18 - Apr. 26
	Weling	Sept.24 - Sept.28
	Yaning	Oct. 7 - Oct. 14
	Kading	Oct. 25 - Oct. 29
1979	Bebeng	Apr. 13 - Apr. 19
	Etang	Jun. 30 - Jul. 1
	Pepang	Sept.16 - Sept.20
	Yayang	Nov. 4 - Nov. 7
1980	Nitang	Jul. 19 - Jul. 22
	Osang	Jul. 22 - Jul. 27
	Yoning	Oct. 28 - Oct. 30
	Aring	Nov. 1 - Nov. 7
1981	Yeyeng	Nov. 17 - Nov. 21
	Dinang	Dec. 23 - Dec. 27
	Daling	Jun. 28 - Jul. 2

TABLE-3.2.2 MONTHLY FREQUENCY OF TYPHOONS AFFECTING THE PROJECT AREA

Year \ Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1970		1									1	
1971					1							
1972	1											
1973										1		
1974	1					1				1	1	
1975												
1976						1						
1977											1	
1978				1					1	2		
1979				1		1			1		1	
1980							2			1	1	
1981						1					1	1
Total	2	1	0	2	1	4	2	0	2	5	6	1

TABLE-3.2.3 MONTHLY RAINFALL AT STO. DOMINGO

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Amount
1956	393.4	318.1	401.6	761.4	357.6	111.1	184.7	258.1	515.8	351.7	471.9	989.1	5114.5
1957	449.3	125.2	-	198.1	138.6	154.6	167.2	245.4	210.5	413.4	519.6	301.0	2922.9
1958	432.8	324.7	331.5	124.3	247.4	146.5	206.1	374.6	195.3	847.4	638.9	243.8	4113.3
1959	349.0	329.3	411.9	76.0	241.3	158.5	234.7	128.4	153.0	225.5	603.7	671.8	3583.1
1960	158.4	175.7	99.6	278.5	320.9	-	103.2	191.6	365.4	464.4	648.4	389.1	3195.2
1961	163.0	69.7	148.1	251.3	154.8	187.5	103.3	235.7	163.7	372.7	388.1	342.5	2580.4
1962	310.3	219.1	161.1	134.3	338.2	72.4	229.1	262.0	395.2	141.5	474.3	252.5	2990.0
1963	236.8	361.3	79.3	77.7	166.3	283.6	187.2	552.9	178.7	195.4	482.4	410.3	3211.9
1964	420.8	272.0	110.5	677.8	162.3	162.3	121.7	175.3	489.4	269.5	436.7	719.5	4017.8
1965	473.2	257.4	298.1	148.7	227.3	167.0	397.3	287.6	191.2	473.5	437.6	539.1	3898.0
1966	508.3	157.9	199.5	137.8	156.7	63.4	397.0	98.9	140.6	398.2	-	861.6	3119.9
1967	574.4	239.2	307.0	201.3	60.8	99.9	136.3	237.9	155.4	197.9	676.1	355.7	3241.9
1968	373.9	166.1	157.2	80.7	17.2	51.6	-	218.4	262.5	158.5	360.1	183.2	2029.4
1969	64.8	51.2	94.5	177.7	88.8	97.4	188.2	163.0	254.3	128.8	419.0	655.4	2383.1
1970	331.2	313.4	310.6	262.6	85.4	197.3	209.5	188.9	241.7	649.3	792.4	485.3	4067.6
1971	442.5	461.8	377.6	193.5	430.9	227.6	441.0	114.7	131.2	566.1	448.1	919.0	4754.0
1972	785.2	159.2	328.9	268.5	109.2	260.8	151.2	-	144.3	-	530.4	438.3	3176.0
1973	298.3	130.8	56.2	91.0	102.1	53.3	-	353.0	281.3	566.3	686.4	1249.4	3868.1
1974	-	315.6	122.5	109.6	131.0	356.0	221.9	151.7	158.2	407.3	548.8	605.1	3127.7
1975	344.7	257.1	52.5	537.7	110.8	174.4	245.1	188.3	211.5	200.6	314.7	1280.0	3917.4
1976	669.6	-	434.0	-	304.2	242.0	82.6	343.1	190.7	260.1	-	-	2526.3
1977	351.0	332.8	167.5	209.8	265.1	96.0	-	201.2	360.8	202.2	846.4	272.6	3305.4
1978	-	185.7	237.6	127.1	224.5	231.9	333.7	-	426.2	387.5	375.9	696.4	3226.5
1979	199.1	185.8	64.7	330.6	147.8	311.4	191.9	147.0	397.3	-	533.4	404.9	2913.9
1980	291.4	277.2	301.5	146.9	118.4	587.0	221.8	263.8	228.5	582.8	450.2	625.5	4095.0
1981	536.7	220.4	50.4	165.5	136.6	315.2	279.7	193.3	471.9	684.4	855.6	537.7	4447.4
Total	9158.1	5906.7	5303.9	5768.4	4844.2	4808.7	5034.4	5574.8	6914.6	9145.0	12939.1	14428.8	56415.4
Number	24	25	25	25	26	25	23	24	26	24	24	25	15
Average	381.6	236.3	212.2	230.7	186.3	192.3	218.9	232.3	265.9	381.0	539.1	577.2	3761.0
Maximum	785.2	461.8	434.0	761.4	430.9	587.0	441.0	552.9	515.8	847.4	855.6	1280.0	5114.5
Minimum	64.8	51.2	50.4	76.0	17.2	51.6	82.6	98.9	131.2	128.8	314.7	183.2	2383.1
S.D.	164.5	97.2	127.0	177.9	102.0	119.1	96.2	99.6	120.2	193.8	150.5	298.2	766.1
C.V.	0.4	0.4	0.6	0.8	0.5	0.6	0.4	0.4	0.5	0.5	0.3	0.5	0.2

Note: Hyphen (-) means that data include some interuptions in recording.

S.D. means standard deviation.

C.V. means coefficient of variation.(S.D./Average)

TABLE-3.2.4 MONTHLY RAINFALL AT GUINOBATAN (Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Amount
1956	100.5	-	-	452.1	180.2	136.7	450.6	220.1	-	140.4	376.9	780.0	2837.5
1957	245.8	61.0	79.1	-	-	229.8	273.0	-	254.7	-	251.7	97.8	1492.9
1958	161.7	91.8	93.0	21.1	-	194.8	245.2	269.7	-	881.4	286.4	66.0	2311.1
1959	-	97.3	229.7	35.1	229.5	120.0	303.3	260.7	248.1	340.2	474.5	595.1	2933.5
1960	-	-	-	-	-	-	-	-	-	-	-	-	
1961	15.5	0.	62.8	32.3	224.3	209.5	335.5	254.5	193.5	323.6	169.7	112.4	1933.6
1962	123.3	87.7	113.1	39.8	339.7	356.0	400.8	250.8	338.1	91.0	330.1	77.2	2547.6
1963	12.9	55.5	11.4	15.4	117.6	365.0	153.5	594.6	248.4	194.8	178.5	186.8	2134.4
1964	172.0	65.8	56.9	160.5	50.7	248.7	127.0	168.2	260.4	220.5	269.8	426.5	2227.0
1965	98.3	41.8	22.6	43.7	60.8	143.5	221.1	73.4	110.3	78.9	88.5	109.0	1091.9
1966	269.2	39.1	75.7	30.4	158.7	157.5	331.2	138.1	178.4	-	373.4	573.9	2325.6
1967	423.4	98.7	101.8	77.9	46.6	109.3	320.0	295.4	431.1	172.0	80.2	63.1	2219.5
1968	92.2	75.9	24.6	10.4	-	-	-	-	880.3	-	-	411.3	1494.7
1969	-	98.5	7.6	15.6	70.3	-	329.0	180.8	316.2	82.2	184.0	344.0	1628.2
1970	221.2	189.9	85.3	66.2	43.6	110.6	506.3	376.8	268.5	-	967.8	223.3	3059.5
1971	243.4	-	173.0	73.5	460.4	213.7	429.3	117.7	137.8	401.1	148.9	593.6	2992.4
1972	52.0	366.9	142.3	22.5	152.1	348.2	277.1	367.3	248.2	95.7	230.4	257.4	2560.1
1973	117.9	14.3	23.9	11.2	63.2	171.6	178.5	448.3	254.6	546.9	491.6	746.3	3068.3
1974	63.9	120.5	39.0	78.9	82.5	468.3	99.8	-	-	446.6	370.4	364.2	2134.1
1975	217.8	57.1	9.2	209.3	83.9	162.5	401.4	238.1	253.2	203.5	-	-	1836.0
1976	343.7	86.1	115.4	13.6	534.2	306.1	-	373.7	288.6	202.2	-	598.7	2862.3
1977	105.5	98.7	21.7	57.0	166.3	83.0	418.8	231.0	349.8	8.6	335.5	25.2	1901.1
1978	24.9	12.0	92.4	123.8	156.7	267.5	240.1	300.9	217.4	347.5	65.3	203.9	2052.4
1979	-	-	-	337.4	85.4	118.4	203.9	90.3	116.8	49.4	121.5	139.3	1262.4
1980	48.4	64.1	117.3	8.9	83.5	76.8	-	98.6	82.9	252.5	177.1	-	1010.1
1981	-	111.4	3.8	129.3	207.2	286.6	673.1	186.8	277.8	276.4	669.7	292.2	3114.3
Total	3153.5	1934.1	1701.6	2065.9	3597.4	4884.1	6918.5	5535.8	5955.1	5355.4	6641.9	7287.2	21735.9
Number	21	22	23	24	22	23	22	22	22	21	22	23	10
Average	150.2	87.9	74.0	86.1	163.5	212.4	314.5	251.6	270.7	255.0	301.9	316.8	2173.6
Maximum	423.4	366.9	229.7	452.1	534.2	468.3	673.1	594.6	880.3	881.4	967.8	780.0	3068.3
Minimum	12.9	0.	3.8	8.9	43.6	76.8	99.8	73.4	82.9	8.6	65.3	25.2	1091.9
S.D.	111.1	74.8	58.3	109.5	131.8	104.1	135.2	126.3	159.3	200.4	211.5	233.5	517.8
C.V.	0.7	0.9	0.8	1.3	0.8	0.5	0.4	0.5	0.6	0.8	0.7	0.7	0.2

Note: Hyphen (-) means that data include some interuptions in recording.

S.D. means standard deviation.

C.V. means coefficient of variation.(S.D./Average)

TABLE-3.2.5 MONTHLY RAINFALL AT LEGAZPI

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Amount
1956	267.7	-	299.7	-	259.1	87.0	175.2	-	511.0	210.9	493.3	829.0	3132.9
1957	364.3	98.8	180.2	195.2	163.7	195.7	225.4	221.0	235.4	337.4	333.0	259.7	2809.8
1958	342.5	238.1	310.7	75.2	145.1	200.3	235.4	315.5	182.2	965.3	427.7	96.8	3534.8
1959	253.9	291.6	411.7	73.4	334.8	72.7	157.3	193.8	176.5	247.4	510.9	613.2	3337.2
1960	-	-	-	424.2	296.1	390.6	193.0	195.5	309.1	483.5	516.6	231.6	3040.2
1961	101.8	-	116.4	130.6	180.2	284.1	207.0	345.5	161.1	312.8	288.8	278.9	2407.2
1962	291.5	182.3	165.3	91.8	405.1	142.6	393.0	343.0	462.4	174.9	408.7	168.2	3228.8
1963	-	158.0	44.9	41.9	-	384.2	247.5	479.3	120.9	142.7	405.8	368.5	2393.7
1964	305.0	253.3	96.6	435.2	166.1	151.2	247.0	257.2	295.3	310.1	359.2	636.2	3512.4
1965	307.2	178.0	242.7	158.4	195.1	281.5	484.4	308.4	255.5	318.1	428.2	553.6	3711.1
1966	592.1	104.8	155.9	87.8	216.3	167.5	424.5	209.1	266.8	400.3	452.0	814.5	3891.6
1967	490.5	148.9	215.3	139.5	-	122.2	124.0	388.2	193.7	219.8	723.4	281.1	3046.6
1968	403.3	78.5	118.3	49.4	19.4	136.6	105.9	235.1	321.3	-	275.7	181.6	1925.1
1969	48.2	24.1	73.1	143.7	31.6	149.7	203.3	168.1	443.5	158.5	333.7	541.4	2318.9
1970	169.6	366.8	292.2	202.2	134.5	203.5	358.3	424.6	219.4	540.2	709.8	558.2	4179.3
1971	391.3	308.2	422.5	137.9	407.8	193.9	394.2	169.0	173.0	473.9	322.0	836.8	4230.5
1972	659.2	-	267.1	95.8	151.0	393.4	174.7	300.7	225.3	185.7	591.7	333.4	3378.0
1973	169.2	101.2	83.0	108.0	-	183.3	317.3	316.6	185.2	511.0	773.6	978.3	3726.7
1974	237.9	368.9	92.3	65.6	259.3	518.9	438.5	161.3	74.6	458.6	565.7	518.4	3760.0
1975	356.7	210.7	122.0	436.1	151.4	159.2	196.5	-	318.6	139.3	372.9	1528.8	3992.2
1976	668.8	160.9	231.4	104.9	423.0	209.3	155.3	390.6	178.1	294.7	460.0	-	3277.0
1977	239.3	217.3	-	-	276.3	107.3	378.1	227.9	391.6	219.7	557.2	175.6	2790.3
1978	-	-	152.5	124.4	206.8	292.3	193.4	385.5	353.3	559.4	261.3	494.6	3023.5
1979	137.7	232.2	73.1	272.9	129.3	307.3	244.8	148.2	456.9	-	326.0	248.9	2577.3
1980	222.7	288.2	298.0	86.1	63.7	551.3	298.5	350.8	282.7	652.4	313.2	288.9	3696.5
1981	463.6	168.5	61.8	156.2	138.6	349.5	238.8	283.6	352.6	490.6	860.8	477.7	4042.3
Total	7484.0	4179.3	4526.7	3836.4	4754.3	6235.1	6811.3	6818.5	7146.0	8807.2	12071.2	12293.9	46253.2
Number	23	21	24	24	23	26	26	24	26	24	26	25	13
Average	325.4	199.0	188.6	159.9	206.7	239.8	262.0	284.1	274.8	367.0	464.3	491.8	3557.9
Maximum	668.8	368.9	422.5	436.1	423.0	551.3	484.4	479.3	511.0	965.3	860.8	1528.8	4230.5
Minimum	48.2	24.1	44.9	41.9	19.4	72.7	105.9	148.2	74.6	139.3	261.3	96.8	2318.9
S.D.	166.1	92.8	109.5	117.2	112.4	127.5	104.5	92.6	113.3	196.6	161.7	323.1	541.8
C.V.	0.5	0.5	0.6	0.7	0.5	0.5	0.4	0.3	0.4	0.5	0.3	0.7	0.2

Note: Hyphen (-) means that data include some interuptions in recording.

S.D. means standard deviation.

C.V. means coefficient of variation. (S.D./Average)

TABLE-3.2.6 MONTHLY RAINFALL AT MALINAO

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Amount
1972	881.0	-	468.9	134.4	101.3	309.7	212.3	424.7	159.5	215.7	533.7	463.9	3905.1
1973	313.5	-	96.3	158.5	155.6	247.4	478.7	391.1	351.7	758.3	-	1120.5	4071.6
1974	331.3	384.9	150.8	373.3	373.4	144.7	292.2	137.1	243.9	574.5	472.8	561.4	4040.3
1975	416.2	29.5	213.5	548.9	131.9	267.6	347.9	251.1	436.3	260.7	324.5	1486.2	4714.3
1976	766.7	270.1	371.9	287.8	387.9	340.7	275.1	305.6	180.0	343.2	534.8	1064.3	5128.1
1977	324.9	358.1	186.7	-	345.2	179.7	409.5	242.7	340.2	243.2	977.0	250.5	3857.7
1978	139.2	211.2	260.1	209.5	267.5	414.1	283.8	345.6	446.8	462.5	420.6	580.3	4041.2
1979	205.7	164.3	34.0	281.7	188.1	307.9	251.8	147.5	356.4	342.5	521.0	363.5	3164.4
1980	415.4	264.1	311.9	206.8	111.3	723.7	120.6	-	285.6	555.6	471.2	499.4	3965.6
1981	-	-	-	-	-	-	-	-	379.1	-	797.0	635.0	1811.1
Total	3793.9	1682.2	2094.1	2200.9	2062.2	2935.5	2671.9	2245.4	3179.5	3756.2	5052.6	7025.0	21088.3
Number	9	7	9	8	9	9	9	8	10	9	9	10	5
Average	421.5	240.3	232.7	275.1	229.1	326.2	296.9	280.7	318.0	417.4	561.4	702.5	4217.7
Maximum	881.0	384.9	468.9	548.9	387.9	723.7	478.7	424.7	446.8	758.3	977.0	1486.2	5128.1
Minimum	139.2	29.5	34.0	134.4	101.3	144.7	120.6	137.1	159.5	215.7	324.5	250.5	3164.4
S.D.	246.4	120.6	136.7	134.8	116.0	169.8	105.6	105.9	99.0	183.3	201.0	391.1	749.6
C.V.	0.6	0.5	0.6	0.5	0.5	0.5	0.4	0.4	0.3	0.4	0.4	0.6	0.2

Note: Hyphen (–) means that data include some interuptions in recording.

S.D. means standard deviation.

C.V. means coefficient of variation.(S.D./Average)

TABLE-3.2.7 MONTHLY RAINFALL AT ALLANG

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Amount
1975	987.3	274.4	–	37.8	–	99.7	77.6	83.0	47.3	21.6	3.4	99.6	1731.7
1976	61.3	1.8	2.8	0.	155.1	169.0	158.5	183.7	18.9	20.7	198.8	–	970.6
1977	6.3	52.0	2.2	43.9	217.5	377.3	790.5	339.6	477.1	–	197.0	30.4	2533.8
1978	3.6	0.	0.	191.7	44.5	201.4	52.1	384.7	723.7	352.9	32.4	10.1	1997.1
1979	0.	14.5	0.	291.4	265.4	951.9	1498.6	759.7	425.2	10.4	343.5	162.3	4722.9
1980	104.1	235.3	–	–	–	–	–	–	–	–	–	–	339.4
1981	13.3	11.4	0.	2.3	9.1	178.5	–	–	–	–	–	–	214.6
Total	1175.9	589.4	5.0	567.1	691.6	1977.8	2577.3	1750.7	1692.2	405.6	775.1	302.4	6720.0
Number	7	7	5	6	5	6	5	5	5	4	5	4	2
Average	168.0	84.2	1.0	94.5	138.3	329.6	515.5	350.1	338.4	101.4	155.0	75.6	3360.0
Maximum	987.3	274.4	2.8	291.4	265.4	951.9	1498.6	759.7	723.7	352.9	343.5	162.3	4722.9
Minimum	0.	0.	0.	0.	9.1	99.7	52.1	83.0	18.9	10.4	3.4	10.1	1997.1
S.D.	363.3	118.4	1.4	119.5	109.8	318.6	627.7	258.9	300.9	167.7	138.9	69.3	1927.4
C.V.	2.2	1.4	1.4	1.3	0.8	1.0	1.2	0.7	0.9	1.7	0.9	0.9	0.6

Note: Hyphen (–) means that data include some interuptions in recording.

S.D. means standard deviation.

C.V. means coefficient of variation.(S.D./Average)

TABLE-3.2.8 MONTHLY MEAN RUNOFF

(Unit: m^3/sec)

Station	Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
Bobongsuran, San Francisco River	(131 km^2)	6.9	5.1	4.5	5.0	4.5	5.8	7.7	7.6	7.7	7.6	7.7	9.3	6.6
Bobongsuran, Cabilogan River	(164 km^2)	12.3	8.2	7.3	8.1	8.6	10.3	13.2	14.3	13.3	14.4	15.4	17.2	11.9
Benanuan, Ogsong River	(11 km^2)	0.9	0.7	0.6	0.6	0.8	1.0	0.9	1.0	1.3	1.7	1.8	1.6	1.1
Nasisi, Nasisi River	(39 km^2)	2.6	1.9	1.8	1.8	1.7	1.7	1.6	1.7	1.7	2.0	2.7	3.1	2.0
Obaliw, Irraya River	(217 km^2)	6.0	6.0	5.5	4.9	5.3	6.7	8.8	8.0	9.2	9.3	11.0	15.7	7.5
Allang, Talisay River	(90 km^2)	2.0	1.0	0.6	0.4	1.1	2.4	4.8	3.9	5.9	3.1	6.2	8.2	3.4
Busac, Quinali River	(232 km^2)	6.0	5.8	5.5	5.8	5.3	6.3	8.1	8.1	8.3	8.9	8.8	8.4	7.1
San Agustin, San Agustin River	(262 km^2)	8.1	8.7	6.7	5.2	5.8	6.0	6.7	7.3	9.7	8.3	9.1	11.5	7.6

TABLE-3.2.9 RECORDED ANNUAL MAXIMUM, MINIMUM AND MEAN WATER LEVEL OF LAKE BATO

Year	Maximum		Minimum		Mean
	Occurrence Date	Gage Height	Occurrence Date	Gage Height	
1960	Oct. 9	EL. 9.22 m	Apr. 22	EL. 5.06 m	EL. 6.44 m
1961	Sept. 7	7.47	Apr. 30	4.82	5.93
1962	Sept.28	7.54	May 17	5.01	6.17
1963	Aug. 15	8.83	May 31	4.67	5.77
1964	Oct. 1	8.61	June 24	4.77	5.91
1965	July 14	8.76	Apr. 19	5.31	6.42
1966	Dec. 29	8.49	May 8	4.94	5.92
1967	Nov. 5	9.36	June 8	4.99	6.43
1968	Sept.30	7.49	Apr. 26	4.81	5.52
1969	Dec. 14	7.55	May 31	3.37	5.28
1970	Oct. 14	10.14	–	–	–
1971	July 16	7.99	–	–	–
1972	Jan. 11	8.88	–	–	–
1973	Oct. 17	9.21	–	–	–
1974	Jan. 1	8.43	June 8	4.69	6.09
1975	Dec. 28	10.45	June 12	4.78	5.93
1976	Jan. 1	9.71	May 18	4.47	6.45
1977	Jan. 1	8.63	May 5	4.86	6.14
1978	Sept.28	8.53	Apr. 19	4.70	5.96
1979	Sept.19	9.98	Apr. 2	4.70	6.20
1980	Nov. 6	8.53	May 16	4.60	5.76
1981	July 4	9.73	May 15	4.74	6.04

TABLE-3.4.1 ESTIMATED PALAY PRODUCTION IN THE PROJECT AREA IN 1979

Season and Planted Condition	River Basin				Total Project Area
	Quinali (A)	Quinali (B)	Yawa	East-Northeast	
(1) Area of Palay Field (ha)					
Gross Palay Field					
- Irrigated	8,530	990	380	2,500	12,400
- Rainfed	3,870	2,010	170	3,250	9,300
Total :	12,400	3,000	550	5,750	21,700
Net (Planted) Palay Field					
- Irrigated	6,320	810	270	2,000	9,400
- Rainfed	3,050	1,590	130	2,330	7,100
Total :	9,370	2,400	400	4,330	16,500
(2) Average Yield of Palay Estimated (ton/ha)					
Wet Season Palay					
- Irrigated	3.1	3.1	2.4	2.9	3.0
- Rainfed	1.7	1.7	1.3	1.6	1.7
Dry Season Palay					
- Irrigated	3.3	3.3	2.5	3.1	3.2
- Rainfed	-	-	-	-	-
(3) Estimated Palay Poduction (1,000 tons)					
Wet Season Palay	24.8	5.2	0.8	9.5	40.3
Dry Season Palay	20.9	2.7	0.7	6.2	30.5
Total :	45.7	7.9	1.5	15.8	70.8

TABLE-3.5.1 IRRIGATION AREA OF EXISTING IRRIGATION SYSTEM

Description	Nos. of Existing Irrigation Systems	Location No. *1	Irrigable Area (ha)	Total irrigable area (ha)
A) The Quinali (A) River Basin				
	27 C.I.S *2	39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65	6,127	
	4 N.I.S *3	-	2,406	8,533
B) The Quinali (B) River Basin				
	8 C.I.S	1, 2, 3, 4, 5, 6, 8, 9	9,984	1,984
C) The Yawa River Basin				
	3 C.I.S	36, 38, 37	388	388
D) The East and North-East Area of Mayon Volcano				
	27 C.I.S	7, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 25	2,097	2,097
Total :	65 C.I.S. 4 N.I.S		10,596 2,406	13,002

Note: *1 Location No. shown in FIG.-3.6.1
*2 Communal Irrigation System
*3 National Irrigation System

TABLE-4.3.1 DAMAGE TO HOUSES DUE TO MUD/DEBRIS FLOW CAUSED BY TYPHOON "DALING" IN 1981

Name of River	Totally Destroyed		Partially Damaged		Total Damage	
	Houses	Value (₱10³)	Houses	Value (₱10³)	Houses	Value (₱10³)
I) Quinali (A)	39	113	335	67	374	180
1) Quirangay	20	58	200	40	220	98
2) Tumpa	4	12	100	20	104	32
3) Maninila	10	29	15	3	25	32
4) Masarawag	5	14	20	4	25	18
5) Ogsong	-	-	-	-	-	-
6) Nasisi	-	-	-	-	-	-
II) Yawa	196	568	605	121	801	689
1) Anuling	23	67	130	26	153	93
2) Budiao	142	411	373	75	515	486
3) Pawa-Burabod	31	90	102	20	133	110
III) Quinali (B)	-	-	-	-	-	-
IV) East and North-east	65	189	188	38	253	227
Total	300	870	1,128	226	1,428	1,096

Note: Damage value per house at the foot of Mayon Volcano is estimated as below, on the basis of the result of field interview survey in 1982.

- Totally destroyed : ₱2,900/house
- Partially damaged : ₱ 200/house

Source: Result of field interview survey in 1982.

TABLE-4.3.2 FLOOD DAMAGE TO ROAD STRUCTURE

(Unit: Pesos)

River Basin Kinds of Road	1975	1976	1977	1978	1979	1980	1981
Quinali (A) River Basin							
National	800,000	-	1,500,000	351,000	722,500	-	1,993,000
Provincial	368,000	-	-	-	103,900	-	800,000
Municipal & City	-	52,500	302,000	-	-	-	-
Barangay	100,000	170,000	323,500	328,500	7,500	-	-
Sub-Total	1,268,000 (2,984,000)	222,500 (463,000)	2,125,500 (3,915,000)	679,500 (1,108,000)	833,900 (1,203,000)		2,793,000 (3,156,000)
Yawa River Basin							
National	-	-	27,000	96,000	30,500	-	-
Provincial	30,000	-	-	-	45,000	-	70,000
Municipal & City	170,000	22,500	62,500	40,000	40,000	-	20,000
Barangay	10,000	82,500	108,000	209,500	277,500	-	235,000
Sub-Total	210,000 (494,000)	105,000 (219,000)	197,500 (364,000)	345,500 (563,000)	393,000 (567,000)		325,000 (367,000)
East and North-East Area							
National	150,000	-	-	-	46,000	-	-
Provincial	150,000	-	-	-	26,000	-	69,000
Municipal & City	-	39,700	220,700	-	-	-	-
Barangay	95,000	296,000	228,000	178,000	330,000	-	-
Sub-Total	395,000 (929,000)	335,700 (699,000)	448,700 (827,000)	178,000 (290,000)	402,000 (580,000)		69,000 (78,000)

- Continued -

River Basin Kinds of Road	1975	1976	1977	1978	1979	1980	1981
Quinali (B) River Basin							
National	51,000	-	204,000	45,000	47,000	-	230,000
Provincial	45,000	-	-	-	121,500	-	120,000
Municipal & City	-	5,100	43,700	-	-	-	-
Barangay	30,000	81,000	90,000	155,000	300,000	-	-
Sub-Total	126,000 (296,000)	86,100 (179,000)	337,700 (622,000)	200,000 (326,000)	468,500 (676,000)		350,000 (396,000)
Total	1,999,000 (4,703,000)	749,300 (1,560,000)	3,109,400 (5,728,000)	1,403,000 (2,287,000)	3,097,400 (3,026,000)		3,537,000 (3,997,000)

Remarks: Amounts in the parentheses are estimated at 1982 price level.

TABLE-4.3.3 FLOOD DAMAGE TO RAILWAY STRUCTURE

(Unit: Pesos)

River Basin	1975	1976	1977	1978	1979	1980	1981
Quinali (A) River Basin	634,000 (1,492,000)	-	-	-	320,000 (462,000)	200,000 (255,000)	1,500,000 (1,695,000)
Yawa River Basin	3,700,000 (8,706,000)	-	-	-	-	-	-
Total	4,334,000 (10,198,000)				320,000 (462,000)	200,000 (255,000)	1,500,000 (1,695,000)

Remarks: Amounts in the parentheses are estimated at 1982 price level.

TABLE-4.3.4 FLOOD DAMAGE TO RIVER FACILITIES

(Unit: Pesos)

River Basin	1975	1976	1977	1978	1979	1980	1981
Quinali (A) River Basin	455,000 (1,071,000)	-	115,000 (212,000)	327,000 (533,000)	801,000 (1,156,000)	2,861,000 (3,653,000)	7,439,000 (8,406,000)
Yawa River Basin	60,000 (141,000)	50,000 (104,000)	-	100,000 (163,000)	170,000 (245,000)	-	-
East & North-East Area	-	-	-	-	-	27,000 (34,000)	350,000 (396,000)
Quinali (B) River Basin	45,000 (106,000)	-	-	133,000 (217,000)	-	90,000 (115,000)	150,000 (170,000)
Total	560,000 (1,318,000)	50,000 (104,000)	115,000 (212,000)	560,000 (913,000)	971,000 (1,401,000)	2,978,000 (3,802,000)	7,939,000 (8,972,000)

Remarks: Amounts in the parenthese are estimated at 1982 price level.

TABLE-4.3.5 <u>ESTIMATED DAMAGE COST TO THE RIVER FACILITIES</u>

(Unit: Pesos)

Date and Typhoon	Quinali (A) River Basin	Yawa River Basin	East North-East Area	Quinali (B) River Basin	Total Damage Cost
Typhoon 'Denang' Dec. 1981	3,492,000	-	67,000	-	3,559,000
Typhoon 'Anding' Nov. 1981	3,470,000	-	70,000	-	3,540,000
Typhoon 'Daling' June, 1981	7,439,000	-	350,000	150,000	7,939,000
Typhoon 'Aring' Nov. 1980	2,861,000	-	27,000	90,000	2,978,000
Typhoon 'Pepang' Sep. 1979	801,600	170,000	-	-	991,000
Typhoon 'Kading' Oct. 1978	327,000	100,000	-	133,000	560,000
Typhoon 'Weling' Sep. 1978	-	100,000	-	-	100,000
Typhoon 'Elang' July 1977	115,000	-	-	-	115,000
Typhoon 'Aring' Dec. 1976	-	50,000	-	-	50,000
Typhoon 'Sisang' Dec. 1975	455,000	60,000	-	45,000	560,000

Remarks: Data Source - Ministry of Public Works and Highways, the District Engineering Office and City Engineering Office.

Amount - Damage costs are based on the price level in each year.

TABLE-4.3.6 ESTIMATED DAMAGE COST TO THE WATERWORKS

(Unit: Pesos)

Date and Typhoon	Quinali (A) River Basin	Yawa River Basin	East North-East Area	Quinali (B) River Basin	Total Damage Cost
Typhoon 'Dinang' Dec. 1981	97,000	-	-	147,000	244,000
Typhoon 'Anding' Nov. 1981	100,000	-	-	150,000	250,000
Typhoon 'Daling' June. 1981	420,000	350,000	-	200,000	970,000
Total	617,000 (697,000)	350,000 (396,000)	-	497,000 (562,000)	1,464,000 (1,655,000)

Remarks: Data Source - Ministry of Public Works and Highways

Amount in the parentheses are estimated at 1982 price level.

TABLE-4.3.7 FLOOD DAMAGE TO GOVERNMENT INFRASTRUCTURE

(Unit: Pesos)

Riber Basin	1975	1976	1977	1978	1979	1980	1981
Quinali (A) River Basin							
Roads	2,984,000	463,000	3,915,000	1,108,000	1,203,000	-	3,156,000
Railways	1,492,000	-	-	-	462,000	255,000	1,695,000
River Facilities	1,071,000	-	212,000	533,000	1,156,000	3,653,000	8,406,000
Water works	-	-	-	-	-	-	697,000
Total	5,547,000	463,000	4,127,000	1,641,000	2,821,000	3,908,000	13,954,000
Yawa River Basin							
Roads	494,000	219,000	364,000	563,000	567,000	-	367,000
Railways	8,706,000	-	-	-	-	-	-
River Facilities	141,000	104,000	-	163,000	245,000	-	-
Water works	-	-	-	-	-	-	396,000
Total	9,341,000	323,000	364,000	726,000	812,000		763,000

- Continued -

River Basin	1975	1976	1977	1978	1979	1980	1981
East & North-East Area							
Roads	929,000	699,000	827,000	290,000	580,000	-	78,000
Railways	-	-	-	-	-	-	-
River Facilities	-	-	-	-	-	34,000	396,000
Water works	-	-	-	-	-	-	-
Total	929,000	699,000	827,000	290,000	580,000	34,000	474,000
Quinali (B) River Basin							
Roads	296,000	179,000	622,000	326,000	676,000	-	396,000
Railways	-	-	-	-	-	-	-
River Facilities	106,000	-	-	217,000	-	115,000	170,000
Water works	-	-	-	-	-	-	562,000
Total	402,000	179,000	622,000	543,000	676,000	115,000	1,128,000
Total	16,219,000	1,664,000	5,940,000	3,200,000	4,889,000	4,057,000	16,319,000

Remarks: Amounts are estimated at 1982 price level.

TABLE-4.4.1 ESTIMATED DAMAGE COST ON THE IRRIGATION FACILITIES

(Unit: Pesos)

Date and Typhoon	Quinali (A) River Rasin	Quinali (B) River Basin	Yawa River Basin	East and North-East Area	Total Damage Cost
Typhoon 'Anding' Nov. 1981	349,800	36,800	36,800	105,800	529,200
Typhoon 'Aring' Nov. 1980	325,400	108,000	-	25,000	458,400
Typhoon 'Pepang' Sep. 1979	622,300	26,400	-	61,400	710,100
Typhoon 'Weling' Sep. 1979	414,200	43,400	-	150,500	608,100
Typhoon 'Kading' Oct. 1978	339,200	31,900	-	116,400	487,500
Typhoon 'Unding' Nov. 1977	195,000	-	-	54,200	249,200
Typhoon 'Didnag' May, 1976	71,800	19,200	-	60,300	151,300
Typhoon 'Sisang' Dec. 1975	228,300	5,200	-	-	233,500

Remarks: Data Source - National Irrigation Administration, Region V.
Damage cost is estimated at 1982 price level.

TABLE-4.5.1 RICE PRODUCTION DAMAGE BY TYPHOON "PEPANG" 1979

Municipality	Area of Standing Palay (ha)	Affected Area Total (ha)	Affected Area No Recovery (ha)	Affected Area With Recovery (ha)	Yield Potential (cavan/ha)	Yield Actual (cavan/ha)	Production Loss (cavan)
Quinali (A) River Basin							
Polangui	964	292	0	292	86	49	10,804
Libon	1,773	1,773	1,291	482	89	48	134,061
Oas	1,411	1,411	52	1,359	85	70	24,805
Ligao	622	622	42	580	85	70	12,270
Total:	4,770	4,098	1,385	2,713	87	59	182,540 (9,127 ton)
Quinali (B) River Basin							
Malinao	1,369	1,369	15	1,354	80	75	7,970
Tabaco	41	41	8	33	75	45	1,590
Total:	1,410	1,410	23	1,387	80	74	9,560 (478 ton)

Source: BAEx, Municipal office, 1980.

TABLE-4.5.2 RICE PRODUCTION DAMAGE BY TYPHOON "DALING", 1981

Municipality Affected	Area Planted (ha) (1)	Stage of Crop (2)	Affected Area: Total (ha) (3)	Affected Area: Completely Damaged/1 (ha) (4)	With Chance of Recovery (ha) (5)	Estimated Yield: Before Calamity (ton/ha) (6)	Estimated Yield: After Calamity (ton/ha) (7)	Production Loss/2 (ton) (8)
Quinali (A)	6,217		2,054	1,554	500			6,010
- Polangui	1,231	Vegetative	578	405	96	3.80	3.50	1,570
- Libon	1,126	"	582	534	72	3.90	3.55	2,110
- Oas	1,188	"	388	265	123	3.50	3.00	990
- Ligao	1,170	"	276	213	116	3.50	3.25	770
- Camalig	770	"	90	61	29	3.50	2.50	240
- Guinobatan	732	"	140	76	64	3.75	3.00	330
Yawa	440		391	171	39			600
- Legazpi City	312	"	312	131	-	3.25	0	430
- Daraga	128	"	79	40	39	3.25	2.25	170
Total:	6,657		2,445	1,725	539			6,610

/1: No chance of recovery /2: (8) = (4) x (6) + (5) x {(6) - (7)}

Source: Crop Damage Survey, Regional Office of Ministry of Agriculture

TABLE-4.5.3 DAMAGE TO AGRICULTURAL PRODUCT DUE TO MUD/DEBRIS FLOW (1980 - 1982)

Basin	Palay		Coconut		Total
	Area (ha)	Value/1 (₱10³)	Area (ha)	Value/1 (₱10³)	(₱10³)
Quinali (A)	105	214	45	68	282
Quinali (B)	-	-	-	-	-
Yawa	91	142	23	35	177
Northeast Area	6	12	15	23	35
Total	202	368	83	126	494

/1 : Damage value per hectare is estimated as follows:

Crop	Unit Yield (ton/ha)	Price (₱/ton)	Damage Value (₱/ha)
Palay			
Quinali (A)	1.7	1,200	2,040
Quinali (B)	1.7	1,200	2,040
Yawa	1.3	1,200	1,560
Northeast Area	1.6	1,200	1,920
Coconut			
(Copra)	0.88	1,600	1,410
(Charcoal)	0.20	450	90

Source: Results of risk analysis

TABLE-4.6.1 DISASTER RELIEF (TYPHOON "DALING")

(Unit: ₱10³)

Area	Pepang	Daling
Quinali (A)	1.7	38.1
Quinali (B)	-	1.1
Yawa	-	2.0
Northeast	-	5.5
Total	1.7	46.7

Source: Regional Office of the Philippine National Red Cross

TABLE-4.6.2 MEDICAL ASSISTANCE RENDERED TO VICTIMS OF TYPHOON "DALING" IN THE PROJECT AREA

Basin	No. of Health Personnel Involved (man-day)	Cost of Personnel /1 (₱10^3)	Cost of Medicines /2 (₱10^3)	Total (₱10^3)
Quinali (A)	7,020	399	234	633
	Physicians - 1,080	162		
	Nurses - 1,080	43		
	Midwives - 4,050	162		
	Sanitary Inspectors - 810	32		
Yawa	220	11	10	21
	Physicians - 20	3		
	Nurses - 30	1		
	Midwives - 130	5		
	Sanitary Inspectors - 40	2		
Total	7,240	410	244	654

/1 : Unit cost of personnel is assumed as follows.

Physicians	:	₱150/day
Nurses	:	₱ 40/day
Midwives	:	₱ 40/day
Sanitary Inspectors	:	₱ 40/day

Source : Provincial Health Office

TABLE-4.7.1 CASUALTIES AND FAMILIES AFFECTED IN THE PROJECT AREA (TYPHOON "DALING" IN 1981)

Basin	Casualties (persons)				Families Affected	Population Affected (persons)
	Dead	Injured	Missing	Total		
Flood Damage	99	0	3	102	571	3,250
- Quinali (A)	96	0	2	98	482	2,750
- Quinali (B)	3	0	1	4	37	210
- Yawa	0	0	0	0	6	30
- Northeast	0	0	0	0	46	260
Mud/Debris Flow Damage	39	107	13	159	1,428	8,140
- Quinali (A)	10	12	0	22	576	3,280
- Quinali (B)	0	0	0	0	0	0
- Yawa	29	95	13	137	852	4,860
- Northeast	0	0	0	0	0	0
Total	138	107	16	261	1,999	11,390
- Quinali (A)	106	12	2	120	1,058	6,030
- Quinali (B)	3	0	1	4	37	210
- Yawa	29	95	13	137	858	4,890
- Northeast	0	0	0	0	46	260

Source : - Regional Office of Ministry of Social and Service Development

- Results of field interview survey

TABLE-4.8.1 TOTAL FLOOD AND MUD/DEBRIS FLOW DAMAGES BY TYPHOON "PEPANG" IN 1979 (1982 FINANCIAL PRICE LEVEL)

(Unit: ₱10^3)

Damage Category	River Basin				Whole Project Area
	Quinali (A)	Quinali (B)	Yawa	East and Northeast Area	
1) Infrastructure	2,821	676	812	580	4,889
- Road	1,203	676	567	580	3,026
- Railway	462	-	-	-	462
- River facilities	1,156	-	245	-	1,401
- Waterworks	*/1	*	*	*	*
2) Houses and Buildings	15,777	1,085	1,812	-	18,674
3) Irrigation Facilities	622	26	-	62	710
4) Agricultural Product	10,950	580	-	-	11,530
5) Indirect Damage/2	423	101	122	87	733
Total	30,593	2,468	2,746	729	36,536

/1 : No data

/2 : 15 % of total damage to infrastructure

TABLE-4.8.2 TOTAL FLOOD AND MUD/DEBRIS FLOW DAMAGES BY TYPHOON "DALING" IN 1981 (1982 FINANCIAL PRICE LEVEL)

(Unit: ₱10^3)

Damage Category	River Basin				Whole Project Area
	Quinali (A)	Quinali (B)	Yawa	East and Northeast Area	
1) Infrastructure	13,954	1,128	763	474	16,319
- Road	3,156	396	367	78	3,997
- Railway	1,695	-	-	-	1,695
- River facilities	8,406	170	-	396	8,972
- Waterworks	697	562	396	-	1,655
2) Houses and Buildings	16,124	1,085	2,561	-	19,770
3) Irrigation Facilities	1,661	384	68	271	2,384
4) Agricultural Product	7,494	-	897	35	8,426
5) Indirect Damage/1	2,093	169	114	71	2,447
Total	41,326	2,766	4,403	851	49,346

/1 : 15 % of total damage to infrastructure

TABLE-5.2.1 CALCULATION THROUGH RATIONAL FORMULA

No. of Base Point	(1) Drainage Area (km^2)	Name of River	(2) Flood Concentration Time (min)	(3) Runoff Coefficient	Return Period (year)	(4) Probable Rainfall Intensity a.	b.	(5) Representative Station: Name of Station	Probable 1-Day Rainfall (mm)	(6) 1-Day Rainfall (mm)	(7) Rainfall Intensity (mm/hr)	(8) Probable Basin 1-Day Rainfall (mm)	(9) Average Rainfall Intensity (mm/hr)	(10) Probable Flood Peak Runoff (Review) (m^3/sec)	(11) 50-Year Flood (Master Plan) (m^3/sec)	(12) Difference (%)
A-59	524.2	Quinali (A)	409	0.70	50	2.74	417	Guinobatan	394	374.3	43.6	342.8	39.9	4,070	4,170	2.4
A-34	84.2	Nasisi	117	0.70	50	2.74	417	"	394	374.3	88.9	436.3	103.6	1,697	1,656	2.5
Y-14	74.4	Yawa	96	0.70	50	2.74	417	Legaspi	510	374.3	96.1	571.5	144.0	2,083	2,142	2.7
Y-12	7.6	Pawa-Burabod	55	0.70	50	2.74	417	"	510	374.3	114.0	664.7	202.4	299	296	1.0
Y-1	9.4	Anuling	49	0.70	50	2.74	417	"	510	374.3	117.2	658.2	206.1	377	373	1.1
B-21	157.8	Quinali (B)	178	0.70	50	2.74	417	Malinao	382	374.3	73.1	395.4	77.2	2,369	2,383	0.6

Note: Each calculation is made as follows:

(4) $I = \frac{b}{t + a}$

(6) $= \frac{b}{24 + a} \times 24$

(7) $I = \frac{b}{(2)/60 + a}$

(8) $= (5) \times 1.5 \times e^{-0.1\left[0.3861 \times (1)\right]^{0.33}}$

(9) $= (7) \times \frac{(8)}{(6)}$

(10) $= \frac{1}{3.6} \times (3) \times (9) \times (1)$

(12) $= \frac{(10)-(11)}{(11)} \times 100$

TABLE-5.2.2 PROBABLE 50-YEAR FLOOD PEAK RUNOFF

Site No.	Name of River	Drainage Area (km^2)	River Course Length (km)	Flood Concentration Time (min.)	Runoff Coeffi- cient	Average Basin Rainfall (mm/day)	Average Rainfall Intensity (mm/hour)	Peak Runoff Discharge (m^3/sec)
A-1	Quirangay River	9.3	9.75	46.	0.70	500.0	153.3	277.
A-2	Tributary	5.6	5.38	26.	0.70	510.4	172.9	188.
A-3	Irraya River	14.9	9.75	46.	0.70	489.0	149.9	434.
A-4	Tagaytay River	26.7	15.00	88.	0.70	473.4	121.9	633.
A-5	Tributary	16.4	6.90	38.	0.70	486.5	154.9	494.
A-6	Tagaytay River	43.1	15.00	88.	0.70	458.9	118.2	991.
A-7	Tagaytay River	44.0	16.73	102.	0.70	458.2	112.1	959.
A-8	Tumpa River	5.7	7.75	37.	0.70	510.1	163.5	181.
A-9	Tagaytay River	49.7	16.73	102.	0.70	454.3	111.2	1074.
A-10	Cabilogan River	52.1	17.61	109.	0.70	452.7	108.0	1094.
A-11	Maninila River	4.9	10.65	51.	0.70	513.0	154.2	147.
A-12	Cabilogan River	57.0	17.61	109.	0.70	449.7	107.3	1189.
A-13	Cabilogan River	58.1	19.31	118.	0.70	449.0	103.7	1171.
A-14	Trapicia River	4.9	8.80	42.	0.70	513.0	160.6	153.
A-15	Cabilogan River	63.0	19.31	118.	0.70	446.2	103.0	1262.
A-16	Cabilogan River	73.4	21.34	130.	0.70	440.8	98.0	1398.
A-17	Masarawag River	10.5	12.23	58.	0.70	497.3	144.6	295.
A-18	San Francisco River	83.9	21.34	130.	0.70	435.9	96.9	1581.
A-19	San Francisco River	91.4	24.79	157.	0.70	432.7	88.2	1567.
A-20	Cabilogan River	128.8	34.79	236.	0.70	419.2	68.9	1725.

- continued -

Site No.	Name of River	Drainage Area (km^2)	River Course Length (km)	Flood Concentration Time (min.)	Runoff Coeffi- cient	Average Basin Rainfall (mm/day)	Average Rainfall Intensity (mm/hour)	Peak Runoff Discharge (m^3/sec)
A-21	Bublusan Creek	18.9	13.75	68.	0.70	482.9	134.9	496.
A-22	Nabonton Creek	8.3	13.45	64.	0.70	502.4	142.6	230.
A-23	Ogsong River	27.2	13.75	68.	0.70	472.9	132.2	699.
A-24	Ogsong River	38.1	21.35	128.	0.70	462.8	103.4	766.
A-25	Nasisi River	11.0	9.25	44.	0.70	496.2	153.8	329.
A-26	Nasisi River	7.7	4.95	24.	0.70	504.0	172.5	258.
A-27	Nasisi River	18.7	9.25	44.	0.70	483.2	149.7	544.
A-28	Nasisi River	26.7	12.25	58.	0.70	473.4	137.6	715.
A-29	Buga River	7.7	11.13	53.	0.70	504.0	150.0	225.
A-30	Nasisi River	34.4	12.25	58.	0.70	465.9	135.5	906.
A-31	Nasisi River	35.7	13.35	63.	0.70	464.8	132.2	918.
A-32	Nasisi River	39.2	19.91	109.	0.70	461.9	110.3	840.
A-33	Nasisi River	6.6	6.00	38.	0.70	507.2	161.6	207.
A-34	Nasisi River	84.2	20.91	117.	0.70	435.8	101.2	1656.
A-35	Quinali (A) River	213.0	34.79	236.	0.70	397.8	65.3	2706.
A-36	Quinali (A) River	216.1	45.04	318.	0.70	397.1	54.4	2286.
A-37	Salog River	30.3	17.90	129.	0.70	469.7	104.6	616.
A-38	Magkaslu River	17.3	16.50	104.	0.70	485.2	117.8	396.
A-39	Salog River	47.6	17.90	129.	0.70	455.7	101.5	939.
A-40	Magkaslu River	13.9	7.50	43.	0.70	490.7	153.0	414.

- continued -

Site No.	Name of River	Drainage Area (km^2)	River Course Length (km)	Flood Concentration Time (min.)	Runoff Coeffi-cient	Average Basin Rainfall (mm/day)	Average Rainfall Intensity (mm/hour)	Peak Runoff Discharge (m^3/sec)
A-41	Tributary	11.2	5.10	24.	0.70	495.8	169.0	368.
A-42	Tributary	25.1	7.50	43.	0.70	475.2	148.2	723.
A-43	Polangui River	79.1	19.40	141.	0.70	438.1	93.9	1444.
A-44	Quinali (A) River	295.2	45.04	318.	0.70	382.7	52.4	3010.
A-45	Quinali (A) River	297.3	50.44	360.	0.70	382.4	48.2	2785.
A-46	Sugtad Creek	28.0	9.90	66.	0.70	472.0	133.1	725.
A-47	Quinali (A) River	325.3	50.44	360.	0.70	378.0	47.6	3013.
A-48	Quinali (A) River	330.6	54.97	396.	0.70	377.0	44.5	2863.
A-49	Talisay River	96.5	24.70	179.	0.70	466.3	89.2	1673.
A-50	Talisay River	132.0	37.20	278.	0.70	452.9	67.5	1734.
A-51	Talisay River	19.5	8.65	56.	0.70	522.0	153.1	581.
A-52	Talisay River	151.5	37.20	278.	0.70	446.7	66.6	1963.
A-53	Talisay River	163.8	42.28	318.	0.70	443.2	60.7	1932.
A-54	Talisay River	174.8	47.06	356.	0.70	440.2	55.9	1901.
A-55	Sun Miguel River	3.8	6.75	54.	0.70	560.5	166.4	123.
A-56	Talisay River	178.6	47.06	356.	0.70	439.2	55.8	1938.
A-57	Talisay River	192.4	50.16	381.	0.70	435.6	52.9	1979.
A-58	Quinali (A) River	523.0	54.97	396.	0.70	354.2	41.8	4252.
A-59	Quinali (A) River	524.2	56.52	409.	0.70	354.0	40.9	4170.
Y-1	Anuling River	9.4	10.23	49.	0.70	671.9	203.8	373.