Appendix-5 Other Relevant Data and Information

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Appendix 5-A Evaluation of rehabilitation/replacement works for Pump Station Facilities

Determination of evaluation base line of the rehabilitation / replacement for the pump station facilities were made in accordance with following literature and guidance.

① ”Agricultural Facilities (Mechanical), Replacement Engineering Guidance” supervised by Ministry of Agriculture, Forestry and Fisheries(MAF) Japan, Rural Development Bureau, Rural Infrastructure Development, Design Division

②”Mechanical Facilities’Project, Construction Superintendent Standard” supervised by Ministry of Agriculture, Forestry and Fisheries(MAF) Japan, Rural Development Bureau, Rural Infrastructure Development, Design Division

③”Pump Station Facilities, Inspection and Maintenance Guidance(Pump Station)” issued by Association for Pump System Engineering Japan

① will be referred mainly to the evaluation on electrical facilities.

② will be referred to the evaluation on the vibration base value (JIS B8301) which is used to control the condition of fluid mechanic (rotate mechanic).

③ will be referred to the evaluation on the determination of spare parts to be changed based on the investigation results of pump station facilities.

(1) Pump Station Facilities

For each pump station, the investigation on working condition, repairing history, vibration of rotate mechanics and noise, rusting and corrosion were executed and subsequent determination on the spare parts to be changed were made as follows.

Iguig pump station (Mechanical facilities)

Equipment name	Required works	Spare parts to be replaced	Upper: Evaluation base line (Number in ○ show reference no. in the guidance. Middle and lower: Present condition by visual and measurement and repairing history.
Main pump	Overhaul		③Require regular maintenance in every 10 years and to check abnormality of impeller
			Continuous use in 20 years, 30,000 hr of accumulate working hours
			No overhaul recorded in the past
	Parts replacement	Shaft sleeve	③Require no wear and tear
			Remarkable leakage due to wear and tear
		Gland packing	③Require no abnormal leakage of water
			Remarkable leakage of water
		Ball bearing	②Require less than 80 μ m in total amplitude for R.P.M 900 min-1
			Recorded 85 μ m for R.P.M 890 min-1
		Gasket, 0 Ring, Oil seal	Checking by break up, it was found to require replacement
		Compound Gauge	③Require regular replacement in every 10 years
			Continuous use in 20 years, impossible in further use due to dirt and damage
Motor	Overhaul, rewinding		③Require no abnormal noise
	Parts replacement	Bearing	Observe high frequency noise. Noise level: 95 dB(A)
			Burning damage history in the past
Suction valve	Parts replacement	Packing	③Require no wear and tear
			Leakage due to wear and tear
Discharge valve	Parts replacement	Bearing	③Require no wear and tear
			Leakage due to wear and tear
		Actuator	③Require indicator and switch to work correctly
			Impossible to work due to dirt and damage by water
Main pipe	Repairing leakage portion		③Require no leakage and corrosion
			Rusting and corrosion on pipe joint and pipe surface
Sealing water pump	Replacement		③Require no abnormal vibration and noise
			Pump was removed due to its inferior
Duplex strainer	Replacement		③Require no abnormality vibration and noise
			Leakage water due to inferior by silt material in the river water

Iguig pump station (Mechanical facilities)

Equipment name	Required works	Spare parts to be replaced	Upper: Evaluation base line (Number in ○ show reference no. in the guidance. Middle and lower: Present condition by visual and measurement and repairing history.
Drain pump	Replacement		②Require less than 50 μ m in total amplitude for R.P.M 1800 min-1
			Recorded 500 μ m for R.P.M 1800 min-1
			Wear and tear on intermediate bearing, Damage on impeller boss
Intake screen	Repainting		③Require no peal off paint
			Observe paint peal off
Ventilation	Replacement		③Require no corrosion and damage
			Corrosion due to water and damage
Pipe for auxiliary equipment	Replacement		③Require no leakage and corrosion
			Observe leakage a lot on valve and pipe due to its inferior
Sand pump			③Require no abnormal vibration and noise
			Not in use now due to inferior

Iguig Booster Pumping Station

Equipment name	Required works	Spare parts to be replaced	Upper: Evaluation base line (Number in ○ show reference no. in the guidance. Middle and lower: Present condition by visual and measurement and repairing history.
Main pump	Replacement	Submersible motor centrifugal pump	③Require no abnormal vibration and no ware and tear of impeller.
			Frequent repairing due to inferior of equipment
			②Require less than 50 μ m in total amplitude for R.P.M 1765 min-1
			Recorded 190 μ m for R.P.M 1765 min-1
Discharge valve	Replacement	Motorized butterfly valve	③Require no wear and tear
			Remarkable leakage due to wear and tear of gland. Rusting on surface.
Non-return valve	Replacement	Non return valve	③Require no peal off of paint and no rusting.
			Remarkable rusting and dirt wholly.
Main pipe	Replacement	Pipe Sleeve joint	③Require no leakage and corrosion
			Rusting wholly and temporary welding repairing on leakage portion.
Overhead crane		Chain block	③Require specified capacity.
			Not in use now. Rental from other source

Amulung pump station (Mechanical facilities)

Equipment name	Required works	Spare parts to be replaced	Upper: Evaluation base line (Number in ○ show reference no. in the guidance. Middle and lower: Present condition by visual and measurement and repairing history.
Main pump (High lift line)	Overhaul		③Require regular maintenance in every 10 years and to check abnormality of impeller
			Continuous use in 20 years, 30,000 hr of accumulate working hours
			No overhaul recorded in the past
	Parts replacement	Shaft sleeve	③Require no wear and tear
			Remarkable leakage due to wear and tear
		Gland packing	③Require no abnormal leakage of water
			Remarkable leakage of water
		Roller bearing	②Require no abnormal vibration and noise.
			Remarkable vibration and operation noise level: more than 90dB(A)
		Gasket, 0 Ring, Oil seal	Checking by break up, it was found to require replacement
		Compound Gauge	③Require regular replacement in every 10 years
			Continuous use in 20 years, impossible in further use due to dirt and damage
Main pump (Low lift line)	Overhaul		③Require regular maintenance in every 10 years and to check abnormality of impeller
			Continuous use in 20 years, 30,000 hr of accumulate working hours
			No overhaul recorded in the past
		Shaft sleeve	③Require no wear and tear
			Remarkable leakage due to wear and tear
			Observe welding repairing history due to wear and tear.
		Gland packing	③Require no abnormal leakage of water
			Remarkable leakage of water
		Roller bearing	②Require no abnormal vibration and noise.
			Remarkable vibration and operation noise level: more than 90dB(A)
		Gasket, 0 Ring, Oil seal	Checking by break up, it was found to require replacement
		Compound Gauge	③Require regular replacement in every 10 years
			Continuous use in 20 years, impossible in further use due to dirt and damage

Amulung pump station (Mechanical facilities)

Equipment name	**Required works**	**Spare parts to be replaced**	**Upper: Evaluation base line (Number in ○ show reference no. in the guidance. Middle and lower: Present condition by visual and measurement and repairing history.**
Motor (High lift line)	Overhaul, rewinding		③Require no abnormal noise
	Parts replacement	Bearing	Observe periodical high frequency noise. Noise level: 95 dB(A)
			Burning damage history in the past
Moter (Low lift line)	Overhaul, rewinding		③Require no abnormal noise
	Parts replacement	Bearing	Observe high frequency noise. Noise level: 95 dB(A)
			Burning damage history in the past
Suction valve (High lift line)	Parts replacement	Packing	③Require no wear and tear
			Leakage due to wear and tear
Suction valve (Low lift line)	Parts replacement	Packing	③Require no wear and tear
			Leakage due to wear and tear
Discharge valve (High lift line)	Parts replacement Inspection/Maintenance	Bearing	③Require no wear and tear
			Leakage due to wear and tear
		Actuator	③Require indicator and switch to work correctly
			Used to be Impossible to start pump due to operation inferior
Discharge valve (Low lift line)	Parts replacement Inspection/Maintenance	Bearing	③Require no wear and tear
			Leakage due to wear and tear
		Actuator	③Require indicator and switch to work correctly
			Used to be Impossible to start pump due to operation inferior
Main pipe	Repairing leakage portion Replacement		③Require no leakage and corrosion
			Rusting and corrosion on pipe joint and pipe surface
		Sleeve jpint	Many holes under ground portion due to corrosion
Sealing water pump	Replacement		②Require less than 30 μ m in total amplitude for R.P.M 3600min-1
			Recorded 75 μ m for R.P.M 3600 min-1
			Observe vertical motion sound and remarkable leakage.
Duplex strainer	Replacement		③Require no abnormality
			Leakage water due to inferior by silt material in the river water

Amulung pump station (Mechanical facilities)

Equipment name	**Required works**	**Spare parts to be replaced**	**Upper: Evaluation base line (Number in ○ show reference no. in the guidance. Middle and lower: Present condition by visual and measurement and repairing history.**
Drain pump	Replacement		②Require less than 50 μ m in total amplitude for R.P.M 1800 min-1
			Recorded 140 μ m for R.P.M 1800 min-1
			Wear and tear on intermediate bearing. Damage on impeller boss
Intake screen	Repainting		③Require no peal off paint
			Observe paint peal off
Ventilation	Replacement		③Require no corrosion and damage
			Corrosion due to water and damage
Pipe for auxiliary equipment	Replacement		③Require no leakage and corrosion
			Observe leakage a lot on valve and pipe due to its inferior
Sand pump			③Require no abnormal vibration and noise
			Not in use now due to inferior

Magapit station (Mechanical facilities)

Equipment name	Required works	Spare parts to be replaced	Upper: Evaluation base line (Number in ○ show reference no. in the guidance. Middle and lower: Present condition by visual and measurement and repairing history.
Main pump	Overhaul		③Require regular maintenance in every 10 years and to check abnormality of impeller
			Continuous use in 15 years, 20,000 hr of accumulate working hours
			No overhaul recorded in the past. Observe sand scratch sound in casing.
	Parts replacement	Shaft sleeve	③Require no wear and tear
			Remarkable leakage due to wear and tear
		Gland packing	③Require no abnormal leakage of water
			Remarkable leakage of water
		Ball bearing	②Require less than 80 μ m in total amplitude for R.P.M 900 min-1
			Recorded 160 μ m for R.P.M 296 min-1
		Gasket, 0 Ring, Oil seal	Checking by break up, it was found to require replacement
		Compound Gauge	③Require regular replacement in every 10 years
			Continuous use in 20 years, impossible in further use due to dirt and damage
Motor	Inspection/Maintenance		③Require no abnormal noise
	Parts replacement	Brush	Observe high frequency noise. Noise level: 95 dB(A)
		Bearing	Burning damage history in the past
Suction valve	Parts replacement	Packing	③Require no wear and tear
			Leakage due to wear and tear
		Actuator	③Require indicator and switch to work correctly
			Impossible to work due to inferior. Always open position
Discharge valve	Parts replacement	Bearing	③Require no wear and tear
			Leakage due to wear and tear
		Actuator	③Require indicator and switch to work correctly
			Impossible to work due to dirt and damage by water
Flap valve	Repainting		③Require no peal off paint
			Observe remarkable paint peal off
Main pipe	Repairing leakage portion		③Require no leakage and corrosion
			Rusting and corrosion on pipe joint and pipe surface

Magapit pump station (Mechanical facilities)

Sealing water pump	Replacement		③Require no abnormal vibration and noise
			Observe bigger operation sound compared with motor output 90dB(A)
			Vertical operation sound. Remarkable leakage on gland and pipe.
Duplex strainer	Replacement		③Require no abnormality vibration and noise
			Leakage water due to inferior by silt material in the river water
Circulation pump	Replacement		③Require no dirt, wound, corrosion, abnormal wear and tear and damage
			Stopped up, dirt caused capacity lower. Recorded replacement.
			Wiring under water.
Drain pump	Replacement		③Require no abnormal vibration and noise
			Observe bigger operation sound compared with motor output 90dB(A)
			Wear and tear of Intermediate bearing . Damage on impeller boss.
Intake screen	Repainting		③Require no peal off paint
			Observe paint peal off
Pipe for auxiliary equipment	Replacement		③Require no leakage and corrosion
			Observe leakage a lot on valve and pipe due to its inferior

(2) Electrical Facilities

Electrical facilities include facilities for 13.8kV switchgear, high voltage switchgear, low voltage switchgear and battery & charger panel. In case that the equipment and facilities are very old and need to be repaired, it will be difficult to procure their units or spare parts because they may be out of manufacturing. Therefore, it would take long time to repair and recover the function, so it badly affects for operation of the facilities.

At the designing of rehabilitation and repairing for the present electrical facilities, which parts should be rehabilitated or repaired are determined based on the "Guidelines on the Technique for Maintenance and Renovation of Plants and Machinery for Agriculture", taking into consideration the following items:

Remarks for which parts should be rehabilitated or repaired

1) Deterioration by aging for electrical facilities may be the deterioration of electrical insulation. They may proceed at the same speed on the same conditions. Therefore, when one of the parts or units for facilities deteriorates, it is considered that the other parts of units also would deteriorate.
2) Since the switchgears are related each other and consist the system, it is necessary that the rehabilitated switchgears should also consist the system. Therefore, not only deteriorated parts or units but also related parts or units should be rehabilitated or repaired.
3) In case that the deteriorated switchgear is functioned in series, it would be difficult to repair only one part of facilities because the bus bars might be installed inside between the main panel and related panels.
4) It is considered to replace the low voltage panels and direct current panels, when they are 20 years old.

Equipment/facilities to be rehabilitated and repaired

1) 13.8kV Switchgears at Amulung and Magapit Substations

Amulung and Magapit substations are comparably shorter in operation than the other pumping stations and have less damage history. These facilities can be continuously operable in future. However, these facilities are especially important, so inspection and maintenance should be conducted and the deteriorated parts should be replaced. If these facilities are damaged, they would badly effect to the whole facilities.

2) High Voltage Switchgears at Magapit Pumping Station

In Magapit Pumping Station, the high voltage incoming panels are installed outside the building. On the other hand, the high voltage pump panels are located inside the building. Therefore, these panels were checked one by one. It is found that the heavily deteriorated panels and bus duct should be replaced, which are damaged by the bird droppings. The transformer having been used for these facilities is also aged, but a periodical checking has been conducted and they should still be able to be used in future. Only checking of the insulation oil should be conducted.

3) Incoming panels at Iguig Pumping Station, Iguig Booster Pumping Station and Amulung Pumping Station

High voltage incoming panels for these pumping stations are installed outside the building. Since the damages of surfaces and inside parts for these panels and lightning panels are heavy, they should be replaced. Bus duct should also be replaced for its heavy rust. The transformers having been used for these facilities are also aged, but a periodical checking has been conducted and they should still be able to be used in future. Only checking of the insulation oil should be conducted.

4) Low voltage switchgears at Iguig Pumping Station, Iguig Booster Pumping Station and Amulung Pumping Station

At these stations, low voltage incoming panels, pump panels and auxiliary panels are installed in line on the ground floor. They are damaged by frequent stoppage of aging, broken wires by electrical short circuit, low insulation by rodent or many repairing experiences of electrical contactors, so they should be replaced in series.

5) Low voltage local control panels

Low voltage local control panels are installed on underground floor. They are damaged by leakage water and rusted on their surfaces at heavily humid conditions as well as some of the base plates for circuit breakers are missing and switches will not operate, therefore, they should be replaced.

6) Dredger pump local control panels at Iguig, Amulung and Magapit Pumping Station

Dredger pump local control panels are installed on the outside of pump building walls. They should be replaced for heavy damage.

7) Direct current panels (Battery and charger panels)

Battery and charger panels for direct current are heavily damaged by means of rodent with the insulation covers for wires. Walls of panels are rusted and cracked. Some partitions are missing and frequent stoppage has happened. Therefore, they should be replaced.

8) Cables

Cables should be replaced when the panels are changed. Duct at the underground floor should be replaced because of heavy rust.

Electrical Facilities at Iguig Pumping Station

Classification	Equipment	Type of Works	Damage History & Present Conditions
13.2kV Switchgears	13.2kV Incoming panel	Replace	Wall bending. Door will not open nor closed. Door knob missing. Rusting on breakers' and contactors' points and lightning arresters. Deterioration of panel walls and parts. Need to replace. At present oil type OCB is used. It is out of manufacturing. Difficult to procure its spare parts. Replace it to VCB. Transformer can be used, however need to inspect and maintain such as conducting purification of insulation oil. Bus duct is rusted with leakage water, so need to replace.
	13.2kV LA panel	Replace	
	Transformer	Inspection & Maintenance	
	Bus duct	Replace	
460V Switchgears	460V Incoming panel	Replace	Many damages of electric meters, indicators and breakers on panels, which is necessary for monitoring. Opening indicator of discharge valve will not operate. Repaired part is not permanently fixed. Walls are bended, dust comes into the panel and deterioration of parts is proceeding by rust. Space heater and inside lights are out of order. Need to replace. Auxiliary panel is installed on the underground floor with high humid conditions. Deterioration is proceeding. Need to replace. Push button on dredger pump local control panel is damaged, so need to replace. Battery is deteriorated. Wall of panel has heavy rust, so removed from the panel. Noise from charger is high. It is deteriorated heavily. Need to replace.
	Pump panel	Replace	
	Auxiliary panel	Replace	
	Sealing water pump local control panel	Replace	
	Drainage pump local control panel	Replace	
	Dredger pump local control panel	Replace	
	Battery and charger panel	Replace	
Cables		Replace	As the panels are replaced, cables should also be replaced. Rusted dust also should be replaced.

Electrical Facilities at Iguig Booster Pumping Station

Classification	Equipment	Type of Works	Damage History & Present Conditions
13.2kV Switchgears	13.2kV Incoming panel	Replace	Panels are damaged and not operated. Transformer, which was used to operate inside panel, is installed on casement and is used. Need to replace for safety operation and security of maintenance.
	13.2kV LA panel	Replace	
230V Switchgears	230V Incoming panel	Replace	Coating deterioration is found. Door is bended. Breakers, transformer and current transformers are heavily rusted. Dust comes into the relays' and timers' cases. It may cause malfunction. There are many rodent damages and rodent dung, which cause short cut of electric circuit and it may happen electric stoppage or electric shock to persons. Panels are heavily damaged, so need to replace.
	Pump panel	Replace	
	Battery and charger panel	Replace	
Cables		Replace	Temporary cabling are conducted from window of pumping building. As the panels are replaced, cables should also be replaced.

Electric Facilities at Amulung Pumping Station

Classification	Equipment	Type of Works	Damage History & Present Conditions
13.2kV Switchgears	13.2kV Incoming panel	Replace	Inside and outside of panels are rusted. Points of contactors and copper plates are also rusted. As the door handle is missing, rain-water comes into panels. Springs and working parts of contactors and breakers are rusted and a lot of dust adheres them. As panels and parts are heavily deteriorated, need to replace. Transformer is re-coated. It will be able to be used in future after being changed insulation oil. Bus duct is rusted and affected by water leakage, so need to replace.
	13.2kV LA panel	Replace	
	Transformer	Inspection & Maintenance	
	Bus duct	Replace	
460V Switchgears	460V Incoming panel	Replace	Whole panels are heavily rusted. Breakers and electric meters are damaged frequently. Stoppage during operation happens frequently, though pump station office repaired the motor starter. Holders of bus bar is broken with clack and electric wires are burn down, it means security becomes poor. Need to replace. Auxiliary panel is installed on the underground floor with high humid conditions. Deterioration is proceeding. Need to replace. Inside parts of instrument panel are missing. Push button on dredger pump local control panel is damaged, so need to replace. Battery is deteriorated. Wall of panel has heavy rust, so removed from the panel. Points coating of charger is damaged by means of rodent. It is deteriorated heavily. Need to replace.
	Pump panel	Replace	
	Auxiliary panel	Replace	
	Sealing water pump local control panel	Replace	
	Drainage pump local control panel	Replace	
	Instrument panel	Replace	
	Dredger pump local control panel	Replace	
	Battery and charger panel	Replace	
Cables		Replace	As the panels are replaced, cables should also be replaced. Rusted dust also should be replaced.

Electric Facilities at Magapit Pumping Station

Classification	Equipment	Type of Works	Damage History & Present Conditions
13.2kV Switchgears	13.2kV Incoming panel	Replace	Since the expansion metal cover of ventilation at the top of panel is broken, birds come into panels and make a nest. Inside of panels are damaged by bird droppings. It causes the malfunction and short circuit. Surfaces of contactors are heavily rusted. Springs and working parts of contactors and breakers are rusted and which cause malfunction. As panels and parts are heavily deteriorated, need to replace. Transformer is re-coated. It will be able to be used in future after being changed insulation oil. Bus duct is rusted and affected by water leakage, so need to replace.
	Transformer primary panel	Replace	
	Transformer	Inspection & Maintenance	
	Bus duct	Replace	
460V Switchgears	Sealing water pump local control panel	Replace	Auxiliary panel is installed on the underground floor with high humid conditions by a water leakage from pipe. Surfaces and points are rusted and discolored. Push button on dredger pump local control panel is damaged, so need to replace. Specifications of replaced battery are different from those of original. It is not suited to the specifications of charger. It is deteriorated heavily. Need to replace.
	Drainage pump local control panel	Replace	
	Dredger pump local control panel	Replace	
	Battery and charger panel	Replace	
Cables		Replace	As the panels are replaced, cables should also be replaced. Rusted dust also should be replaced.

Electric Facilities at Amulung Substation

Classification	Equipment	Type of Works	Damage History & Present Conditions
13.8kV Switchgears	13.8kV Incoming panel	Inspection and Maintenance	Electric points covers are rusted because of open type facilities. However their deterioration is lighter than that of other electric facilities at pumping stations. Insulators, transformers and outside panels are re-coated. They will be able to be used in future after repairing the damaged portions, replacing the deteriorated battery or checking the transformers. Enclosed type panels are affected by means of leaked water from broken roof of storing house. They need to be conducted the inspection and maintenance.
	Auxiliary transformer panel		
230V Switchgears	Control panel	Inspection and Maintenance	
	Distribution panel		
	Instrument panel		
	Battery and charger panel		
	Battery	Replace	
69kV substation	Disconnecting switch	Inspection and Maintenance	
	Lightning arrester		
	Oil circuit breaker		
	Current transformer		
	Potential and current transformer		
	Transformer		
	Bushing current transformer		

Electric Facilities at Magapit Substation

Classification	Equipment	Type of Works	Damage History & Present Conditions
13.8kV Switchgears	13.8kV Incoming panel	Inspection and Maintenance	Facilities are open type. Top of distribution panel and electric point covers are rusted. However their deterioration is lighter than that of other electric facilities at pumping stations. Insulators, transformers and outside panels are re-coated. They will be able to be used in future after repairing the damaged insulators or checking the transformers. Although control panels are installed inside of pump building, some of switchgears are installed outside, both of them consist the system. All of them need to be conducted inspection and maintenance.
	Auxiliary transformer panel		
230V Switchgears	Control panel	Inspection and Maintenance	
	Distribution panel		
	Battery and charger panel		
69kV substation	Disconnecting switch	Inspection and Maintenance	
	Lightning arrester		
	Oil circuit breaker		
	Current transformer		
	Potential and current transformer		
	Bushing current transformer		

Appendix 5-B Rehabilitation/replacement works for the equipment

Name of pump station: Iguig pump station

Equipment name	Specification	Type of works	Parts to be replaced	Q'ty	Equipment to be purchased in
Main pump	Type: 600mm x 500mm vertical mixed flow pump with volute casing Requirement: 37.6m3/m x 13.7m x 890min-1 x 120kW	Overhaul	 Shaft sleeve Gland packing Bearing Gasket, o-ring, oilseal Compaund gauge	3 3 3 3 3 6	Japan
Motor	Type: Vertical squirrel cage induction motor Requirement: 120kW x 8P x AC460V x 60Hz	Overhaul and rewinding	 Bearing	3 3	Local
Suction valve	Type: 600mm manual sluice valve	Parts replacement	Packing	3	Japan
Discharge valve	Type: 600mm motorized butterfly valve	Parts replacement	Packing Actuator	3 3	Japan
Main pipe	Diameter: 600mm Material: Rolled steel	Repairing leakage portion		Necessary portion	Local
Sealing water pump	Type: 32mm submersible motor pump Requirement: 60l/m x 39m x 3600min-1 x 1.5kW	Repalcement		2	Japan
Duplex strainer	50mm duplex strainer	Repalcement		2	Japan
Drain pump	Type: 80mm submersible motor pump Requirement: 600l/m x 23m x 1800min-1 x 7.5kW	Replacement		2	Japan
Intake screen	Dimension: 1.6mW x 2.6mH Material: Mild steel	Repainting		1	Local
Ventillation		Replacement	Duct	1	Local
Pipe for auxiliary equipment		Replacement	Pipe and fittings	1	Local
Sand pump	Type: 80mm submersible motor pump Requirement: 500l/m x 12m x 1800min-1 x 3.7kW			2	Japan

Rehabilitation/replacement works for the equipment

Name of pump station: Iguig pump station

Classification	Equipment	specification	Type of works	Q'ty
13.2kV Switchgears	13.2kV Incoming panel	Metal enclosed, self-standing for indoor use	replace	1
	13.2kV LA panel	3P, 13.2kV, 60Hz, 600A	replace	1
	Transformer	ONAN, outdoor type	Inspection and	1
		3P, 13.2/0.48kV, 500kVA	Maintenance	
	Bus duct	3P, 13.2kV, outdoor type	replace	1
460V Switchgears	460V Incoming panel	Metal enclosed, self-standing for indoor use	replace	1
		3P, 13.2kV, 60Hz, 800A		
	Pump panel	120kW x 3	replace	3
	Auxiliary panel	3P, 13.2kV, 60Hz, 225A	replace	1
	Sealing Water Pump	Metal enclosed, wall-mounting for indoor use	replace	1
	Local Control Panel			
	Drainage Pump Local Control Panel	Metal enclosed, wall-mounting for indoor use	replace	1
	Dredger Pump Local Control Panel	Metal enclosed, wall-mounting for indoor use	replace	1
	Battery and charger panel	Metal enclosed, self-standing for indoor use	replace	1
		Nickel-cadmium pocket plate alkaline type		
		DC100V, 60Ah/5hr		
Cable			replace	1set

Rehabilitation/replacement works for the equipment

Name of pump station: Amulung pump station

Equipment name	Specification	Type of works	Parts to be replaced	Q'ty	Equipment to be purchased in
Main pump	Type: 700mm x 600mm	Overhaul		3	Japan
(High lift line)	vertical mixed flow pump		Shaft sleeve	3	
	with volute casing		Gland packing	3	
	Requirement: 70.5m3/m x		Bearing	3	
	20.5m x 593min-1 x		Gasket, o-ring, oilseal	3	
	315kW		Compaund gauge	6	
Main pump	Type: 800mm	Overhaul		1	Japan
(Low lift line)	vertical mixed flow pump		Shaft sleeve	1	
	with volute casing		Gland packing	1	
	Requirement: 80.3m3/m x		Bearing	1	
	13.6m x 593min-1 x		Gasket, o-ring, oilseal	1	
	240kW		Compaund gauge	2	
Motor	Type: Vertical squirrel	Overhaul and		3	Local
(High lift line)	cage induction motor	rewinding			
	Requirement: 315kW x		Bearing	3	
	12P x AC460V x 60Hz				
Motor	Type: Vertical squirrel	Overhaul and		1	Local
(Low lift line)	cage induction motor	rewinding			
	Requirement: 240kW x		Bearing	1	
	12P x AC460V x 60Hz				
Suction valve	Type: 700mm manual	Parts replacement	Packing	3	Japan
(High lift line)	sluice valve				
Suction valve	Type: 800mm manual	Parts replacement	Packing	1	Japan
(Low lift line)	sluice valve				
Discharge valve	Type: 700mm motorized				Japan
(High lift line)	butterfly valve	Parts replacement	Packing	3	
		Inspection/maintenance	Actuator	3	
Discharge valve	Type: 800mm motorized				Japan
(Low lift line)	butterfly valve	Parts replacement	Packing	1	
		Inspection/maintenance	Actuator	1	
Main pipe	Diameter: 700mm, 800mm	Repairing leakage	outside of the building	Necessary	Local
	Material: Rolled steel	portion		portion	
			700mm/800mm sleeve joint	6	Japan
Sealing water pump	Type: 40mm submersible motor pump	Repalcement		2	Japan
	Requirement: 200l/m x 39m x 3600min-1 x 3.7kW				
Duplex strainer	50mm duplex strainer	Repalcement		2	Japan
Drain pump	Type: 80mm submersible motor pump	Replacement		2	Japan
	Requirement: 600l/m x 27m x 1800min-1 x 7.5kW				
Intake screen	Dimension: 2mW x 2.6mH	Repainting		2	Local
	Material: Mild steel				
Ventillation		Replacement	Duct	1	Local
Pipe for auxiliary equipment		Replacement	Pipe and fittings	1	Local
Sand pump	Type: 80mm submersible motor pump			2	Japan
	Requirement: 500l/m x 12m x 1800min-1 x 3.7kW				

Rehabilitation/replacement works for the equipment

Name of pump station: Amulung pump station

Classification	Equipment	specification	Type of works	Q'ty
13.2kV Switchgears	13.2kV Incoming panel	Metal enclosed, self-standing for indoor use	replace	1
	13.2kV LA panel	3P, 13.2kV, 60Hz, 600A	replace	1
	Transformer	ONAN, outdoor type	Inspection and	1
		3P, 13.2/0.48kV, 2000kVA	Maintenance	
	Bus duct	3P, 13.2kV, outdoor type	replace	1
460V Switchgears	460V Incoming panel	Metal enclosed, self-standing for indoor use	replace	1
		3P, 13.2kV, 60Hz, 800A		
	Pump panel	315kW x 3, 240kW x 1	replace	4
	Auxiliary panel	3P, 13.2kV, 60Hz, 400A	replace	1
	Sealing Water Pump	Metal enclosed, wall-mounting for indoor use	replace	1
	Local Control Panel			
	Drainage Pump Local Control Panel	Metal enclosed, wall-mounting for indoor use	replace	1
	Instrument panel	Metal enclosed, wall-mounting for indoor use	replace	1
	Dredger Pump Local Control Panel	Metal enclosed, wall-mounting for indoor use	replace	1
	Battery and charger panel	Metal enclosed, self-standing for indoor use	replace	1
		Nickel-cadmium pocket plate alkaline type		
		DC100V, 60Ah/5hr		
Cable			replace	1set

Rehabilitation/replacement works for the equipment

Name of pump station: Iguig booster pump station

Equipment name	Specification	Type of works	Parts to be replaced	Q'ty	Equipment to be purchased in
Main pump	Type: 200mm submersible motor centrifugal pump Requirement: 5.4m3/m x 9.9m x 1740min-1 x 15kW Submersible motor Requirement: 15kW x 4P x AC460V x 60Hz	Replacement		3	Japan
Discharge valve	Type: 200mm motorized butterfly valve	Replacement		3	Japan
Non-return valve	Type: 200mm swing type non-return valve	Replacement		3	Japan
Main pipe	Diameter: 200mm, 250mm Material: Rolled steel	Replacement Replacement	 250mm sleeve joint	3 6	Local Japan
Overhead crane	Type: 0.5ton chainblock	Replacement		1	Local

Rehabilitation/replacement works for the equipment

Name of pump station: Iguig booster pump station

Classification	Equipment	specification	Type of works	Q'ty
13.2kV Switchgears	13.2kV Incoming panel	Metal enclosed, self-standing for indoor use	replace	1
	13.2kV LA panel	3P, 13.2kV, 60Hz, 600A	replace	1
		3P, 75kVA ONAN transformer		
230V Switchgears	230V Incoming panel	Metal enclosed, self-standing for indoor use	replace	1
		3P, 13.2kV, 60Hz, 225A		
	Pump panel	15kW x 3	replace	3
	Battery and charger panel	Metal enclosed, self-standing for outdoor use	replace	1
		Nickel-cadmium pocket plate alkaline type		
		DC100V, 60Ah/5hr		
Cable			replace	1set

Rehabilitation/replacement works for the equipment

Name of pump station: Magapit pump station

Classification	Equipment	specification	Type of works	Q'ty
13.2kV Switchgears	13.2kV Incoming panel	Metal enclosed, self-standing for indoor use	replace	1
	Transformer primary panel	3P, 13.2kV, 60Hz, 600A	replace	2
	Transformer	ONAN, outdoor type	Inspection and	2
		3P, 13.2/0.48kV, 3500kVA	Maintenance	
	Bus duct	3P, 13.2kV, outdoor type	replace	2
	Sealing Water Pump	Metal enclosed, wall-mounting for indoor use	replace	1
	Local Control Panel			
	Drainage Pump Local Control Panel	Metal enclosed, wall-mounting for indoor use	replace	1
	Dredger Pump Local Control Panel	Metal enclosed, wall-mounting for indoor use	replace	1
	Battery and charger panel	Metal enclosed, self-standing for indoor use	replace	1
		Nickel-cadmium pocket plate alkaline type		
		DC100V, 60Ah/5hr		
Cable			replace	1set

Rehabilitation/replacement works for the equipment

Name of pump station: Magapit pump station

Equipment name	Specification	Type of works	Parts to be replaced	Q'ty	Equipment to be purchased in
Main pump	Type: 1800mm x 1500mm vertical mixed flow pump with volute casing Requirement: 340m3/m x 14.6m x 296min-1 x 1050kW	Overhaul	 Shaft sleeve Gland packing Bearing Gasket, o-ring, oilseal Compaund gauge	4 4 4 4 4 8	Japan
Motor	Type: Vertical wound rotor induction motor Requirement: 1050kW x 24P x AC3300V x 60Hz	Inspection/maintenance	 Brush Bearing	4 4 4	Local
Suction valve	Type: 1800mm motorized butterfly valve	Parts replacement	Packing Actuator	4 4	Japan
Discharge valve	Type: 1650mm motorized butterfly valve	Parts replacement Inspection/maintenance	Packing Actuator	4 4	Japan
Flap valve	Type: 2000mm dia. muti-door flap valve	Repainting		4	Local
Main pipe	Diameter: 1500mm, 1800mm Material: Rolled steel	Repairing leakage portion		Necessary portion	Local
Sealing water pump	Type: 65mm submersible motor pump Requirement: 440l/m x 30m x 3600min-1 x 5.5kW	Repalcement		2	Japan
Duplex strainer	50mm duplex strainer	Repalcement		2	Japan
Circulation pump	Type: 32mm line pump Requirement: 60l/m x 39m x 3600min-1 x 1.5kW	Replacement		4	Japan
Drain pump	Type: 100mm submersible motor pump Requirement: 1300l/m x 27m x 1800min-1 x 15kW	Replacement		2	Japan
Cooling unit		Replacement		4	Local
Intake screen	Dimension: 3mW x 4.5mH Material: Mild steel	Repainting		1	Local
Ventillation		Repainting	Duct	4	Local
Pipe for auxiliary equipment		Replacement	Pipe and fittings	1	Local

Rehabilitation/replacement works for the equipment

Name of pump station: Amulung substation

Classification	Equipment	specification	Type of works	Q'ty
13.8kV Switchgears		Metal enclosed, self-standing for outdoor use	Inspection and	1
	13.8kV Incoming panel	3P, 13.8kV, 60Hz, 600A	Maintenance	
	Auxiliary transformer panel	3P, 13.8/0.24kV, 30kVA		
230V Switchgears			Inspection and	1
	Control panel	Metal enclosed, self-standing for indoor use	Maintenance	
	Distribution panel	Metal enclosed, self-standing for indoor use		
	Instrument panel	Metal enclosed, self-standing for indoor use		
	Battery and charger panel	Metal enclosed, self-standing for indoor use		
		Nickel-cadmium pocket plate alkaline type	replace	1set
		DC100V, 60Ah/5hr		
69kV substation		Open switchyard type	Inspection and	1
	Disconnecting switch	3P, 600A	Maintenance	
	Lightning arrester	60kV,10kA		
	Oil circuit breaker	3P, 600A		
	Current transformer	50/5A		
	Potential and current transformer	69kV/115V		
	Transformer	ONAN		
		3P, 67/13.8kV, 3000kVA		
	Bushing current transformer	150/5A		

Rehabilitation/replacement works for the equipment

Name of pump station: Magapit substation

Classification	Equipment	specification	Type of works	Q'ty
13.8kV Switchgears		Metal enclosed, self-standing for outdoor use	Inspection and	1
	13.8kV Incoming panel	3P, 13.8kV, 60Hz, 600A	Maintenance	
	Auxiliary transformer panel	3P, 13.8/0.24kV, 30kVA		
230V Switchgears			Inspection and	1
	Control panel	Metal enclosed, self-standing for indoor use	Maintenance	
	Distribution panel	Metal enclosed, self-standing for indoor use		
	Battery and charger panel	Metal enclosed, self-standing for indoor use		
		Nickel-cadmium pocket plate alkaline type		
		DC100V, 60Ah/5hr		
69kV substation		Open switchyard type	Inspection and	1
	Disconnecting switch	3P, 600A	Maintenance	
	Lightning arrester	60kV,10kA		
	Oil circuit breaker	3P, 600A		
	Current transformer	1000/5A		
	Potential and current transformer	69kV/115V		
	Transformer	ONAN		
		3P, 67/13.8kV, 7000kVA		
	Bushing current transformer	400/5A		

Equipment and Tools for Inspection and Maintenance

Measuring Equipment and Tools

Equipment/Tools	Q'ty *
Vivro meter	2
Thickness gauge	2
Dial gauge with stand	2
High voltage detector	2
Low voltage detector	2
Clamp ammeter	2
Electrical tester	2
Insulation resistance tester (Megger)	2
Grounding resistance tester	2
Earth hook set	2
Insulation gloves	2
Electrician tool set	2

* 1unit for each pump irrigation office (IAAPIS, MPIS)

Hanging equipment and Tools

Pumping station	Equipment/Tools	Specification	Q'ty
Iguig pumping station	Wire rope	dia.16mm x 6m	4
	Shackle		8
Amulung pumping station	Wire rope	dia.20mm x 6m	4
	Shackle		8
Magapit pumping station	Wire rope	dia.33.5mm x 6m	4
	Shackle		8
Iguig Booster pumping station	Wire rope	dia.16mm x 6m	4
	Shackle		8

Appendix-5-C Records on Troubles and their Repairs of Pump Facilities

IGUIG Pump Station

YEAR	EQUIPMENT / TROUBLE	REPAIR DESCRIPTIONS
1991	Nos. 1, 2, 3, Motors / Periodical inspection	Overhaul, cleaning, stator coil drying and repainting.
1996	Outdoor transformer / Periodical inspection	Insulation oil filtering, sludge removal and de-aeration, radiator repainting.
1999	Nos. 1, 2, 3, Motors / Periodical inspection	Overhaul, cleaning, stator coil drying and repainting.
1999	No. 2 Motor / Insulation resistance drop	Rewinding of stator coil in Manila.
2000	No. 2 Motor / High vibration	Thrust bearing replacement.
2001	Nos. 1, 2 Main pump gland / Water leak	Gland packing replacement.
2001	No. 3 Motor / Bearing damaged	Inspected.
2002	No. 3 Main pump gland / Water leak	Gland packing replacement.
2002	No. 1 Discharge valve / Malfunction	No repair record.
2002	Nos. 2, 3 Main pump gland / Water leak	Gland packing replacement.
	<Other typical troubles>	
1)	Nos. 1, 2, 3 Main pump control panels / Start failure	Magnet contactor removal and contact cleaning / polishing.
2)	Battery and charger panel / “DC Fault” indication	Charger and batteries inspected.
3)	Nos. 1, 2, 3 Discharge valves / Motor actuator stained and malfunction	Magnet contactor, limit switches inspected, but highly stained and not remedied. Pump operation with the valve fully opened.
4)	Nos. 1, 2 Sealing water pumps	Pump bearings, motors, foot valves repaired.
5)	Nos. 1, 2 Drain pumps	Impellers, bushings, bearings, oilers repaired.
6)	Ventilation ducts / Corroded	No repair record.
7)	Lighting facilities / Damaged	Bulb replacement, installation of temporary lighting around pumps. Those at high locations left non-repaired.
8)	Suction inclined gate / Operation impossible, shaft bending by soil settlement	No repair record. Suction pit dewatering, sand removal and inspection by closing the gate can not be done.

(Periodical inspection of outdoor transformer and main pump motors was carried out by inspection companies.)

IGUIG Booster Pump Station

YEAR	EQUIPMENT / TROUBLE	REPAIR DESCRIPTIONS
1991	Nos. 1, 2, 3 Motors / Periodical inspection	Overhaul, cleaning, stator coil drying and repainting.
1999	Nos. 1, 2, 3 Motors / Periodical inspection	Overhaul, cleaning, stator coil drying and repainting.
2000	Nos. 1, 2, 3 Main pump / Motor over current by pump bearing wear	Thrust bearing, radial bearing replacement.
2000	No. 2 Main pump gland / Water leak	Overhaul and readjustment.
2000	No. 3 Main pump foot valve / Malfunction	Cleaning and inspection.
2001	No. 1 Main pump / Shaft, bearing	Shaft repair by welding and machining, radial bearing replacement.
2002	Nos. 1, 2, 3 Main pump bearings / Wear and abnormal sound	Overhaul, radial bearing replacement.
2002	Nos. 1, 2, 3 Main pump / Bearings and bushings	Overhaul, repair, bearing replacement.
	<Other typical troubles>	
1)	Nos. 1, 2, 3 Main pumps / Impeller wear	Overhaul, cleaning.
2)	Nos. 1, 2, 3 Foot valves / Malfunction	Cleaning, inspection.
3)	Nos. 1, 2, 3 Discharge valve/ Leak at gland	No repair record.
4)	Lighting facilities / Damaged	No repair record.

(Periodical inspection of main pump motors was carried out by inspection company.)

AMULUNG Pump Station

YEAR	EQUIPMENT / TROUBLE	REPAIR DESCRIPTIONS
1991	Nos. 1, 2, 3, 4 Motors / Periodical inspection	Overhaul, cleaning, stator coil drying and repainting.
1996	Outdoor transformer / Periodical inspection	Oil leak repair, top cover gasket replacement, coil demoisturing, sludge removal and de-aeration of insulation oil, radiator cleaning / rust removal, repainting, readjustment and test.
1999	No. 3 Motor overheat	No repair record.
1999	Nos. 1, 2, 4 Motor / Periodical inspection	Overhaul, cleaning, stator coil drying and repainting.
1999	No. 3 Motor / Insulation resistance drop	Stator coil rewinding in Manila.
2000	No. 2 Main pump control panel / Wiring burnt	Burnt and melted terminals replaced.
2001	No. 4 Main pump gland / Water leak	Gland packing replacement.
2001	No. 2 Main pump gland / Gland broken	Gland bolts replaced.
2001	No. 3 Main pump gland / Water leak	Gland packing replacement
2002	No. 2 Discharge valve / Malfunction	No repair record.
2002	Nos. 1, 2, 3, Main pump gland / Water leak, gland distortion	Gland packing replacement.
2002	No. 4 Main pump / Shaft sleeve wore	Shaft sleeve repaired by welding and machining.
2002	Outdoor transformer / Periodical inspection	Oil leak repair, top cover gasket replacement, coil demoisturing, sludge removal and de-aeration of insulation oil, radiator cleaning / rust removal, repainting, readjustment and test.
	<Other typical troubles>	
1)	Nos. 1, 2, 3 Main pump control panels / Start failure	Magnet contactor removal for contact cleaning and polishing.
2)	Battery and charger panel / “DC Fault” indication	Charger and batteries inspected.
3)	Nos. 1, 2 Sealing water pumps	Pump bearings, motors, foot valves repaired.
4)	Nos. 1, 2 Drain pumps	Impellers, bushings, bearings, oilers repaired.
5)	Ventilation ducts / Corroded	No repair record.
6)	Lighting facilities / Damaged	Bulb replacement and installation of temporary lighting around pumps. Those at high locations left non-repaired.
7)	Suction inclined gates / Operation impossible, shaft bending by soil settlement	No repair record. Suction pit dewatering, sand removal and inspection by closing the gates can not be done.

(Periodical inspection of outdoor transformer and main pump motors was carried out by inspection companies.)

MAGAPIT Pump Station

YEAR	EQUIPMENT / TROUBLE	REPAIR DESCRIPTIONS
1990	Nos. 1, 2 Drain pumps	Intermediate bearing replacement.
1990	Nos. 1, 2 Sealing water pumps	Rubber bushing replacement.
1990	Nos. 1, 2, 3, 4 Water cooling units	Cooling water circulation pumps and coolers replaced.
1991	Nos. 1, 2, Drain pumps	Rewinding of motor coils.
1997	No. 4 Suction pit / Sand accumulated and blocked	Left and sand removal works completed in 2000.
1998	No. 4 Motor/ Burnt	Coil rewinding, motor bearings and slip rings replaced (at pump station by repair company).
2001	Nos. 1, 2, 3 Motor / Periodical inspection	Overhaul, cleaning, drying, insulation recovery, brush lifting device readjustment, motor bearing replacement and lubrication oil replacement. Surge test, coil winding resistance measurement, insulation resistance test, load test and no load test.
2002	Nos. 1, 2 Outdoor transformers / Periodical inspection	Oil leak repair, gasket replacement, sludge removal and de-aeration of insulation oil, radiator cleaning / rust removal, repainting, readjustment and test.
2001	Battery and charger panel	Batteries replaced.
	<Other typical troubles>	
1)	Nos. 1, 2 Sealing water pumps	Foot valves repaired.
2)	Nos. 1, 2 Drain pumps	Impellers, bushings, bearings, oilers repaired.
3)	Lighting facilities / Trouble	Bulb replacement, installation of temporary lighting around pumps. Those at high locations left non-repaired.
4)	Oil circuit breaker and contactor in each electrical panel / Malfunction	Contacts cleaned and polished.

(Periodical inspection of outdoor transformer and main pump motors was carried out by inspection companies.)

AMULUNG Sub Station

YEAR	EQUIPMENT / TROUBLE	REPAIR DESCRIPTIONS
1997	Battery and charger panel / Transformer	Coil rewinding.
1998	Outdoor transformer automatic tap changing device / Periodical inspection	Oil leak repair, gasket replacement, sludge removal and de-aeration of insulation oil, radiator cleaning /rust removal, readjustment, repainting and test.
2002	Outdoor transformer automatic tap changing device / Periodical inspection	Gasket replacement, sludge removal and de-aeration of insulation oil, desiccation agent replacement, repainting, readjustment and test.
	<Other typical troubles>	
	Power transmission lines and electric poles to pump stations damaged by typhoon	Inclined electric poles repaired.

(Periodical inspection of outdoor transformer was carried out by inspection company.)

MAGAPIT Sub Station

YEAR	EQUIPMENT / TROUBLE	REPAIR DESCRIPTIONS
2002	Outdoor transformer / Periodical inspection	Oil leak repair, gasket replacement, sludge removal from insulation oil, radiator cleaning, readjustment, repainting and test.

(Periodical inspection of outdoor transformer was carried out by inspection company.)

Appendix 5-D . The Culculation for Motor Output in IGUIGU Booster Pump

1. Basic conditions

1-1) Main pump			
1) Purpose	:	Irrigation	
2) Pump type	:	Submersible mixed-flow volute pump	
3) Pump numbers to be installed	:	3	nos.
4) Pump numbers to be operated (N)	:	3	nos.
5) Total discharge flow (Q)	:	16.20	m^3/min
1-2) Discharge Pipe			
1) Materials	:	Steel pipe	
2) Nominal diameter (D)	:	250	mm
3) Pipe length (L)	:	20.4	m
4) Loss coefficient (C)	:	0.033	
	:		
1-3) Watre Level			
1) Suction pit water level			
(1) Lowest water level (L.W.L)	:	17.35	m
(2) Highest water level (H.W.L)	:	20.00	m
(3) Design water level (S.W.L)	:	17.35	m
2) Discharge tank water level			
(1) Lowest water level (L.W.L)	:	25.55	m
(2) Highest water level (H.W.L)	:	25.55	m
(3) Design water level(D.W.L)	:	25.55	m
1-4) Inhouse friction loss,etc (Hp)	:	0.59	m
(1) Check valve loss	:	0.42	m
(2) Discharge loss	:	0.17	m

2. Basic design calculation

2-1) Capacity of each pump (q)

$q = Q / N$: 5.40 m^3/min

2-2) Discharge pipe friction loss (Hf)

$Hf = CxL/DxV^2/2g$: 0.46 m

Designed actual head (Ha)

$Ha = DWL - SWL$: 8.20 m

3. Pump total head (HT)

$HT = Hf + Hp + Ha$: 9.25 m

Pump total head is decided as; : 9.9 m

4. Motor output (P)

4-1) Required motor output (P)

$P = K \times \gamma \times q \times HT \times (1 + \alpha) / \eta P / \eta G$		:	12.53	kw
where, K	: 0.163 (Elec.moter), 0.222 (Engine)	:	0.16	
γ	: Density of water	:	1.00	kgf/l
q	: Pump capacity	:	5.40	m^3/min
HT	: Total head	:	9.9	m
ηP	: Pump efficiency	:	80	%
ηG	: Reduction gear efficiency	:	100	%
α	: Allowance	:	15	%
Motor output is decided as;		:	15	kw

5. Pump rotation speed (n)

5-1) Net positive suction head available NPSH (AV)

NPSH (AV) = HA - Hs - hV - HL ----------(1)		:	10.09	m
where, HA	: Atomospheric pressure $10.33 \times (1-2.257 \times 10^{-5} \times h)^{5.526}$	:	10.33	m
h	: Altitude	:	0.00	m
Hs	: Actual suction head(suction:positive)	:	0.00	m
hV	: Vapour pressure (20 ℃)	:	0.24	m
HL	: Suction pipe friction loss(at pumprated capacity)	:	0.00	m

5-2) Net positive suction head required NPSH (RQ)

NPSH (RQ) = $(n \times q^{0.5}/S)^{4/3}$ ----------(2)

where, n : Pump rotation speed (min-1)

q	: Pump capacity	:	5.40	m^3/min
S	: Suction specific speed	:	1,500	

Centrifugal pump (S=1500)
Mixed-flow pump (S=1300)
Axial-flow pump (S=1200)

From equation (1) and (2),NPSH (AV) ＞ NPSH (RQ)

$n < S \times (NPSH(AV))^{3/4} / q^{0.5}$ and $n <$ 3,654 min^{-1}

5-3) Specific speed (Ns)

n = Ns x HT3/4/q0.5		:	1,921	min^{-1}
where, Ns	: Specific speed by pump type and ratings	:	800	
q	: Pump capacity	:	5.40	m^3/min
HT	: Pump total head	:	9.9	m

Total head at one stage for multi stage pump

Pump synchronous speed is decided in consideration of
frequency of the area and number of motor poles as follows.
Selected rotation speed is less than the maximum speed lead by
the equations (1) and (2).

: 1,800 min^{-1}

Appendix.5-E Expenditures for Operation and Maintenance

Fixed Expenditures (Peso)	Amulung Office	Magapit Office
Personnel Expenditures	3,434,000	10,674,000
Office Expenditures	117,000	1,455,000
Incentive for ISF	130,000	0
Operation Cost for Pumps	3,895,000	12,896,000
Sub-total	7,576,000	25,025,000
O/M Cost (Peso)		
Pump Repair	200,000	500,000
Sedimentation Excavation	137,000	
Irrigation Canal	857,000	3,725,000
Drainage Canal	792,000	6,177,000
O/M Road	385,000	1,531,000
Sub-total	2,371,000	11,933,000
Total (①)	9,947,000	36,958,000
Irrigated Area (②)	5,186 ha	16,747 ha
Damaged Ratio (③)	15%	15%
Collective Ratio (④=100-③)	85%	85%
ISF Collective Area (⑤=②*④)	4,408 ha	14,235 ha
Price of Rice(peso/8Cavan(400kg)) (⑥)	3,800	3,563
ISF Collective Ratio (⑦=①/⑤/⑥)	59%	73%

TOTAL

Required ISF (①)	46,905,000 peso
Irrigated Area (②)	21,933 ha
Damaged Ratio (③)	15%
Collective Ratio (④=100-③)	85%
ISF Collective Area (⑤=②*④)	18,643 ha
Price of Rice(peso/8Cavan(400kg)) (⑥)	3,680
ISF Collective Ratio (⑦=①/⑤/⑥)	68%

Calculation for Fixed Expenditures

1)Personnel and Office Expenditures

	(Amulung Office)		(Magapit Office)	
	Personnel Exp.	Office Exp.	Personnel Exp.	Office Exp.
1999	3,141,395	110,000	10,356,922	835,339
2000	3,345,251	125,000	9,915,205	1,474,989
2001	3,364,926	115,000	10,397,598	1,433,371
Average	3,283,857	116,667	10,223,242	1,454,180
Increase Staff	1 Person		3 Persons	
Additional Exp.	150,000		450,000	
Total	3,433,857		10,673,242	

Office Expenditure in Magapit is calculated in the average of 2000 and 2001.

2)Incentive for IA

Incentive fee is calculated in the average.

1999	118,200
2000	157,300
2001	115,000
Average	130,167

3)Pump operation cost

	Irrigated Area (ha)		Electric charge (Peso/ha)	Pump operation (Peso)
	Dry Season	Wet Season		
Iguigu・Amulung	2,593	2,593	751	3,894,686
Magapit	9,784	6,963	770	12,895,190

Calculation for electric charge(for Pump) per ha.

Iguigu・Amulung

Year	Irrigated Area (ha)	Electric charge	Electric charge (Peso/ha)
1999	3,110	3,147,989	1,012
2000	3,415	2,689,940	788
2001	3,685	1,829,739	497
計	10,210	7,667,668	751

Damaged ratio in Iguigu/Amulung is high and the electric charges in the data are unstable, so that the charge is calculated in the total for 4 years.

Magapit

Year	Irrigated Area (ha)	Electric charge	Electric charge (Peso/ha)
1999	11,990	9,068,564	756
2000	8,180	4,972,092	608
2001	12,766	9,934,759	778
			770

The electric charge is calculated in the average of 1999 and 2001. One crop season in 2000 was stopped becouse of WRDP construction works.

Calculation for O/M Cost in Intake Facilities

The main work is sedimentation ecavation in the Intake. The excavation volume is assumed from the actual past records. The fuel cost only is calculated for O/M cost, because the O/M equipments are supplied.

Sedimentation Excavation Unit:m3

	1998	1999	2000	2001	2002	Average	Total
Iguigu	1,860	4,880	3,630	3,910	(19,620)	3,570	6687.5
Amulung		3,450	2,080	2,660	4,280	3,118	
Cost		583,800	380,000	425,000		462,933	
Cost per m3		70.1	66.6	64.7		67.1	

O/M Cost

Case	Excavation Volume (m3/year)	Unit Price (peso/m3)	Cost (peso/year)
Without Equipments	6,688	67.1	448,954
With Equipments	6,688	20.4	136,425

Works	Equipment	Volume	Fuel (l/kwh)	Horsepower (kw)	Ope.Hours (Hrs/day)	Fuel price (Peso/l)	Fuel cost per m3
Sedimentation Excavation	Backhoe 0.4m3	135 m3	0.188	99	5.7	20	15.7 Peso/m3
Spreading Excavated Soil	Bulldozer 16ton	430 m3	0.188	102	5.3	20	4.7 Peso/m3

Calculation for O/M Cost in Irrigation Canal

1)Iguigu, Amulung

The main works are sedimentation excavation and repairs of damaged parts of concrete canal.
The cost is calculated from the actual O/M cost for last 2 years.

O/M Cost for past 2 years

Year	2000	2001	Total	O/M Cost per km (peso/km)
Cost(peso)	200,000	174,350	374,350	91,305
Length(km)	2.2	1.9	4.1	

	Canal Length (km)	O/M Cost per km(peso/km)	O/M Cost (peso)
Iguigu	14.89	91,305	1,359,531
Amulung	32.00	91,305	2,921,760
		Total	4,281,291
		O/M Cost per year (for 5 years plan)	856,258

2)Magapit

The main works are the removal of sedimentation soil and rehabilitation of canal slope.
The cost is calculated from the actual O/M cost for last 2 years.

O/M Fee for past 2 years

Year	1999	2000	Total	O/M Cost per km (peso/km)
Fee(peso)	4,247,151	2,260,478	6,507,629	152,047
Length(km)	28.6	14.2	42.8	

	Canal Length (km)	O/M Cost per km(peso/km)	O/M Cost (peso)
Magapit	122.49	152,047	18,624,237
		Total	18,624,237
		O/M Cost per year (for 5 years plan)	3,724,847

Calculation for O/M Cost in Drainage Canal

1) Iguigu, Amulung

The fuel cost only is calculated for O/M cost, because the equipments are supplied. The volume of sedimentation soil per year was assumed from the excavated volume described in the request letter.

	Drainage Length (km)	Quantity(requested) Length for excavation (km)	Excavation (m3) (Sedimentation volume)	Sedimentation Volume per m(m3/m)	Years for Sedimentation	Sedimentation Volume per year (m3/year/m)	Sedimentation Volume per yer(m3/year)	Fuel (Peso/l)	O/M Cost (Fuel(peso/year)
Iguigu	13.63	6	13,750	2.30	12	0.192	2,612	40	104,480
Amulung	32.41	21	133,400	6.36	12	0.530	17,177	40	687,080
							19,789		791,560

O/M cost per year without equipments supply

Sedimentation Volume per yer(m3/year)	Actual Price (Peso/m3)	O/M Cost
19,789	153	3,027,717

Works	Equipment	Volume	Fuel (l/kwh)	Horsepower (kw)	Ope.Hours (Hrs/day)	Fuel Price (Peso/l)	Fuel Cost per m3
Excavation and loading	Backhoe 0.35m3	100 m3	0.188	60	5.7	20	12.9 Peso/m3
Soil Transportation(1km)	Dump Truck 4ton	36.36 m3	0.054	135	6.1	20	24.5 Peso/m3

2) Magapit

The Drainage excavation cost per m3 is caluculated from the actual works done by WDP in Magapit as follows.

Drainage Length	Actual Works			Years for Sedimentation	Annual O/M cost per m	O/M cost per year
	Exca.Length	Cost	Cost per m			
150,000	113,147	46,587,319	411.75	10	41.175	6,177,000

Calculation for O/M Cost in O/M Road

The main work for O/M is gravel laying for road. The fuel cost only is calculated, because the O/M equipments are supplied.

Iguigu

Road Width	Gravel thick.	Length	Gravel Area	Gravel	Fuel(peso) Backhoe	Fuel(peso) DumpTruck	Fuel(peso) Bulldozer	Mate. Cost(peso)	Total(peso)
3.5 m	0.10 m	6,084 m	21,294 m2	2,129 m3	17,000	212,900	17,700	212,900	460,500
3.0 m	0.10 m	4,136 m	12,408 m2	1,241 m3	9,900	124,100	10,300	124,100	268,400
Total		10,220 m	33,702 m2	3,370 m3	26,900	337,000	28,000	337,000	728,900

Alcala, Amulung

Road Width	Gravel thick.	Length	Gravel Area	Gravel	Fuel(peso) Backhoe	Fuel(peso) Dump Truck	Fuel(peso) Bulldozer	Mate. Cost(peso)	Total(peso)
3.5 m	0.10 m	9,580 m	33,530 m2	3,353 m3	26,800	335,300	27,800	335,300	725,200
3.0 m	0.10 m	7,210 m	21,630 m2	2,163 m3	17,300	216,300	18,000	216,300	467,900
Total		16,790 m	55,160 m2	5,516 m3	44,100	551,600	45,800	551,600	1,193,100
Total(Alcala & Amulung)		27,010 m	88,862 m2	8,886 m3	71,000	888,600	73,800	888,600	1,922,000
							O/M cost per year(5 years plan)		384,400

O/M cost per year without equipment supply

Gravel Area (m2/year)	Actual Price (Peso/m2)	O/M Cost (peso/year)
88,862	42.6	3,785,521
	O/M cost per year(5 years plan)	757,104

Magapit

Road Width	Gravel thick.	Length	Gravel Area	Gravel	Fuel(peso) Backhoe	Fuel(peso) Dump Truck	Fuel(peso) Bulldozer	Mate. Cost(peso)	Total(peso)
3.5 m	0.10 m	89,450 m	313,075 m2	31,308 m3	250,500	3,130,800	259,900	3,130,800	6,772,000
3.0 m	0.10 m	13,550 m	40,650 m2	4,065 m3	32,500	406,500	33,700	406,500	879,200
Total		103,000 m	353,725 m2	35,373 m3	283,000	3,537,300	293,600	3,537,300	7,651,200
							O/M cost per year(5 years plan)		1,530,240

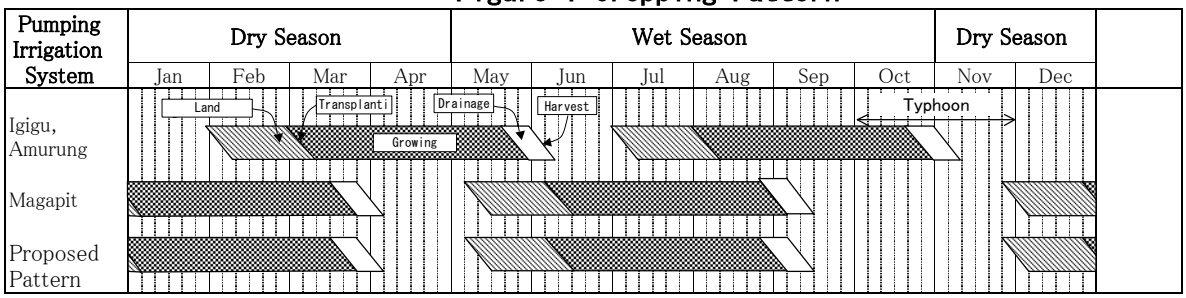
O/M cost per year without equipment supply

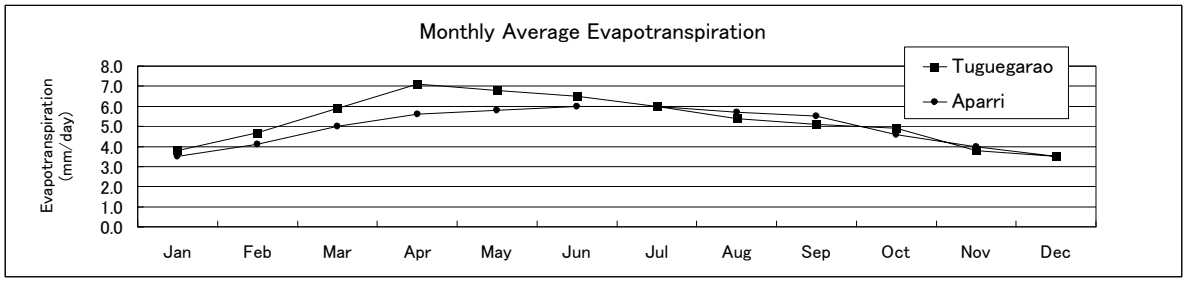
Gravel Area (m2/year)	Actual Price (Peso/m2)	O/M Cost (peso/year)
353,725	42.6	15,068,685
	O/M cost per year(5 years plan)	3,013,737

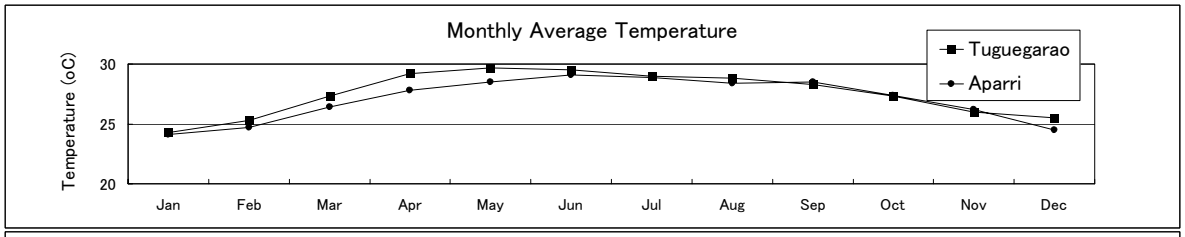
Works	Equipment	Volume	Fuel (l/kwh)	Horsepower (kw)	Ope.Hours (Hrs/day)	Fuel Price (Peso/l)	Fuel Cost per m3
Material Loading	Backhoe 0.35m3	160 m3	0.188	60	5.7	20	8.0 Peso/m3
Transportation (20km)	Dump Truck 4ton	8.89 m3	0.054	135	6.1	20	100.0 Peso/m3
Spreading and Compaction	Bulldozer 10ton	160 m3	0.188	67	5.3	20	8.3 Peso/m3
							116.3 Peso/m3

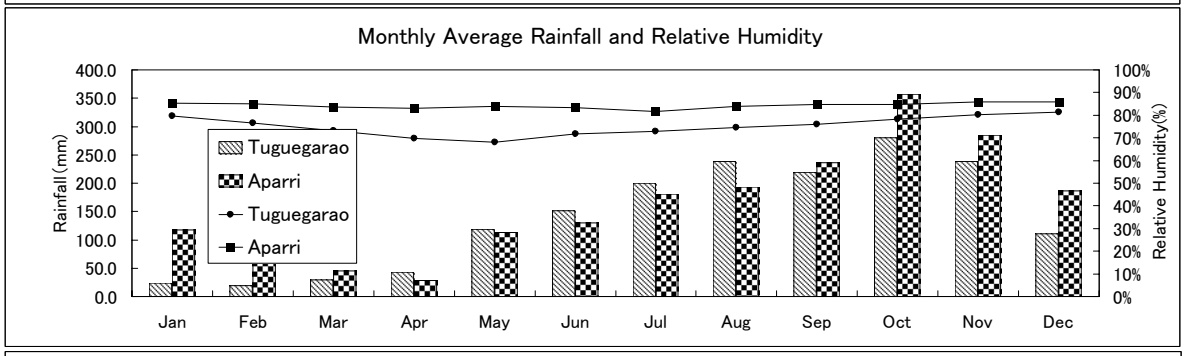
Appendix 5-F Cropping Pattern & Standard Cost and Income of Rice Production in Agricultural Pilot Center

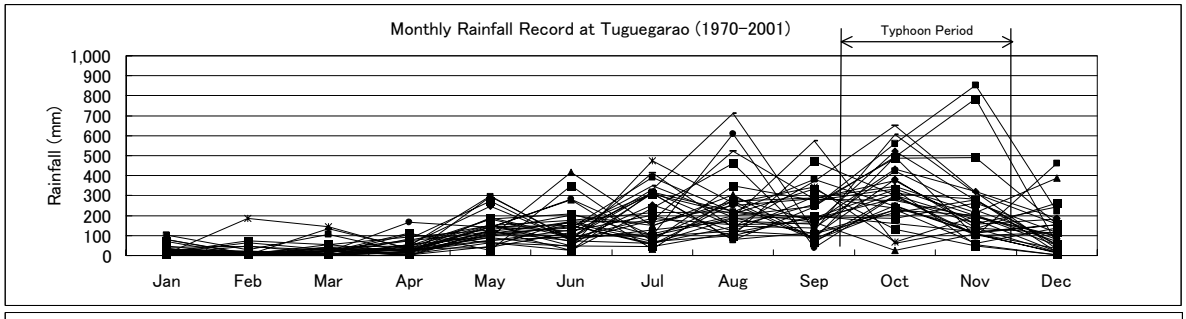
Figure-1 Cropping Pattern











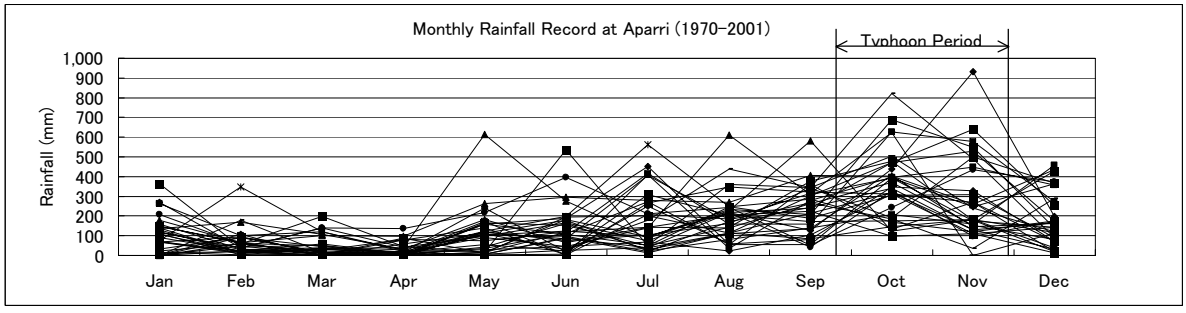


Table-2 Standard Cost and Income of Rice Production in Agricultural Pilot Center

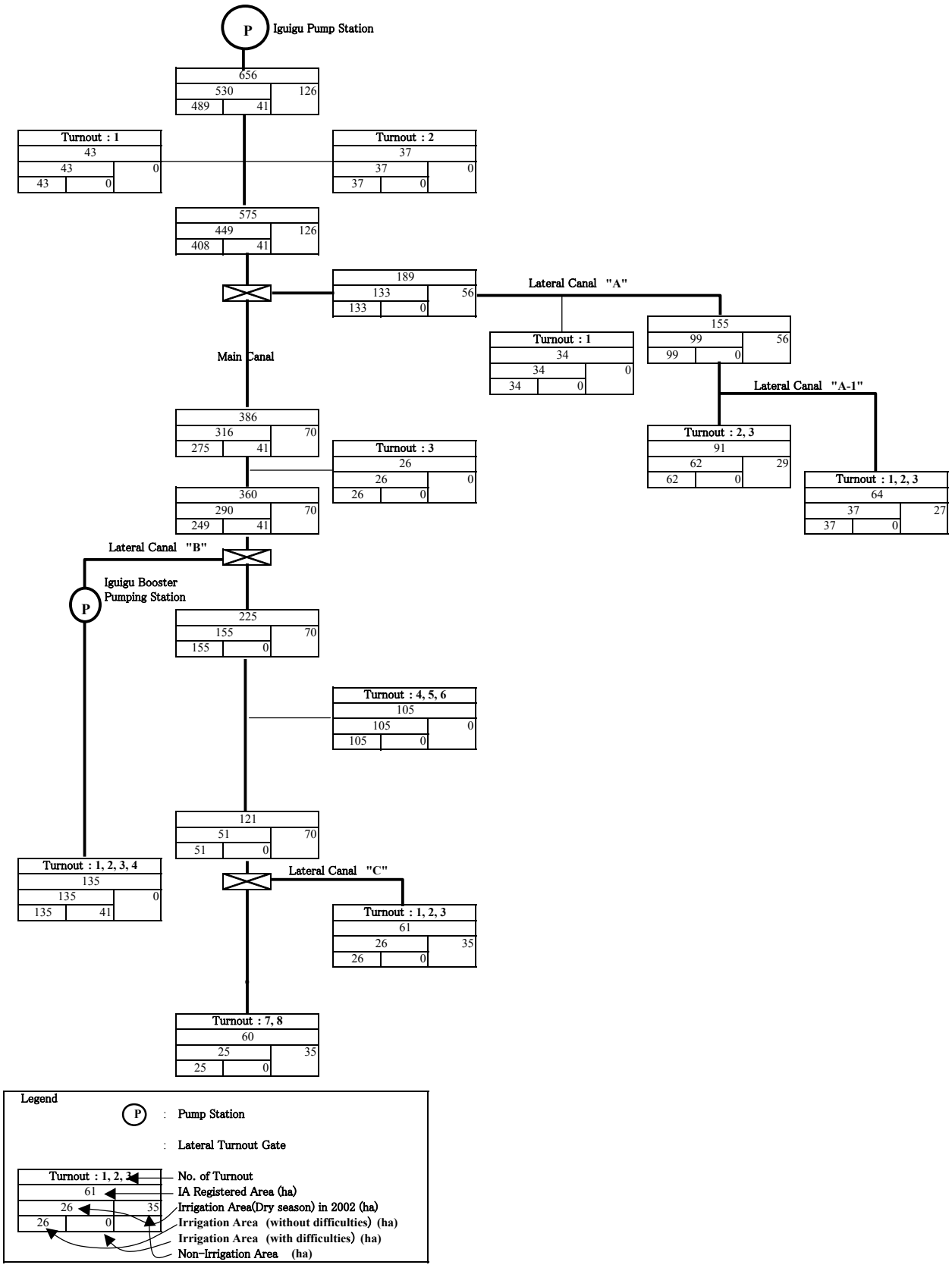
(Price in September 1996)

Item	Unit	Unit Price (P)	Quantity (/ha)	Amount (P/ha)	Remark
A. Labor Cost					
Seedbed preparation	M-A-d	130	2	260	
Sowing	M-d	60	0.5	30	
Cleaning/repairing dikes	M-d	60	2	120	
Land preparation					
Plowing	M-A-d	130	8	1,040	
First harrowing	M-A-d	130	2	260	
Second harrowing	M-A-d	130	2	260	
Final harrowing	M-A-d	130	1	130	
Fertilizer application					
(basal)	M-d	60	0.5	30	
Pulling of seedlings	M-d	60	12	720	
Transplanting	M-d	60	24	1,440	
Weeding	M-d	60	5	300	
Spraying (3x)	M-d	60	3	180	
Baiting	M-d	60	1	60	
Fertilizer application					
(topdressing)					
First	M-d	60	1	60	
Second	M-d	60	1	60	
Harvesting and threshing		5,250	1	5,250	
Hauling	cav.	2	100	200	
Drying	cav.	2	100	200	
Sub-total				**10,600**	
B. Invested Material Cost					
Certified seeds (40kg)	bag	600	1	600	(40 kg/bag)
Fertilizer					
14-14-14	bag	340	3	1,020	(50 kg/bag)
Urea	bag	375	4	1,500	(50 kg/bag)
Organic fertilizer (Lakas Ani)	bag	145	7	1,015	(50 kg/bag)
Pesticides				0	
Molluscicide	lit	750	1	750	
Herbicide	lit	360	1	360	
Insecticide	lit	500	1	500	
Fungicide	lit	600	1	600	
Sub-total				**6,345**	
C. Fixed Cost				**0**	
Irrigation fee (6% of harvest)	kg	300	7.5	2,250	100 cav x 50kg x 6% = 300 kg
Interest on capital				678	1% per month for 4 months = (A+B)x0.04
Sub-total				**2,928**	
D. Total Cost of Production				**19,873**	
E. Gross Income	kg	5,000	7.5	**37,500**	100 cav x 50kg = 5000 kg
F. Net Profit				**17,627**	
G. Net Profit Ratio				**89%**	F/D

(Source) "Region 02 Technoguide RICE (Revised Edition), December 1996, APC"

Appendix.5-G Network Diagram for Irrigation System

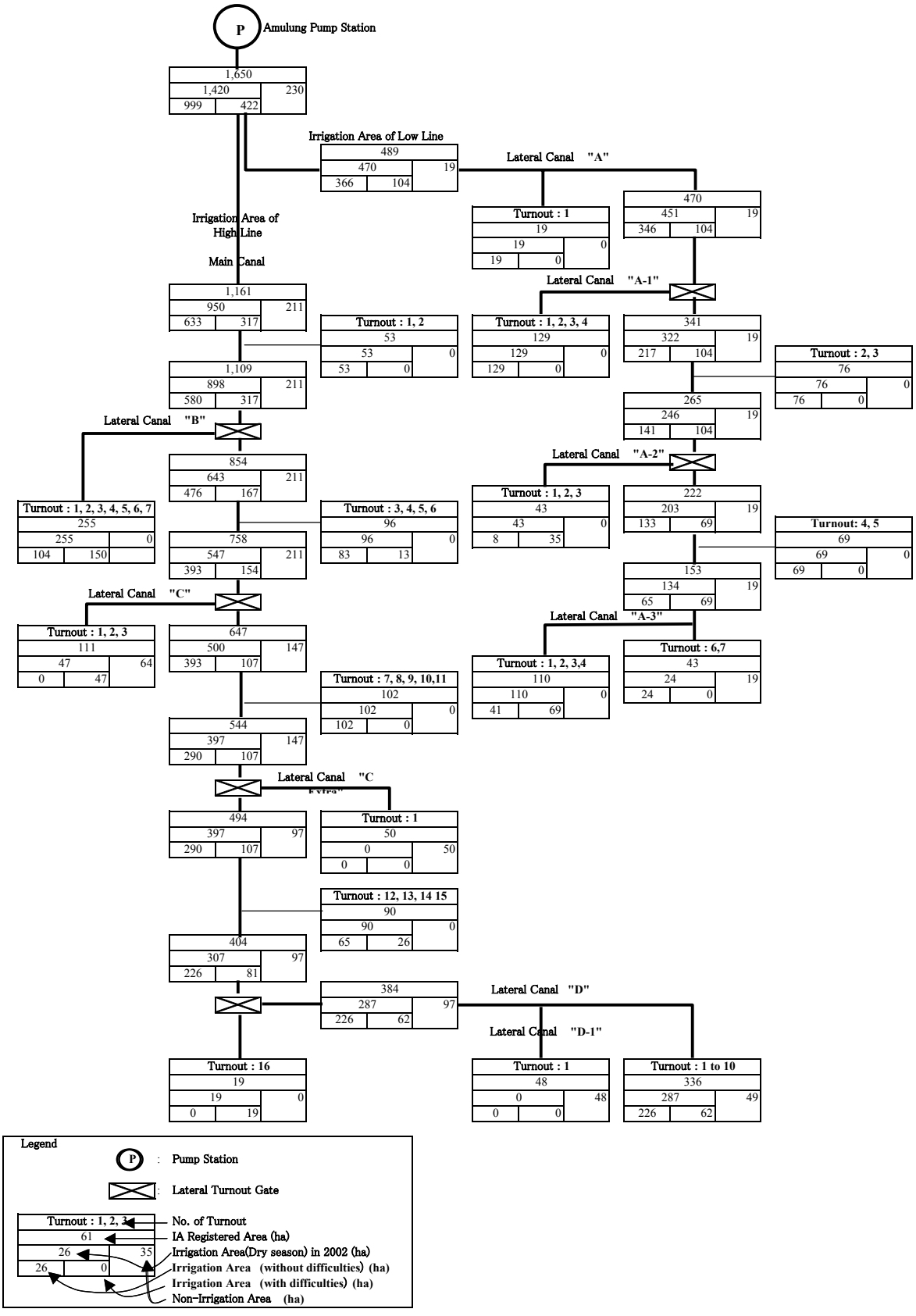
DWG-1 Network Diagram for Iguigu Pumping Irrigation System



(Note)

1) The data is based on "Irrigation Area(Dry season) in 2003" of Amulung Irrigation office.
2) Non-Irrigation Area is based on "Iguig Farm Ditch Layout Map: 1/8,000".
3) Non-Irrigation Area = IA Registered Area - Irrigation Area(Dry season) in 2002.

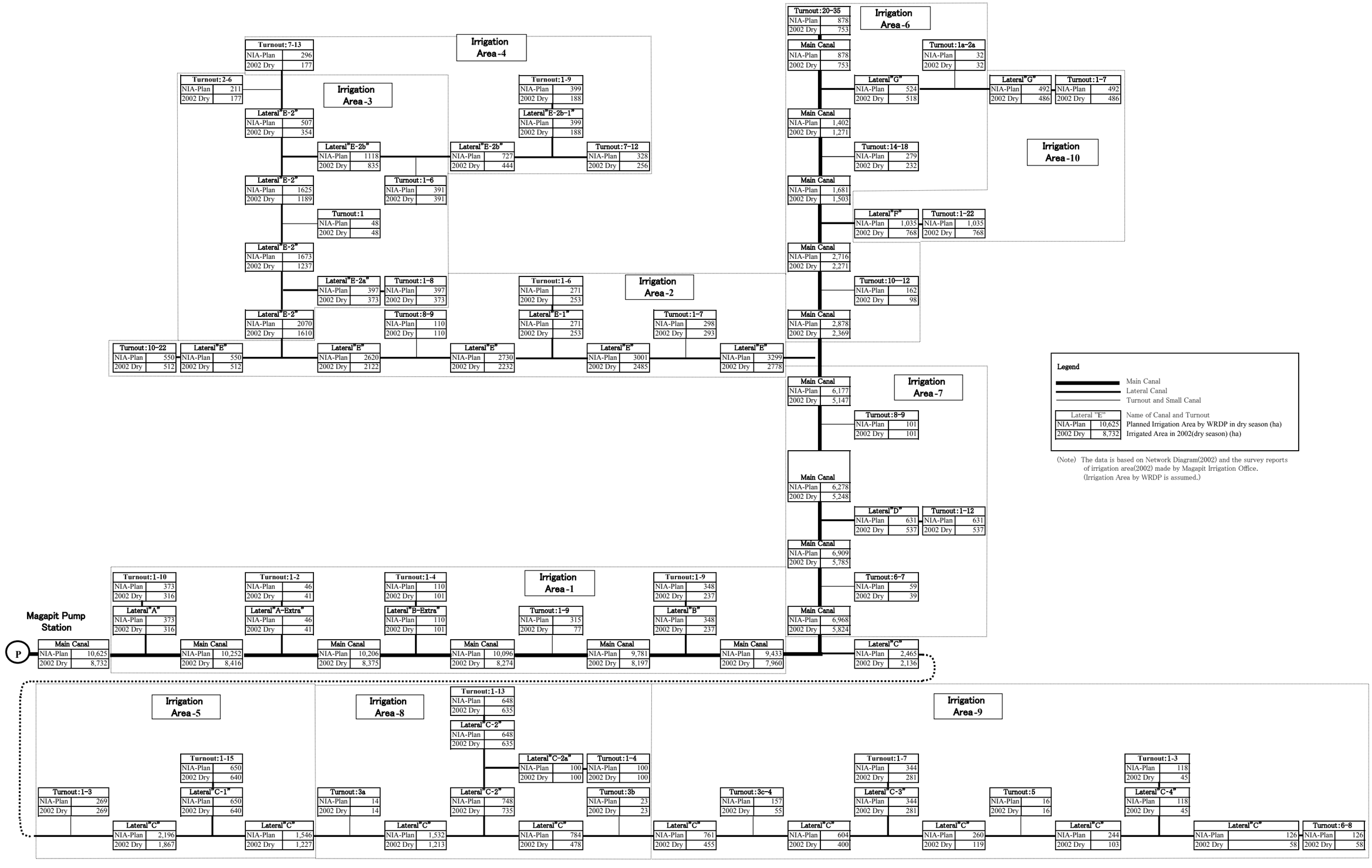
DWG-2 Network Diagram for Amulung Pumping Irrigation System



(Note)

1) The data is based on "Irrigation Area(Dry season) in 2003" of Amulung Irrigation office.
2) Non-Irrigation Area is based on "Iguig Farm Ditch Layout Map: 1/8,000".
3) Non-Irrigation Area = IA Registered Area − Irrigation Area(Dry season) in 2002.

DWG-3 Network Diagram for Magapit Pumping Irrigation System



Legend

- Main Canal
- Lateral Canal
- Turnout and Small Canal

Lateral "E"	Name of Canal and Turnout
NIA-Plan 10,625	Planned Irrigation Area by WRDP in dry season (ha)
2002 Dry 8,732	Irrigated Area in 2002(dry season) (ha)

(Note) The data is based on Network Diagram(2002) and the survey reports of irrigation area(2002) made by Magapit Irrigation Office. (Irrigation Area by WRDP is assumed.)

Table-1 Outcome of Farmhouse Survey

(Survey period:October 2002)

Pumping irrigation system	Amurung			Igigu			Average	Magapit													Average	Average
Sample farmer	(1)	(2)	(3)	(4)	(5)	(6)		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)		in area
Family number	5	3	6	3	4	6	4.5	5	5	2	7	4	6	12	5	7	4	3	5	3	5.2	4.9
Worker	1	1	1	1	1	2	1.2	1	1	1	4	2	1	7	1	2	2	1	1	1	1.9	1.6
Full-time farmer	0	1	0	0	0	1	0.3	0	0	1	4	1	1	1	1	0	1	1	1	0	0.9	0.6
Part-time farmer	1	0	1	1	1	1	0.8	1	1	0	0	1	0	6	0	1	0	0	0	1	0.8	0.8
Except farmer	0	0	0	0	0	0	0	0	0	0	0		0	0	0	1	1	0	0	0	0.2	0.1
Not worker (housewife)	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0.9	1.0
School children	3	1	4	0	1	2	1.8	3	3	0	2	2	2	4	0	4	1	1	3	1	2.0	1.9
School children	3	1	3	0	1	2	1.7	3	2	0	2	2	2	4	0	4	1	1	3	1	1.9	1.8
Preschooler	0	0	1	0	0	0	0.2	0	1	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1
Others	0	0	0	1	1	1	0.5	0	0	0	0	0	0	2	0	3	0	0	0	0	0.4	0.4
Farmland (ha)	2.34	1.43	1.99	0.56	1.45	1.1	1.48	1.5	10	1	3	4	5	7	7	3.2	2	1	5	1	3.90	2.69
Dry season crop	2.34	1.43	1.99	0.56	1.45	1.1	1.48	1.5	10	1	3	4	5	7	7	3.2	2	1	5	1	3.90	2.69
Paddy field	1.14	0.93	1.59	0.56	1.45	1.1	1.13	1.5	10	1	3	4	5	7	7	2.2	2	1	5	1	3.82	2.48
Field	1.2	0.5	0.4	0	0	0	0.35	0	0	0	0	0	0	0	0	1	0	0	0	0	0.08	0.21
Rainy season crop	2.34	1.43	1.99	0.56	1.45	1.1	1.48	1.5	5	1	3	4	2.5	7	2	3.2	2	1	3	0	2.71	2.09
Paddy field	1.14	0.93	1.59	0.56	1.45	1.1	1.13	1.5	5	1	3	4	2.5	7	2	2.2	2	1	3	0	2.63	1.88
Field	1.2	0.5	0.4	0	0	0	0.35	0	0	0	0	0	0	0	0	1	0	0	0	0	0.08	0.21
Farmhouse economy																						
Income	111,245	110,360	129,962	39,150	98,600	62,400	91,953	209,312	452,000	40,000	135,000	Educatio	256,000	205,000	180,450	328,000	106,000	58,000	215,000	143,200	200,824	146,388
Agricultural income	95,245	80,360	111,462	17,250	65,450	28,400	66,361	65,000	452,000	40,000	135,000	240,000	256,000	205,000	180,450	253,000	95,000	58,000	215,000	93,200	177,415	121,888
Crop	84,245	68,360	66,462	12,750	60,450	28,400	53,445	65,000	432,000	40,000	135,000	240,000	256,000	160,000	180,450	143,000	95,000	58,000	200,000	58,200	158,665	106,055
Hog raising	11,000	12,000	45,000	4,500	5,000	0	12,917	0	20,000	0	0		0	45,000	0	110,000	0	0	15,000	35,000	18,750	15,833
Sideline	16,000	30,000	18,500	21,900	33,150	34,000	25,592	144,312	0	0	0	24,000	0	0	0	75,000	11,000	0	0	50,000	23,409	24,500
Expenditure	113,509	107,052	139,244	41,400	99,019	62,502	93,788	189,164	359,800	60,200	140,000	236,280	217,750	195,700	135,930	253,210	110,990	29,215	180,840	106,300	170,450	132,119
Agri investment	39,689	50,472	63,744	17,950	46,649	21,222	39,954	64,564	178,600	19,800	38,800	42,000	133,750	99,500	87,650	82,810	16,890	9,955	47,200	30,300	65,561	52,758
Seed	5,135	3,900	3,880	1,027	3,900	1,252	3,182	2,800	21,000	2,400	2,800	2,600	6,500	7,000	4,550	2,860	0	0	6,000	650	4,551	3,867
Fertilizer/Chemical	5,350	16,424	19,590	4,840	16,080	6,010	11,382	6,540	54,000	2,250	13,500	16,400	70,000	20,000	26,850	10,950	8,140	2,830	10,300	5,000	18,982	15,182
Machine	1,700	1,280	0	0	0	0	497	17,500	28,000	1,500	0	8,000	0	0	20,000	2,000	0	0	6,000	1,200	6,477	3,487
Water user's fee	8,664	7,068	12,084	4,283	0	3,000	5,850	10,124	75,600	3,750	22,500	15,000	35,250	52,500	26,250	16,500	6,750	7,125	16,900	3,750	22,461	14,156
Livestock material	3,000	3,000	4,000	1,000	3,000	0	2,333	0	0	0	0	0	0	20,000	0	15,000	2,000	0	8,000	15,000	4,615	3,474
Land fee	0	0	6,400	0	12,565	0	3,161	0	0	9,900	0	0	22,000	0	5,000	3,500	0	0	0	0	3,108	3,134
Interest of financing	9,200	5,000	8,000	0	9,648	2,400	5,708	27,600	0	0	0	0	0	0	0	32,000	0	0	0	4,000	4,892	5,300
Employment	6,640	13,800	9,790	6,800	1,456	8,560	7,841	0	0		0	0	0	0	5,000	0	0	0	0	700	475	4,158
Living expenses	73,820	56,580	75,500	23,450	52,370	41,280	53,833	124,600	181,200	40,400	101,200	194,280	84,000	96,200	48,280	170,400	94,100	19,260	133,640	76,000	104,889	79,361
House/furniture	0	2,500	0	0	0	0	417	8,000	60,000	10,000	20,000	12,000	8,000	20,000	4,000	10,000	500	0	20,000	7,000	13,808	7,112
Fuel	0	1,080	1,250	0	1,620	2,640	1,098	3,600	0	0	4,000	4,680	20,000	14,000	3,480	5,000	0	1,140	3,240	1,800	4,688	2,893
Electric fee	1,020	3,000	3,000	1,200	4,800	1,440	2,410	8,000	7,200	400	7,200	24,000	6,000	7,200	4,800	5,400	3,600	3,120	8,400	1,200	6,655	4,533
Food	43,800	36,500	35,000	18,250	24,000	29,200	31,125	57,000	90,000	30,000	50,000	108,000	30,000	15,000	36,000	100,000	20,000	10,000	72,000	56,000	51,846	41,486
Education	25,000	10,000	34,250	4,000	16,950	7,000	16,200	43,000	18,000	0	20,000	21,600	20,000	40,000	0	40,000	70,000	5,000	30,000	10,000	24,431	20,315
Others	4,000	3,500	2,000	0	5,000	1,000	2,583	5,000	6,000	0	0	24,000	0	0	0	10,000	0	0	0	0	3,462	3,022
Balance	-2,264	3,308	-9,282	-2,250	-419	-102	-1,835	20,148	92,200	-20,200	-5,000	########	38,250	9,300	44,520	74,790	-4,990	28,785	34,160	36,900	30,374	14,269

(Note)

1) JICA Study Team have requested to the office of Amurung pumping irrigation office and Magapit pumping irrigation office to implement the surveys.

2) Average farmer in Magapit pumping irrigation system rents 2 ha of farmland.

Table-2 Inventory Survey for IA

(March 2003)

Pumping irrigation system	Igigu	Amurung		Sum or Average	Magapit													Sum or Average	Total or Average
WUA	1. Igum	1. Amaria	2. Hiline		1. East Ralo	2. Saniat	3. Camarap	4. North Abari	5. Futusukab	6. Kinauegan	7. Mandara	8. Daraya	9. Bicarl-Abagao	10. Mitagiba	11. JIgiran-Dodan	12. Jiminira-Fushina	13. Banganan		
WUA registration	Nov-88	Feb-89	Sep-89	89	Jul-87	May-88	Jan-88	Jun-88	Jun-88	Nov-88	Nov-88	Oct-88	Jan-88	Jan-89	Nov-88	Jul-91	May-91	87 -91	87 -91
Type of contract	Stage III	Stage III		Stage III							Type I							Type I	
Composition & number of member																			
Men	585	591	940	1,531	793	345	1,007	367	665	480	90	270	219	325	190	455	469	5,675	7,791
Women	40	20	50	70	71	21	47	16	2	49	8	20	11	26	5	28	8	312	422
Total	625	611	990	1,601	864	366	1,054	383	667	529	98	290	230	351	195	483	477	5,987	8,213
Number of farmer	625	611	990	1,601	864	366	1,054	383	877	529	98	290	230	351	195	483	508	6,228	8,454
Admission rate of WUA	100%	100%	100%	100%	100%	100%	100%	100%	76%	100%	100%	100%	100%	100%	100%	100%	94%	96%	97%
Connected canal	MC; A, A1, B, C	A, A1, A2, A3	MC; B, C, C-Extra, D, D1		A, A-ext, B-ext, MC	B, MC	E, E-1, E-2, E-2a, E-2b	E, E-2	MC, G	C, C-3, C-4	C-2a, C	C-2	C	C-1	E-2b, E-2b1	D, MC	F		
Registered area of irrigation (ha)	656	489	1,161	1,650	563	271	1,749	484	1,778	710	138	652	266	619	358	666	952	9,206	11,512
Average own land area (ha/household)	1.05	0.80	1.17	1.03	0.65	0.74	1.66	1.26	2.67	1.34	1.41	2.25	1.16	1.76	1.84	1.38	2.00	1.54	1.40
Agrarian form																			
Landowner	232	430	540	970	255	111	278	115	264	158	20	87	69	105	58	145	150	1,815	3,017
Tenant	281	70	350	420	609	255	776	268	613	371	78	203	161	246	137	338	358	4,413	5,114
Acquisition at agrarian reform	47	45	60	105							NA							NA	NA
Leaseholder	65	66	40	106							NA							NA	NA
Average unit product (kbn/ha)	(Rainy season product.: 2001, Dry season product.: 2002)										(2001)							(2001)	
Rainy season product	75	80	85	84	65	65	37	32	30	20	65	65	35	35	25	25	35	41	49
Dry season product	70	90	90	90	80	80	87	72	70	65	85	87	70	70	40	70	85	74	76
Average unit product (ton/ha)																			
Rainy season product	3.8	4.0	4.3	4.2	3.3	3.3	1.9	1.6	1.5	1.0	3.3	3.3	1.8	1.8	1.3	1.3	1.8	2.1	2.5
Dry season product	3.5	4.5	4.5	4.5	4.0	4.0	4.4	3.6	3.5	3.3	4.3	4.4	3.5	3.5	2.0	3.5	4.3	3.7	3.8
Collection rate of water fee	(Rainy season product.: 2001, Dry season product.: 2002)										(2001)							(2001)	
Rainy season product	55%	50%	37%	41%	77%	77%	80%	50%	51%	57%	72%	72%	52%	52%	17%	60%	58%	58%	55%
Dry season product	3%	62%	65%	64%	69%	69%	65%	72%	43%	46%	74%	74%	66%	66%	46%	51%	44%	60%	58%
Property of WUA (Peso)																			
First 5 years	500	1,025	804	1,829	4,000	1,006	5,474	2,558	500	2,558	350	1,000	120	350	895	2,000	700	21,512	23,841
2001	2,137	2,595	19,833	22,428	6,820	3,130	65,759	11,971	55,648	7,955	10,134	25,347	1,500	700	5,067	54,032	43,436	291,497	316,062
Non-agricultural occupation (to the fifth)																			
Carpenter	O	O	O								O								O
Fishery	O	O	O								O								O
Hog raising	O	O	O								O								O
Driver											O								O
Mason											O								O
Merchant		O	O																O
Poultry farming			O																O
Average agricultural income																			
Rainy season product							7,000	5,500	8,500	11,000	10,000	10,000	8,500	8,000	6,000	7,500	8,500	7,538	
Dry season product							8,000	6,500	9,500	15,000	12,000	12,000	9,000	9,000	7,500	8,500	9,000	8,808	
Annual income	15,000	24,600	22,500	23,550			15,000	12,000	18,000	26,000	22,000	22,000	17,500	17,000	13,500	16,000	17,500	16,346	17,302
O&M plan making of WUA																			
Document Style					-	-	-	-	O	-	-	-	-	-	-	-	O		
Unwritten law					O	O	O	O	-	O	O	O	O	O	O	O	-		
Making time	Joint making with NIA										every season								
Activity of WUA except water management																			
Exhibition of farming tech.	O	O	O								NA								
Prevention of disease & insect		O	O								NA								
Production of seed			O								NA								
Relief of death			O								NA								
Shift plan to agricultural cooperation	O	O	O								NA								

(Source) Inventory Survey Report of WUA by Igigu Amurung pumping irrigation office and Magapit pumping irrigation offic

(Note) Assumed function as an agricultural cooperation association: 1) Financing support, 2) Distribution of invested material, 3) Marketing of rice, 4) Communal threshin