No.

IRRIGATION AND WATER MANAGEMENT DIVISION
AGURICULTURE AND LIVESTOCK DEPARTMENT
MINISTRY OF AGRICULTURE, FORESTRY AND FISHERIES
THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE

IMPLEMENTATION REVIEW STUDY REPORT ON THE PROJECT FOR REHABILITATION AND IMPROVEMENT OF MALIANA I IRRIGATION SYSTEM IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE

May 2007

JAPAN INTERNATIONAL COOPERATION AGENCY

SANYU CONSULTANTS INC.

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PREFACE

In response to a request from the Government of the Democratic Republic of Timor-Leste, the Government of Japan decided to conduct an implementation review study on the Project for Rehabilitation and Improvement of Maliana I Irrigation System and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Timor-Leste an implementation review team from February 19 to March 3, 2007.

The team held discussions with the officials concerned of the Government of Timor-Leste, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Democratic Republic of Timor-Leste for their close cooperation extended to the teams.

May 2007

Masafumi KUROKI
Vice-president,
Japan International Cooperation Agency

May 2007

LETTER OF TRANSMITTAL

We are pleased to submit to you the implementation review study report on the Project for Rehabilitation and Improvement of Maliana I Irrigation System in the Democratic Republic of Timor-Leste.

This study was conducted by Sanyu Consultants Inc., under a contract to JICA, during the period from February 2005 to May 2007. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Timor-Leste and formulated the most appropriate basic design for the project under Japan's Grant Aid Scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Kazumitsu TSUMURA

Project manager,

Implementation review study team on
the Project for Rehabilitation and
Improvement of Maliana I Irrigation System
in the Democratic Republic of Timor-Leste.

Sanyu Consultants Inc.

SUMMARY

(1) Overview of the Timor-Leste

More than 70% of the total labor population has been engaged in agriculture, forestry and fishery sectors, producing 26% of GDP (2001) in Timor-Leste where agriculture constitutes mainstay of the state, playing key role in the economy and society of the nation. However, food self-sufficiency of staples such as rice, maize and cassava has remained at around 60%. As for annual requirement of rice, annual demand is estimated at 64,820 ton/year assuming the unit consumption at the rate of 75kg/ person/ year. From this basis of consumption, the deficit amounts to over 25,500 ton as the gap between national annual production and the annual demand. Future prospect of rice consumption will reach 100kg/ person/ year, implying need of additional imports given the continuation of the current trend of domestic production.

The Government of Timor-Leste has presented two goals of development in the National Development Plan (formulated in May 2002), i.e., 1) poverty reduction throughout the country and all the regions and sectors in the country, 2) equitable and sustainable economic growth to promote health, education and welfare improvement targeted at all the population. Also, the Government has placed importance on agriculture, forestry and fishery sectors, attaching foremost priority to "improving of food self-sufficiency" and "poverty reduction and livelihood improvement in rural areas" as the development goals of the sectors.

Maliana I irrigation area, the target area of the Project, is located in rural area in Bobonaro district in western of the country at the boundary of Indonesia. Paddy cropping is the most popular in the area owing to abundant rainfall of about 2,000 mm/year, where the paddy production is ranked as the second among 13 districts in the country. Thus, the district is deemed as a granary of Timor-Leste, constituting an important area in pursuing nationwide targets of "improving of food self-sufficiency" and "reduction of rural poverty with livelihood improvement".

(2) Background and Summary of the Requested Japan's Grand Aid Scheme

In the Maliana I area, irrigation activities by traditional intake facilities started in the 1940s. In 1972 of the Portuguese time, a fixed weir of 4.7m in height was constructed together with the main canal, siphon and the secondary canals. During the Indonesian age, the first rehabilitation works of canals were carried out in 1986 by raising the fixed weir by 0.7 m and provision of scouring gate and sediment settling basin at the intake side. However, the raised portion of the fixed weir was damaged and washed out during a flood in 1992. Since then, the structure of the intake has not provided stable irrigation water to the Maliana I area due to this damage.

The request for this Project is based on a Feasibility Study conducted by an Australian consultant under the budget provided by the Trust Fund for East Timor (TFET) through the Agricultural Rehabilitation Project 3 (ARP 3) sponsored by the World Bank. Since Timor-Leste encountered a difficulty in funding for the Project, the request was submitted to Japan.

(3) Summary of the Study Results and Contents of the Project

In response to a request from the Government of Timor-Leste, the Government of Japan decided to conduct a basic design study on the Project for Rehabilitation and Improvement of Maliana I Irrigation System. Japan International Cooperation Agency (JICA) sent to Timor-Leste a study team from March 2 to 29, 2005. The team discussed with officials concerned of MAFF of Timor-Leste. A field survey on the current status of farming and operation and maintenance (O/M) of the irrigation facilities was conducted in the Maliana I area. As a result, the team recognized the necessity of an urgent rehabilitation works of the facilities. After the team returned from the Project site, further studies in Japan were made. Then, the team was sent to Timor-Leste in order to discuss a draft basic design from January 9 to 15, 2006, and as this result, the basic design report was finalized.

Since then, the Government of Japan has periodically suspended economic assistance to Timor-Leste due its social unrest. While Japanese assistance was resumed in October 2006, JICA decided to conduct an implementation review study on the Project. JICA sent to Timor-Leste a study team from February 19 to March 3, 2007. The team held discussions with the officials concerned of Timor-Leste, and conducted a field study at the study area.

In the Project, the plan will be made in the light of what have been requested by the Government of Timor-Leste, the results of field study and consultation with the offices concerned and the following policies for the various components of rehabilitation on the irrigation facilities of Maliana I;

1) Rehabilitation of the washed out portion of the weir that had been raised by 0.7 m,
2) Construction of new sluice and intake gates, rehabilitation of existing sediment settling basin and intake structures along the canals,
3) Rehabilitation of protection wall of aqueduct,
4) Rehabilitation and extension of the main canal and secondary canals, construction of steel slide gates for turnouts,
5) Stable irrigation water with an intake capacity of 1.37 m^3/s to the maximum command area of 1,050 ha (1,050 ha in rainy season and 350 ha in dry season),
6) Construction of a storage for O/M equipment (68 m^2) and gate keeper's hut (15 m^2), and
7) Soft component plan concerning smooth O/M activities of the above components.

The outline of the basic design is given in the following;

Headworks of Maliana I

Subject	Scale of facilitates and etc	Remarks
1) Bulobo River	River basin: 19.8 km^2 Design flood discharge: 310 m^3/sec Design flood stage: 256.70 m Water level of drought: 0.2 m^3/sec Gradient of riverbed: 1/86	100-year reliable flood-flows 5-year reliable low-flows Upper stream of headwork
2) Design discharge	Rainy season: 1.37m^3/sec, Dry season: 0.46m^3/sec	Include 0.015m^3/sec of intake water for domestic supply
3) Design irrigable area	Rainy season: Paddy 1,050 ha, Dry season: Paddy 150 ha, Other crops: 200 ha	
4) Fixed headworks	Type of headwork: Flowing type Elevation of the crest: 254.40 m Width: 17.10 m, Height: 5.40 m, Length: 8.50 m Length of downstream side of face: 10.0 m, Maximum thickness of face: 2.1 m Length of riverbed protection: 12m	Raising by 0.7 m with high strength concrete.
5) Scouring sluice	Width of scouring sluice: 7.40m Gate type: Manual rack type Scouring sluice gate: width 3.0m x height 1.5mx2 gates	
6) Intake structure	Gate type: Manual rack type Intake gate: width 1.5m x height 1.0mx2 gates	
7) Sediment settling basin	Sediment settling basin: width 8.0m x length 13.0m Scouring gate: width 1.6m x height 1.5mx1 gate	
8) Canal intake	Canal intake gate: width 1.8m x height 1.0mx1 gate	

Main and Secondary Canals

Name of canal	Main canal	Ramaskora secondary	Ritabau secondary
1) Scale			
Design discharge:	1.37～1.35 m^3/sec	0.96～0.16 m^3/sec	0.39～0.17 m^3/sec
Canal length:	L = 1,527m	L = 3,945m Existing canal: 1,570m Extension lining: 2,375m	L = 5,250m Existing canal: 2,890m Extension lining: 2,360m
2) Typical cross section			
Type of canal:	Open lining canal by wet masonry lining	Open lining canal by wet masonry lining	Open lining canal by wet masonry lining
Width of canal invert: Height of side wall: Width of canal top:	1.60m～5.70m 0.90m～1.80m 1.60m～7.10m	0.40m～1.60m 0.30m～0.80m 1.00m～3.20m	0.40m～1.10m 0.40m～0.80m 0.80m～2.30m
3) Appurtenant structures	Total 25 places	Total 48 places	Total 79 places

Bank Protection Retaining Wall for Aqueduct

Subject	Right bank	Left bank
1) Retaining protection wall		
Structure type	Wet masonry	Wet masonry
Extension	72.5 m	34.0 m
Height	3.0～4.5 m	4.5 m
2) Block for riverbed foot protection	345 m^2	252 m^2

Building Facilities

Name of facilities	Storage for O/M equipment	Gate keeper's hut
1) Location	Near STA.3+360, station of Ramaskora secondary canal	Upper stream side of the left bank of Maliana I headworks
2) Structure type	One story house of RC beam, block wall, concrete foundation	One story house of RC beam, block wall, concrete foundation
3) Building area	10.5m x 6.5m = 68.3 m^2	4.2m x 3.5m = 14.7 m^2

Outline of Soft Component Plan

Expert	Details of major activities
(1) Discipline related to organizational management	
Organizational management expert: A staff of international NGO, 2.0 M/M	1) Elucidating methods of O/M, problems on water management and irrigation rotation, social situations by holding workshop and inquiring current status of existing organizations, 2) Explaining definition and responsibilities of WUA, significance of organizational management to the beneficiaries through orientation, 3) Providing by-law manual of WUA (draft), 4) Conducting a questionnaire survey on the required amount of water fee targeted on the beneficiaries of irrigation, 5) Organizing management organizations for constructing tertiary canals into groups, 6) Holding PCM workshop for discussing method of collecting and amount of water fee to be charged, and 7) Holding workshop for instructing financial balance, data management and methods of accounting management.
(2) Discipline related to water management	
Water management expert: A Japanese consultant, 2.3 M/M	1) Organizing a study tour to Laclo irrigation project (assuming participants: 4 WUA board members, 2 gate operators and other volunteer participants), 2) Providing field training on water management, 3) Producing maps of command area, beneficiary area covered by tertiary canals, 4) Extracting problems on cropping and irrigation rotation and formulating water distribution plan, 5) Providing water management manual (draft), and 6) Completing water management manual by utilizing the draft thereof and revising wherever necessary reflecting the extracted issues thereon.

(4) Construction Period and Project Cost Estimation

Project implementation requires 5 months to complete detailed design and 9 months for the construction. The Project cost in the case of implementing it under the Grant aid scheme fund is roughly estimated at 738.1 million J.Yen (737.8 million J.Yen to be undertaken by Japan; 0.34 million J.Yen by Timor-Leste side).

(5) Evaluation of the Project

By rehabilitating the washed out portion (0.7 m) of Maliana I fixed weir by flood, direct effect is brought about by the improved state as compared to currently insufficient intake from the water source Bulobo river. The peak intake discharge during rainy season will be increased from 0.88 m^3/sec to 1.37 m^3/sec, or by 0.49 m^3/sec.

Necessity of adequately managing, operating and maintaining irrigation facilities by WUA are recognized through the implementation of the soft component plan, thus acceptable amount and method of

collecting water fee from the users in the first year are determined. Furthermore, gates installed at sediment scouring sluice, water intake, sediment settling basin and gates installed at turnouts are properly operated in a linkage and irrigation water is distributed to tertiary canals. In addition, it is expected that WUA members can avail the practical manual on water management

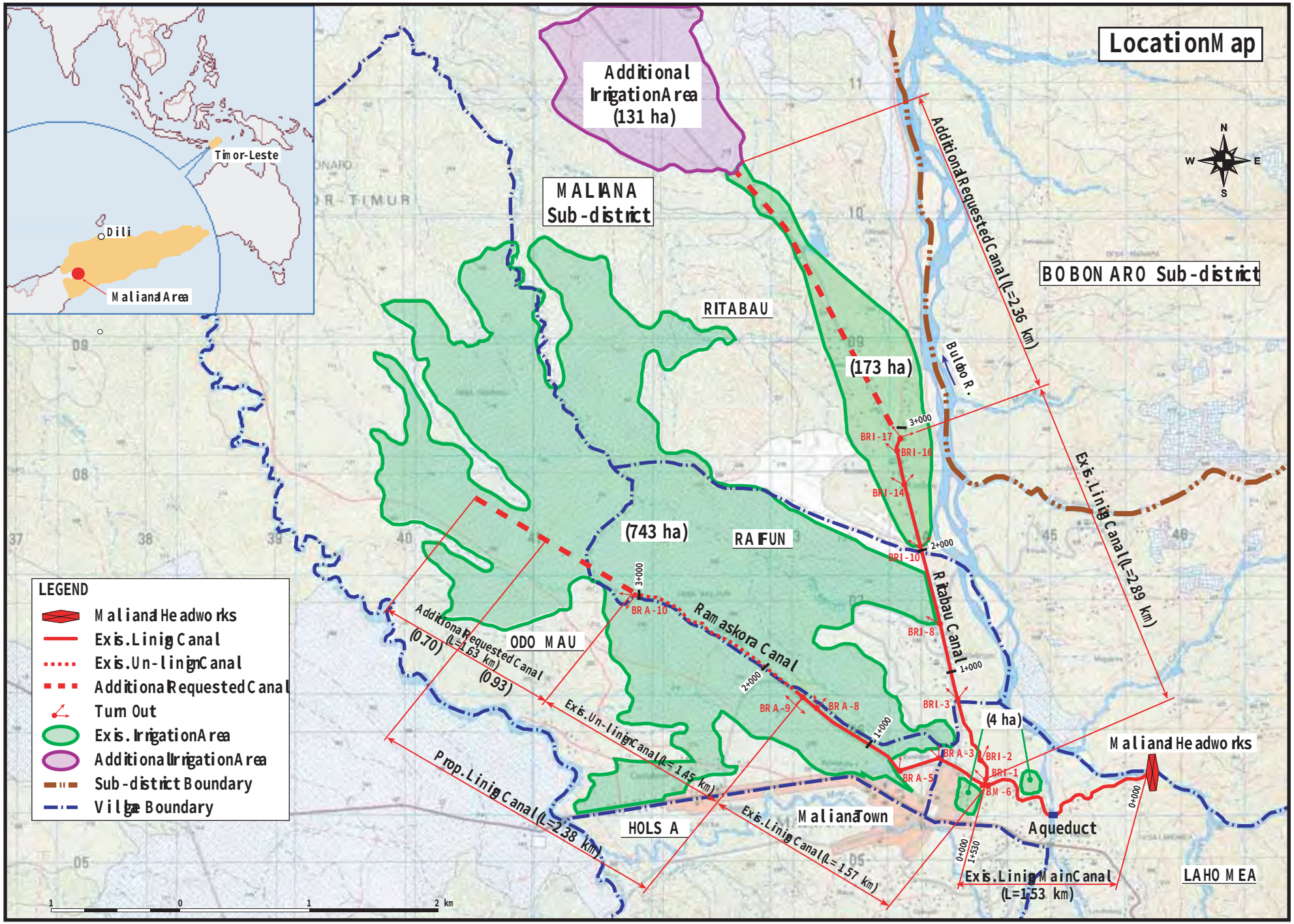
As an indirect effect, efficient distribution of irrigation water will be realized up to the terminal command areas of the beneficiary of Maliana I through both the rehabilitating and improving of existing irrigation canals and stabilized water intake, resulting in the expected expansion of cropping area of paddy. Also, as another indirect effect, it is expected that labor burden of beneficiaries for such maintenance practices as dredging for guide wall, and de-silting sediment basin, annually practiced by the farmers concerned, will be reduced through the rehabilitation and improvement of water intake and sediment scouring facilities.

Besides, as an anticipated effect, prevention of risk can be counted in a way that if current scouring at the riverbed under retaining wall supporting the Aqueduct is left intact without the Project, the scouring would further develop until the Aqueduct falls down. If it happens, conveyance of irrigation water to the beneficiary command would completely be cut out. Then, the beneficiary would have to wholly rely on rain-fed. Roughly estimated annual damage amounts to 218.3 thousand US$, as the difference between irrigated and rain-fed paddy production.

From what have been mentioned above, the Project aims to distribute stable irrigation water to Maliana I area by securing water intake at the weir of Maliana I through the rehabilitation of washed out portion of the weir, also by improving existing irrigation canals. The Project thereby envisages entailing benefit from expansion of area under irrigated paddy and resulting increased rice production, and these benefits are believed to greatly contribute to development agriculture, forestry and fishery sectors in Timor-Leste. In the view of human security, shortage of rice is one of the factors to social unrest in the country, therefore, the Project is concluded highly significant and worthwhile to carry it out by Japan's Grant Aid scheme to this end. Nevertheless, it is the prerequisite for the Project formation 1) to affirm sustainable support for organizational strengthening of WUA towards the realization of pertinent O/M of irrigation facilities after their rehabilitation and improvement, and 2) to commit the construction of tertiary canals through beneficiary cost bearing for land acquisition / tenancy for implementing construction works. If these preconditions are actually met, The Project will be implemented smoothly and effectively.

CONTENTS

Appendices


Location Map
Timor-Leste
Dili
Maliana Area
Additional Irrigation Area (131 ha)
MALIANA Sub-district
BOBONARO Sub-district
RITABAU
(173 ha)
Additional Requested Canal (L=2.36 km)
Bulobo R.
Exis. Lining Canal (L=2.89 km)
(743 ha)
RAFUN
Ramaskora Canal
Ritabau Canal
ODO MAU
Additional Requested Canal (L=1.63 km)
(0.70)
(0.93)
Exis. Un-lining Canal (L=1.45 km)
Prop. Lining Canal (L=2.38 km)
Exis. Lining Canal (L=1.57 km)
(4 ha)
Maliana Headworks
Maliana Town
Aqueduct
HOLSA
LAHOMEA
Exis. Lining Main Canal (L=1.53 km)
BRI-17
BRI-16
BRI-14
BRI-10
BRI-8
BRI-3
BRA-10
BRA-9
BRA-8
BRA-5
BRA-3
BRI-2
BRI-1
BM-6
3+000
2+000
1+000
0+000
1+530
LEGEND
Maliana Headworks
Exis. Lining Canal
Exis. Un-lining Canal
Additional Requested Canal
Turn Out
Exis. Irrigation Area
Additional Irrigation Area
Sub-district Boundary
Village Boundary
1 0 1 2 km

PERSPECTIVE

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ABBREVIATIONS

Abbreviations

ADB	Asian Development Bank
ALD	Agriculture and Livestock Department
ARP	Agricultural Rehabilitation Program
ASC	Agriculture Service Center
DAC	District Agriculture Coordinator
DIO	District Irrigation Officer
DEO	District Extension Officer
DFO	District Forestry Officer
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
FAD	Fisheries and Aquaculture Department
FAO	Food and Agriculture Organization
FWRD	Forestry and Water Resource Department
IIMI	International Irrigation Management Institute
IWMD	Irrigation and Water Management Division
MAFF	Ministry of Agriculture, Forestry and Fisheries
MPF	Ministry of Planning and Finance
MTCPW	Ministry of Transport, Communications and Public Works
NDP	National Development Plan
NDES	National Directorate for Environmental Service
O/M	Operation and Maintenance
PKF	Peace Keeping Force
SIP	Sector Investment Program
SSECTOPD	Secretary of State for Environmental Coordination, Territorial Ordering and Phizical Development
TFET	Trust Fund for East Timor
WFP	World Food Program
WSS	Water and Sanitation Service
WUA	Water User's Association

Glossary

cm	centimeter	ha	hectare
hr	hour	kg	kilogram (=1,000 gram)
km	kilometer	km^2	square kilometer
KVA	kilo volt-ampere	lit.	liter
m	meter	m^2	square meter
m^3	cubic meter	min	minute
MM	man month	m/sec	meter per second
m^3/sec	cubic meter per second	N	Newton
sec	second	t	ton (1,000 kg)
%	percent	l/s/ha	liter per second per hectare

Currency

Japanese Yen (J. Yen)
US Dollar (US$)

Exchange rate (March 2007)

US$ = J.Yen 119.59

Chapter 1 Background of the Project

Chapter 1 Background of the Project

1-1 Background of the Project

(1) Background of the Project

Timor-Leste is located at the east of Indonesia, with 14,600 km^2 of land area and about 976,000 of population as estimated in 2005 (WB) composing of 13 districts. After the period of over 400 years of colonization by Portugal, Timor-Leste was annexed to Indonesia in 1976. It experienced the war of independence until May 2002 and became independent with the support of multinational force by the resolution of U.N. Security Council.

The topography of the country is characterized by hilly mountains and dissected valleys, where monsoon climate mainly prevails with high precipitation in the rainy season ranging from November to April. The climate in Northern Tropical Savanna extends the central part of the country including the capital Dili where annual rainfall of 600 - 2,500 mm has been recorded, though the rainfall pattern considerably differs by the region of the country. The target area of the Project, Maliana in the Bobonaro district, has about 2,000 mm of average annual rainfall.

The command area of Maliana I, the target area of Japan's Grant Aid scheme, is located at the uppermost stream of the Bulobo River of Bobonaro district. The target command area is about 900 ha of farmland, distributed in the command area of the headwork, starting from 1.5 km downstream of the intake weir. The irrigation activities have been kept by means of traditional water intake facilities since 1940s. As the intake weir, the existing fixed weir (4.7m in height) was constructed in 1972 under Portuguese colonization, simultaneously main canal siphon and secondary canals were developed. Thereafter, in the Indonesian regime, the first rehabilitation works for canals were carried out in 1979. In 1986 various repair works such as raising of the fixed weir (by 0.7m), repair and raising of the retaining wall protection works, repair of scouring gate of sediment settling basin and rehabilitation of the canal intake gate were performed. Immediately after the rehabilitation, collapse of the siphon along the main canal took place and progressed but replaced by the existing aqueduct during 1989 - 90. Nevertheless, due to loss of the raised part of intake weir caused by flood in 1992, the steady supply of irrigation water has currently failed. To cope with this short supply, irrigation from Bulobo River has been supplemented with rain-fed water and reuse of irrigation water during rainy season to maintain the command beneficiary, actually feeding only about 600 ha under paddy and 250ha under upland crops mainly consisting of maize. Similarly, farmers have to completely rely on irrigation for cropping in dry season (May to October) during which rain is hardly expected, but current cropping area is limited to 100ha for both paddy and upland crops owing to the damaged irrigation facility.

(2) Contents of the Request

This request has been based on the Feasibility Study (F/S) by Australian consultants using TFET (Trust Fund for East Timor) of World Bank's ARP 3 (Agricultural Rehabilitation Program, Phase 3). Since it

could hardly obtain sufficient amount of funds to pursue the project, then Japan's Grant Aid was requested.

The request from Timor-Leste consists of principally rehabilitating the existing facilities of the Project area. During the stage of basic design (BD), the contents of the original requests have partly been modified. Based on the modified request, consultations and discussions were made between Irrigation and Water Management Division (IWMD) of Ministry of Agriculture, Forestry and Fisheries (hereinafter referred to as MAFF), the implementing agency of Timor-Leste, and the JICA Study Team to finalize the contents of the request on "the Project for Rehabilitation and Improvement of Maliana I Irrigation System (hereinafter referred to as "the Project")". The detailed contents of the request have finally been confirmed at the Minutes of Discussion (M/D) as shown in Table 1-1 and Table 1-2.

① Repairing of the present facilities

Table 1-1 Contents of the request (Repair works)

Original request	At the time for M/D signs (underlined words tell modified and/or added words)
1) To raise the existing weir crest by 0.7 m by anchoring a capping of concrete with steel plates armoured to the downstream face of the weir,	Raising the existing weir crest by appropriate height and attaching sand sluiceway, if necessary,
2) Grouting of the foundation of the existing weir,	Same as the original request
3) Raising of the abutments retaining walls upstream of the crest with reinforced concrete,	Same as the original request
4) Repairs on the concrete of the existing intake and sedimentation basin,	Same as the original request
5) De-silting of the existing canals,	Same as the original request
6) Repair canal lining and structure.	Same as the original request
7) —	Rehabilitation of retaining walls for aqueduct bridge.

② Installation of new facilities

Table 1-2 Contents of the request (New facilities)

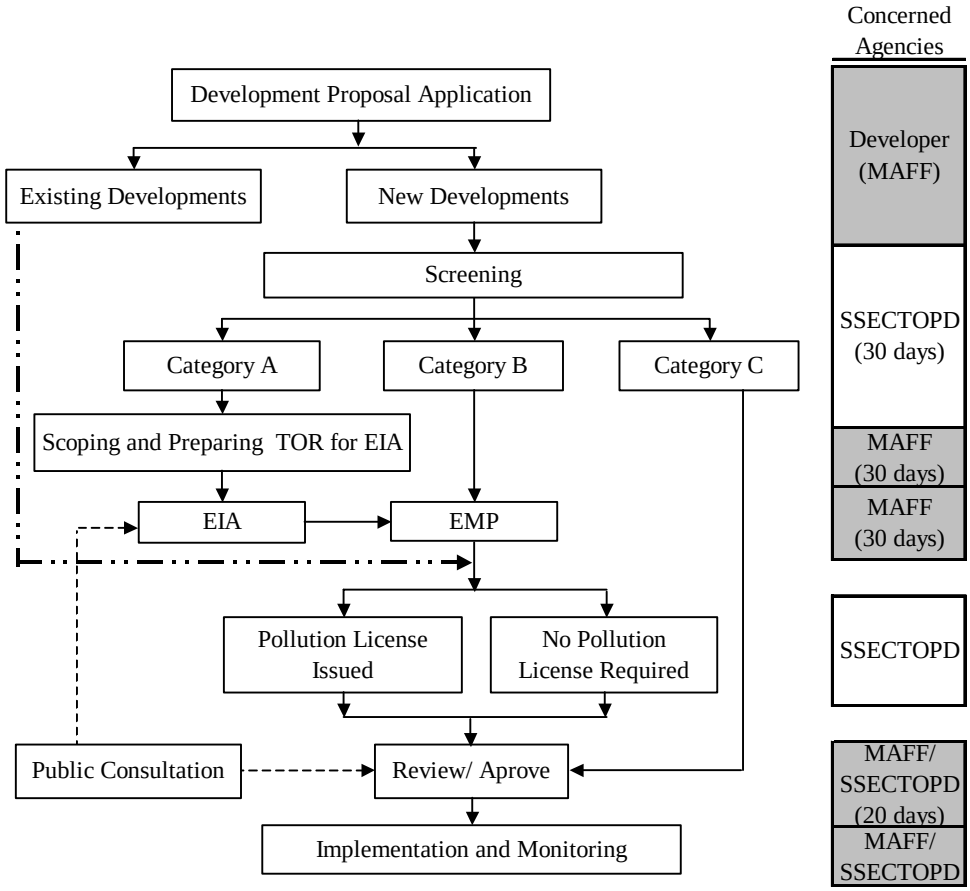
Original request	At the time for M/D signs (underlined words tell modified and/or added words)
1) Installation of new gates for the sluice outlet and canal intake,	Installation of new gates for intake, sluice outlet of sediment basin and canal intake
2) Installation of steel slide gates at the division structure of Maliana I main canal and other offtake structures,	Same as the original request
3) Construction of the Ramaskora secondary canal,	Construction and extension of the Ramaskora secondary canal,
4) —	Extension of the Ritabau secondary canal,
5) Construction of meeting place for the water users association (WUA),	Same as the original request
6) Construction of the water guards house,	Same as the original request
7) Construction of a storage shed,	Same as the original request
8) Construction of a drying floor.	Same as the original request
9) Strengthening of the WUA.	Same as the original request

1-2 Environmental and Social Consideration

(1) Procedures by the proposed environment guideline of the Timor-Leste

According to "Guideline #1: Environmental Requirements for Development Proposal" stated in the proposed "Environment Guideline (draft)" that is currently being implemented in Timor-Leste, developer (The developer of Maliana I Project is MAFF) of new and improvement projects is required to submit an application to National Directorate for Environmental Service (NDES), the Secretary of State for Environmental Coordination Technical Ordering and Physical Development (SSECTOPD) and to secure approval on the contents of the development plan as indicated in the flowchart of Figure 1-1. Accordingly, prior to the project implementation, MAFF shall provide an Environmental Management Plan (EMP) and obtain permission from SSECTOPD as a prerequisite procedure to implement the Project.

In February 26, 2007, NDES-SSECTOPD approved the EMP which prepared and submitted by MAFF in April 2006.



EIA:Environmental Impact Assessment
EMP:Environmental Management Plan Sorce: Environmental Guideline # 1, SSECTOPD

Figure 1-1 Flowchart of environmental assessment procedures

The Maliana I rehabilitation Project is related with "A. Agricultural development and B. Irrigation & drainage and flood measure sectors" in the 12 sectors classified by the Guideline. Also, the item subject to

regulation in the Project implementation corresponds to "6. Irrigation system" in "B. Irrigation & drainage and flood control sector" as shown in Table 1-3.

Table 1-3 Categories of irrigation and drainage and flood control measure sectors

Items	Category A	Category B	Category C	Maliana I
A. Agricultural development sector				
1. Land clearance & reclamation to farmland	> 10 ha	2 ~ 10 ha	< 2 ha	0 ha
2. Introduction of GMO(Genetically Modified Organism) crops	All	—	—	N.A.
3. Widespread pest / disease control programs	All	—	—	N.A.
4. Widespread fertilizer application programs	All	—	—	N.A.
5. Dams with impounding reservoirs	> 10 ha	1 ~ 10 ha	< 1 ha	N.A.
B. Irrigation, drainage and flood control measure sector				
6. Irrigation system (new development area)	**> 200 ha**	**50 ~ 200 ha**	**< 50 ha**	**164 ha**
7. Land reclamation area	> 50 ha	5 ~ 50 ha	0 ~ 5 ha	0 ha

Source: Environmental Guideline # 1, SSECTOPD N.A: Not applicable

The terminal command area under Maliana I, which was considered non-irrigated area of about 290 ha in the initial stage, has been affirmed as the most part of the command area that has already received irrigation water from the tertiary canals on a supplementary basis by rainfed. On the other hand, considering the command area of Ritabau secondary located downstream of the basin with an area of 164 ha (of which net irrigated area is 131 ha), the command area of Maliana I rehabilitation project will be classified into category B and will not be subjected to EIA assessment according to the above-mentioned categorization. In this context, the formulation of EMP will be requested later for the proposed Project. Thus, the procedure will have to be completed including the approval of the EMP by SSECTOPD, the holding of general assembly to the beneficiaries to reach consensus and finally the implementation of the rehabilitation Project will be authorized.

(2) Contents of EMP

EMP is regarded as a plan of extracting anticipated environmental impacts, proposed monitoring methods and measures to alleviate them. The environmental guidelines required by EMP include the following:

① Potential impacts mitigation

The potential environmental impacts of the development, a feasible and cost-effective measures to prevent or reduce such impacts to acceptable levels shall be properly specified from the start of construction and through the operation phase. Mitigation measures shall be clearly set out within the framework of a full work plan and schedule.

② Contractor covenants

The contractor shall agree to contracts set out within the EMP and shall be reflected in subsequent contracts for construction works.

③ Monitoring, reporting and auditing

Specific arrangements, methods and procedures for inspection, monitoring and reporting during construction and operational phases shall be prepared for the Project. Actual environmental impacts as they arise during the Project life and the effectiveness of proposed mitigation shall be documented. A schedule of periodic audits to inform the EMP process shall be established.

④ Organizations and management

Responsibilities for implementation of all provisions of the EMP shall be clearly defined. Procedures necessary to be followed in case of information obtained during monitoring and audits shall be clearly specified.

⑤ Resources and costs

The resources necessary to implement the EMP shall be specified, as well as those responsible for making those resources available.

⑥ Capacity building and training

Capacity building and training needs shall be identified to ensure that impacts can be properly managed, controlled, and implemented without cumulative or long-term impacts from development. Staffing requirements and other supporting arrangements shall be identified to demonstrate the capacity to implement the EMP.

⑦ Letter of commitment

The EMP shall include a letter signed by the developer regarding its commitment to implement all mitigation measures and other provisions contained therein.

(3) Outline of measures required for the approval of EMP in the Project

① Preventive measures against occurrence of turbid flow around Maliana I Intake weir and aqueduct

Since riverbed will be excavated to the required depth during the construction of downstream apron and riverbed protection works in the rehabilitation of intake weir, the occurrence of turbid flow from the excavation will be anticipated. In this concern, the construction of temporary works by means of a cofferdam with a diversion canal is necessary to prevent the river flow into the construction site. However, assuming rise in groundwater level in the construction area, dewatering by a submersible pump is necessary. The turbid water that will be pumped out from the construction area shall be discharged into a sedimentation pond so that only the supernatant water will be discharged to the river downstream of the construction site.

② Earth retaining wall to prevent collapse of banks of Main canal

Out of the four drainage works installed along the Main canal, two of them have risk of discharging turbid water into the downstream during rainy season. Runoff from rainwater is merged down to the

mountain slope that may collapse main canal (a site collapsed on December, 2005 but repaired by MAFF and the beneficiaries). According to the plan, wet masonry protection walls will be constructed at downstream side so that they can reinforce the downstream side of the main canal. The conveyance capacity of the corrugated pipe used in the existing drainage works will have to be examined and if necessary, replace the pipe with the same or larger diameter as will be planned during detailed design.

③ Preventive Measures against occurrence of turbid flow at quarry borrow pits

A quarry for borrowing masonry material is planned along the river 2 km and 3 km downstream of Bulobo River, in addition to already planned quarry area around the water intake of Maliana I to collect material for constructing Ritabau secondary canal. In this plan, Environmental guideline (draft), "guideline 2 -Mechanized sand and gravel extraction from rivers and borrow pits-" machinery excavation of sand and gravel from riverside borrow pits will be pursued. Turbid water plausibly occurring during quarrying excavation is not allowed to discharge downstream, but is retained for allowing infiltration into the ground so that only supernatant water is discharged downstream after sedimentation. Besides, the current regulation prohibiting the collection of gravel from the riverbed within the reach of 10 meter or nearer to the protection bank for the objective of maintaining current course and gut of the stream will be observed.

Chapter 2　Contents of the Project

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

2-1-1 Overall Goal and Project Purpose

(1) Overall Goal

The Government of Timor-Leste has placed the top priority in the development targets of agricultural, forestry and fishery sectors in the NDP (National Development Plan) on "Achieving food security and improving of food self-sufficiency. The overall goal of the Project is, therefore, to aim at improvement of self-sufficiency rate of rice, presently estimated at around 60% in the Timor-Leste by expanding the irrigation area of paddy by means of the rehabilitation of the irrigation facilities in Maliana I, thus, meeting the overall goal of the Project, as **"To increase irrigated paddy land in the Project area".**

(2) Project Purpose

In the Sector Investment Plan (SIP), MAFF has adopted "Improving the productivity of food crops is a precondition for a general improvement in food security" as a development task for attaining "Improve cropping efficiency under irrigation". In order to contribute to this approach, **" To distribute stable irrigation water to Maliana I area"** is taken as the purpose of the Project.

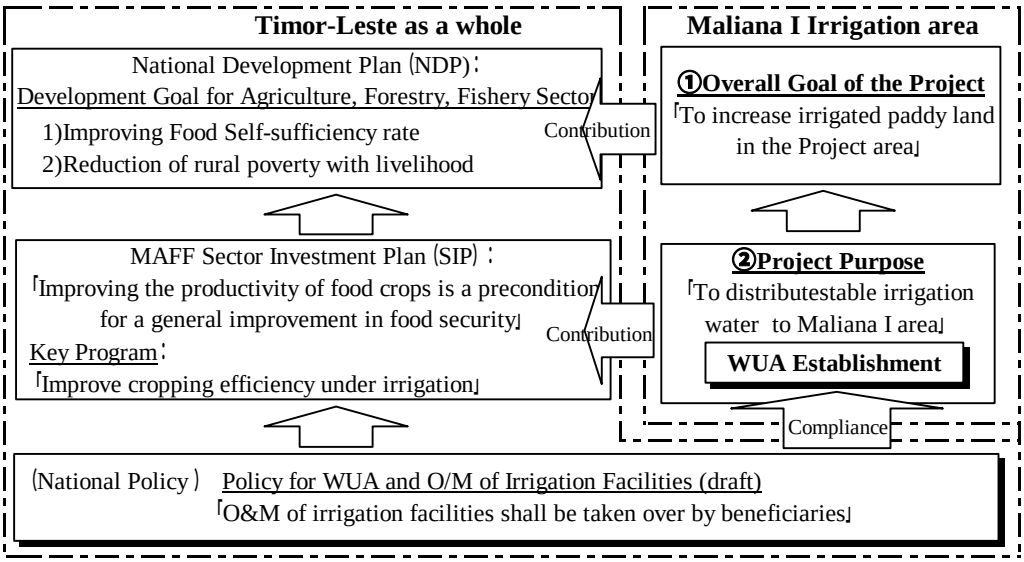


Figure 2-1 Relation between the national development plan and Project purpose

2-1-2 Outline of the Project

The Project aims at "To distribute agricultural water to irrigation area of Maliana I properly by taking water efficiently from River with raising part of the fixed headwork which washed out by flood, and by rehabilitating and improving the network of irrigation canal system". And, MAFF will establish a guideline to transfer the management of irrigation facilities to Water User's Association (WUA) of Maliana I to be organized, based upon "the policy for WUA and Operation and Maintenance (O/M) of irrigation facilities (draft)", while MAFF regularly and instructs and monitors the process of its management. However, human resources and their capacity are still insufficient because of short history behind Timor-Leste after independence, leading to difficulty in the instruction on the use of irrigation facilities and water management. To cope with these issues, a soft component plan will be conducted to instruct the measures of strengthening organizational management and water management for the facilities rehabilitated by the Project.

As a result of evaluating what has been requested from the government of Timor-Leste in domestic analysis, the Table 2-1 and 2-2 has been concluded as the items of the target works under the cooperation.

(1) Rehabilitation works

Table 2-1 Contents of the request and results of the evaluation (1/2)

Original request (Underlines show revised / added parts at the time of M/D	Results of evaluation (under Japanese assistance)
1) Raising the existing weir crest by appropriate height and attaching sand sluiceway, if necessary,	① Raising existing weir crest by 0.7 m with high-strength concrete [note 1)]. ② Constructing 10 m length of downstream apron with max.2.1 m thickness. ③ Attaching 12 m length of riverbed protection by crossing type concrete blocks to the apron ④ Attaching (sand) scouring sluice to the weir in the Bulobo River.
2) Grouting of the foundation of the existing weir,	Filling the eroded part of weir with high-strength concrete instead of grouting.
3) Raising of the abutments retaining walls upstream of the crest with reinforced concrete,	① Banking along protection retaining walls with dry masonry as freeboard for the raising part. ② Placing concrete blocks at the front of upstream retaining walls of the right bank. ③ Rehabilitating upstream retaining wall of the right bank by wet masonry after removing cracked part. ④ Repairing mid and downstream retaining wall of the right and left bank by applying new mortar joint to existing wet masonry. ⑤ Repairing downstream retaining wall of the right bank by filling wet masonry to the eroded part.
4) Repair the concrete of the existing intake and sedimentation basin,	① Partly rehabilitating protection wall to meet the necessity of newly installing gates at the existing intake ② Using existing sidewall on the right side as it is, while constructing a new one on the left side of sediment settling basin.
5) De-silting of the existing canals,	De-silting canal during canal rehabilitation work.
6) Repair canal lining and structure	① Main canal: Widening 42 m length of canal sections at insufficient area of flow, and rehabilitating 90% of canal lining out of 1,530 m total length depending on the existing condition. ② Ramaskora secondary canal: Rehabilitating 70% of canal lining out of 1,570 m total length depending on the existing conditions and attached structures. And lining 1,450 m length of existing earth canal with wet masonry. ③ Ritabau secondary canal: Rehabilitating 100% of canal lining of 2,890 m total length depending on the existing conditions and attached structures.
7) Rehabilitation of retaining walls for aqueduct bridge	At right bank retaining wall: ① Rehabilitating 8 m section of upstream retaining wall after removing existing part of wet masonry with 5m of corner cut. ② Leaving midstream retaining wall, section unaffected by flood as it is. ③ Rehabilitating 7 m section of downstream retaining wall after removing existing part of wet masonry. ④ Newly placing crossing type concrete blocks as riverbed protection ⑤ Covering backside on the top of retaining protection wall with wet masonry. At left bank retaining wall: ⑥ Constructing new retaining protection wall by wet masonry. ⑦ Placing crossing type concrete blocks as riverbed protection ⑧ Stopping water leaking from the Aqueduct by flexible material. ⑨ Rehabilitating wooden cover of the Aqueduct new material.

Note: 1) high-strength concrete: a method of concrete work employing higher strength of concrete provided with higher rate of cement content (enriched proportion) than normal concrete to reinforce the structure by coating the deteriorated concrete structures.

(2) New facilities

Table 2-2 Contents of the request and results of the evaluation (2/2)

Original request (Underlines show revised / added parts at the time of M/D	Results of evaluation (under Japanese assistance)
1) Installation of new gates for intake, sluice outlet of sediment basin and canal intake,	① Constructing a new scouring sluice with control gates. ② Installing new intake gates by replacing the existing intake screen. ③ Installing a new scouring gate with rehabilitating the existing sediment settling basin. ④ Installing new gates by replacing the existing Main canal intake gate and canal scouring gates
2) Installation of steel slide gates at the division structure of Malian I main canal and other offtake structures,	Installing steel slide gates by manual at turnouts (off-take structures) of the Main and Secondary canals with rehabilitating canal structures by RCC.
3) Construction and extension of the Ramaskora secondary canal,	Lining 930 m length of canal, out of additional request with 1,630 m length (30 m increased by the result of actual survey measurement).
4) Extension of the Ritabau secondary canal,	Lining 2,360 m length (660 m increased by the result of actual survey measurement) of canal requested additionally.
5) Construction of meeting place for the water users association of (WUA)	The building has function of storing parts of the intake and off-take facilities restored by the Project, including gate bodies, handles, wooden step logs of off-take regulators, lubricant oil for operation and maintenance of gates, recoating paints for gate bodies and manuals. Besides, responding to the request, another function is added to be used as the meeting hall of WUA, thus constructed as the regularly available structure for multipurpose use
6) Construction of the water guards house,	Constructing as name of gate keeper's hut.
7) Construction of a storage shed,	Excluded from the Japan's Grant Aid scheme.
8) Construction of a drying floor.	Excluded from the Japan's Grant Aid scheme.
9) Strengthening of the WUA.	Strengthening managerial capacity of WUA and instruction of water management for irrigation facilities are executed by introducing soft component plan.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Policy

The followings are the basic policies on the Project under the Grant Aid scheme for achieving the overall goal which is "To increase irrigated paddy land in the Project area", and Project purpose which is "To distribute stable irrigation water to Maliana I area".

Basic policy-1: The rehabilitation plan is to be designed based mainly on the restoration of the existing facilities.

Basic policy-2: According to "Policies for WUA and O/M of Irrigation Facilities (draft)" prepared by MAFF, the purpose of establishing WUA is urged towards the irrigation projects with the rehabilitation of irrigation facilities, and subsequent plan of complete turn over to WUAs in the 11th year after their establishment. Since MAFF is striving to pursue this principle and intends to establish a WUA in the Maliana I through the implementation of the Project, the facilities are designed so that the burden of WUA on O/M can be reduced.

Basic policy-3: The raised portion by 0.7 m in Indonesian time, of the fixed weir constructed in 1972 under Portuguese regime, was washed out during a flood in 1992. Due to this damage, sufficient discharge has not been taken from the source of Bulobo River. The washed out portion, therefore, will be rehabilitated in the Project.

Basic policy-4: By the rehabilitation of the washed out portion mentioned above, it is expected that sufficient discharge from intake facilities can cover wider the irrigable area so that distribution system in such main and secondary canals can be designed to secure stable water distribution to the extended command area and to meet the cropping schedule planned by WUA.

2-2-1-2 Natural Conditions

The following will be adopted as the design criteria on natural conditions.

Policy-1: As to flood and droughty discharge conditions of Bulobo River, the results of analysis in the F/S report by the WB will be adopted as the criteria for the design in terms of data on rainfall quantity and River flow as the basis of determining scale of designed facilities, because they are in conformity with the result of interview survey towards beneficiary people.

Policy-2: The dimensions of the facilities are designed to have relevant function / structure so that the WUA can operate and manage in an economically feasible way, and inflow of harmful sediments contained in River flow into the main canal can be minimized.

Policy-3: Since rainfall is concentrated in rainy season, the working schedule is planned taking rainfall patterns of both rainy season (November to April) and dry season (May to October) into

consideration.

2-2-1-3 Socio-economic Conditions

The following will be adopted as the policy on socio-economic conditions.

Policy-1: Because the existing irrigation canals are also used for domestic purpose such as washing clothes and bathing other than irrigation, due consideration will be made in formulating canal rehabilitation plan and construction schedule,

Policy-2: Since the Project area has been cultivated very close to both sides of existing irrigation facilities in the Project area, it will be designed to minimize area of land acquisition accompanying compensation for crops.

Policy-3: Assuming the existence of illiterate gate operators and group leaders, as many explanatory pictures as possible will be used in various instruction manuals, and simple ways of O/M will be pursued.

Policy-4: Employment opportunities are very much limited for younger generations resulting in the increase of unemployment in urban areas on one hand, almost all technical skilled labor has been supplied by Filipinos, Chinese and Indonesians, on the other. Further, local population is strongly conscious of their territorial defense and they have been accustomed to procure laborers from communities located around the construction sites in a rotational employment system. These situations will fully be regarded in the employment of labor force in the Project.

2-2-1-4 Farming and Irrigation Conditions

The following will be adopted as the criteria for conditions of farming and irrigation plan.

Policy-1: Since Maliana I area has a better condition of marketing and the beneficiaries in the area have intention of expanding the irrigated cropping area, the Project contributes to the overall goals of the Project, i.e." To increase irrigated paddy land in the Project area ".

Policy-2: Cropping pattern is proposed in a manner to reduce the peak water requirement by staggered puddling period within the Project area, thereby matching the period with February, the period of the maximum flow occurring in Bulobo River.

Policy-3: Cropping pattern is also proposed to efficiently intake the 5-year reliable low-flows, considering current cropping patterns, monthly flow of Bulobo River and pattern of effective rainfall.

Policy-4: Design criteria for irrigation plan is determined justifying the relevance of the cropping patterns as the above proposed and water requirement already proposed in the F/S report by the WB, also considering available intake discharge in the water source (Bulobo River) and effective rainfall.

The followings explain the reasons why the above policy are adopted:

(1) State of sale and marketing of rice (Policy-1)

According to the results of the Baseline survey shown in Table 2-3 on the status of marketing paddy, self consumption rate of paddy is around 60% and the rest 40% is sold outside of the Project area. The farmers carry their paddy to Maliana town market and some are purchased by Agriculture Service Center (ASC) in Bobonaro district (7%).

Table 2-3 Marketing volume of paddy in Maliana I
(Total of effective reply from 34 farm households)

Form of consumption / sale	Total quantity of 34 farm households	Percentage
1.Self-consumption	52,710 kg	60%
2.Quantity sold		
1) Quantity delivered to Maliana market	28,650 kg	33%
2) Quantity sold to ASC	6,450 kg	7%
3) Quantity sold to middlemen	250 kg	-
Sub-total of sale	35,350 kg	40%
Grand Total	88,060 kg	100%

Source: Baseline survey

In addition, the beneficiary in Maliana I has a better condition of marketing with cheaper production cost, in promoting irrigated rice production within the area in future due to the fact that 1) middlemen visit Maliana town market from outside of the district, for example, other sub-districts of Bobonaro district, capital Dili, Ermera district (in western region) and further from Baucau district (in eastern region), and also 2) cheaper inputs such as seed paddy and fertilizers are directly imported from Indonesia (West Timor).

During the field survey of B/D on March 17 2005, a workshop was held to conduct an interview survey (in which 137 farmers have given valid response) where a question was asked to the beneficiaries on the expansion of cropping area in dry season in a way "If irrigation facilities in Maliana I is rehabilitated and sufficient water can be conveyed during dry season, how many hectares do you intend to cultivate in your field?" The result is shown in Table 2-4.

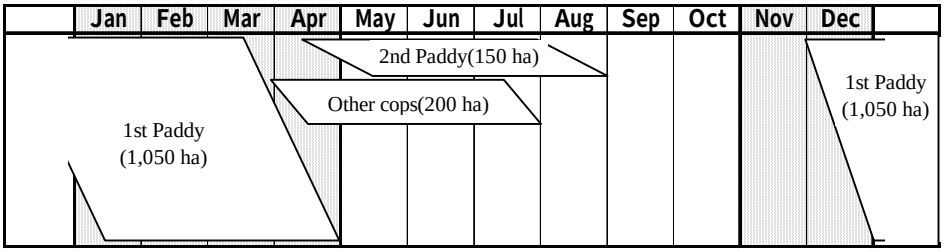
Table 2-4 Farmers' Willingness of cultivation after rehabilitation

	less than 1 ha	**more than 1 ha**	no comment	Total
Actual cropping last year	62%	**26%**	12%	100%
Willing cropping after rehabilitation	39%	**54%**	7%	100%

Result was about two(2) times, 54% of beneficiaries intend to cultivate more than 1 ha with sufficient irrigation during dry season after rehabilitation, in comparison with current state only 26% at present. Although the respondents did not specify crop species, the figure proves that "they will cultivate more only if sufficient water is available in dry season, hence irrigated area will be expanded."

(2) Planned cropping pattern (Policy-2 and Policy-3)

The cropping pattern is proposed in Basic Design (B/D) considering the expansion of irrigated area in which irrigated paddy cropping area can be maximized through differentiated puddling practice within the total target area of 1,050 ha in a staggered puddling period allocated to upstream (shared at 30%), mid-stream (shared at 30%), and downstream (shared at 40%). Also, this cropping pattern is adjusted in



compliance with the maximum discharge of Bulobo River taking place in February, resulting in the cropping pattern shown in Figure 2-2.

Figure 2-2 Planned cropping pattern proposed by the B/D

As a result of estimating water supply for the above proposed cropping pattern, the water requirement of each crop is given in Table 2-5 (as to the detailed calculation, refer to "Appendix 6-8 Estimation of water requirement"). In this estimation, the total of planned maximum water supply is equivalent to 5-year reliable low-flows of Bulobo River.

Table 2-5 Designed intake discharge in 3-year and 5-year reliable low-flows of Bulobo river

	Rainy season, water requirement at critical period (early February) paddy area：1,050ha upland area： 0ha	Dry season, water requirement at critical period (early July) paddy area：150ha upland area：200ha
1) Water requirement of paddy	1.35 m^3/sec	0.33 m^3/sec
2) Water requirement of upland	—	0.11m^3/sec
3) Water for domestic supply	0.015 m^3/sec	0.015 m^3/sec
Maximum Designed Intake Total	**1.37 m^3/sec**	**0.46 m^3/sec**
(Reference) Low flow in Bulobo River (3-year reliability)	1.67 m^3/sec	0.49 m^3/sec
Low flow in Bulobo River (5-year reliability)	1.37 m^3/sec	0.46 m^3/sec

(3) Design dimensions of irrigation planning (Policy-4)

In the F/S report by WB, design water requirements is calculated on the basis of FAO Irrigation and Drainage Paper "Crop Water Requirements". Here, the study team verifies the validity of WB F/S report based on FAO technical papers and adopted each parameter of irrigation calculation in the light of a result of field survey as shown in Table 2-6.

Table 2-6 Design criteria for calculation of water requirement

Item of parameter	F/S report by World Bank	Present view	Adopted value by study
①Crop coefficient (kc)	1) Paddy (HYV)：1.05, 1.10, 0.95 2) Upland crop：0.4, 0.54, 0.96, 0.98, 0.82, 0.35	Same as left	Same as left
②Crop evapotranspiration (ET_0)	Monthly value obtained by the pan evaporation method	Same as left	Same as left
③Percolation rate (paddy)	2.5mm	Up and midstream: 3.0mm Downstream: 5.0mm	Same as left
④Crop water requirement (paddy): ④=①+②+③	Maximum：6.4mm	Maximum: 7.5 mm	Same as left
⑤Water requirement for puddling (Ponding depth：50mm included)	1) Puddling period：1 month 2) Water requirement (paddy in rainy season：300mm, paddy in dry season：250mm)	Same as left：calculation method is reviewed	Same as left
⑥Water requirement after mid drainage (paddy)	50mm/15 day after planting	Same as left：calculation method is reviewed	Same as left
⑦Effective rainfall (1953～for 74 year)	1 in 5 years (80 % of average rainfall above 80%)	Same as left	Same as left
⑧Irrigation efficiency: Ep = Ef×Ec	58% (There is not any distinction between the paddy and upland crops)	1) Paddy: 41.6% 2)Upland:36.4%	1)Paddy: 54.4% 2)Upland:47.6%
a) Application efficiency: Ea	Not mentioned	1) Paddy: 80% 2) Upland: 70%	1) Paddy: 80% 2) Upland: 70%
b) Canal efficiency: Eb	Not mentioned	80%	80%
c) Farm efficiency: (B.P. of tertiary canal) Ef = Ea×Eb	80% (There is not any distinction between the paddy and upland crops)	1) Paddy: 64% 2)Upland: 56%	1) Paddy: 64% 2) Upland: 56%
d) Conveyance efficiency (after improved)：Ec	72.5%	65%	85%

① Crop coefficient (kc)

The crop coefficient (kc) is used in calculation of daily water consumption for crops. It should be decided according to the growth stages of each crop and the WB F/S report has adopted those in Table 2-7.

Table 2-7 Crop coefficient (kc) used in the WB F/S report

Growing stage	Growth in the Initial stage		Development stage		Mid-season stage		Late-season stage	
Paddy (HYV)：3.5 months	1.05	1.05	1.10	1.10	0.95	0.95	0.0	—
Upland crops (maize, beans, vegetables)：4 months	0.40	0.54	0.96	0.96	0.98	0.82	0.35	0.0

Because the crop coefficients of paddy in the WB F/S report are accorded with FAO technical paper, this value is adopted in the Project, as a result of the confirmation by the study team. Despite the fact that upland crops show different values by crop species, water requirement of paddy accounts for the most part of overall water requirement. Taking these into consideration and for convenience of calculation, the values of WB F/S report are adopted for the estimation of crop coefficient.

② Crop evapotranspiration rate (ETcrop)

The evapotranspiration rate is influenced by temperature, humidity, solar radiation, direction of wind etc. of this project area. The following values were adopted for estimation of the rate, measured with Pan's evaporation method mentioned in the WB F/S report.

Table 2-8 Monthly evapotranspiration rate (ET_0) in Maliana I area

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Evapotranspiration (ET_0, mm)	1.4	1.2	1.3	1.8	2.2	2.9	4.1	4.2	3.9	3.7	2.4	1.5

In this context, the daily crop evapotranspiration rate (ETcrop) is calculated by following formula.

$ETcrop = kc \times ET_0$

where, ETcrop : Daily crop evapotranspiration (mm)
kc : Crop coefficient
ET_0 : Daily evapotranspiration (mm)

③ Percolation rate (Paddy)

The percolation rate is calculated by soil type. Percolation rate in Maliana I area is reported as 2～3 mm/day in WB F/S report. Also, daily percolation rate observed in this field survey by the study team is shown in Table 2-9. The maximum daily percolation rate is 2.29 mm, indicating that the adopted value of the WB is basically correct.

Table 2-9 Observation of percolation rate

Date	Upstream of Ritabau canal (0.2 km downstream from diversion point) (mm)		Midstream of Ritabau canal (1.0 km downstream from diversion point) (mm)		Midstream of Ramaskora canal (1.5 km downstream from diversion point) (mm)	
	Percolation rate	Water requirement per day	Percolation rate	Water requirement per day	Percolation rate	Water requirement per day
18 March	0.76	0.76	—	—	—	—
19 March	—	—	1.94	2.31	—	—
20 March	1.39	2.55	2.24	3.25	0.45	0.46
21 March	1.73	2.44	—	—	—	-
22 March	1.33	1.85	2.29	2.99	—	—
23 March	—	—	—	—	1.17	1.33
24 March	—	—	—	—	—	—
Maximum	1.73	2.55	2.29	2.99	0.45	0.46

Note: (—) indicates that unobserved or unreliable data.

Therefore, 3.0mm/day is adopted as the percolation rate. On the other hand, 5.0 mm/day is anticipated in the terminal reach of Maliana I area by the reasons, i) observation data is not obtained in this study, ii) this area is not irrigated in dry season and plow sole is not well developed.

④ Daily water requirement (Paddy)

The daily water requirement is shown with the sum of above-mentioned crop evapotranspiration and percolation rate. It is derived from the following formula.

Water requirement per day (mm/day) = Crop evapotranspiration rate (ETcrop) ＋ Percolation rate

From the observation of the percolation rate in this B/D field study and the result of the calculation of crop evapotranspiration, maximum daily water requirement shall be calculated at 7.5 mm (as of beginning of July) and 7.5 mm is adopted.

⑤ Water requirement for puddling

According to WB F/S report, water requirement for puddling is estimated (i) beginning of rainy season crops, 300 mm/day and (ii) beginning of dry season crops, 250 mm/day. Because the paddy field is puddled right after harvest of rainy season crop, water requirement for puddling of dry season crop is considered less than rainy season crops.

(a) Calculation method in World Bank's F/S report

1) Rainy season crops：300 mm／30 days＝10.0 mm/day
2) Dry season crops：250 mm／30 days= 8.3 mm/day

(b) Calculation method in BD period in this project

In the case of puddling certain block of paddy field, the total block is not simultaneously but differentially puddled in order to reduce peak water requirement. Given that paddy is transplanted one day after the puddling and all the blocks have been puddled within N days, net mean water requirement for puddling in N days is estimated as follows.

$$Sn = [D+d \times (N-1)] / N$$

where, Sn ：Net average water requirement for puddling (mm/day)
D ：Water requirement for puddling
(rainy season crops = 300 mm, dry season crops = 250 mm)
d ：Daily water requirement (calculated by 7.5mm, the maximum value)
N ：Number of puddling day (30 days)

1) Rainy season crops (max)：Sn = [300+7.5 x (30－1)]／30 = 17.3 mm/day
2) Dry season crops (max)：Sn = [250+7.5 x (30－1)]／30 = 15.6 mm/day

⑥ Water requirement after mid-drainage

(a) Calculation method in WB F/S

50 mm／15days＝3.3 mm

(b) Calculation method in this B/D study

Similar to the calculation for puddling, the net average water layer replacement is calculated as the following.

$$Wn = [W+d \times (N-1)] / N$$

where, Wn ：Net average water requirement of after mid-drainage (mm/day)
W ：Water requirement of after mid-drainage (50 mm)
d ：Daily water requirement (calculated maximum value is 7.5 mm)
N ：Number of mid-drainage days (15 days)

$$Wn = [50+7.5 \times (15-1)] / 15 = 10.3 \text{ mm/day}$$

⑦ Irrigation efficiency

According to FAO technical paper, irrigation efficiency is considered classifying the efficiency into 3 grades of Ea, Eb and Ec. And comparison of the applied value in WB F/S report and adopted value in this BD are shown in Table 2-10.

Table 2-10 Comparison of irrigation efficiency

Efficiency	Explanation in FAO technical paper	Viewpoint in BD study	Applied value in WB F/S	Adopted value in BD (paddy)
1) Application efficiency (Ea)	Proportion of irrigation water available to crops directly and inflow at field block intake	Loss in farm land with canal ditch	―	0.80
2) Branch canal efficiency (Eb)	Proportion of inflow at field block intake and inflow at field block district intake	Canal and conveyance loss including after tertiary canals	―	0.80
3) Conveyance efficiency (Ec)	Proportion of inflow at field block district intake and inflow from water source intake	Conveyance loss of main canal and secondary canal	0.725	0.85
4) Farm efficiency (Ef)	①Application efficiency (Ea)×② Branch canal efficiency (Eb)	Loss in farm land and after tertiary canals	0.80	0.64
5) Irrigation efficiency (Ep)	③Conveyance efficiency (Ec)×④ Farm efficiency (Ef) i. e. Ep=Ea×Eb×Ec	Overall irrigation efficiency	**0.58**	**0.544**

(4) Verified result of proposed cropping pattern and irrigation plan

View result of irrigation calculation is summarized as Table 2-11 in (i) existing cropping pattern, (ii) proposed cropping pattern in WB F/S report and (iii) proposed cropping pattern in the BD study (detail refer to attached data-1, irrigation calculation).

Table 2-11 Cropping pattern and maximum intake discharge

	①Existing cropping pattern	②Proposed cropping pattern by WB F/S report			③Proposed cropping pattern in the BD study
Target area	1,050 ha	900 ha	900 ha	900 ha	1,050 ha
Rainy season (1st)	1)Paddy: 600 ha 2)Upland: 250 ha	1)Paddy: 750 ha 2)Upland: —	1)Paddy: 600 ha 2)Upland: —	1)Paddy: 500 ha 2)Upland: —	1)Paddy: 1,050 ha 2)Upland: —
Dry season (2nd)	1)Paddy: 100 ha 2)Upland: 100 ha	1)Paddy: 480 ha 2)Upland: 150 ha	1)Paddy: 480 ha 2)Upland: —	1)Paddy: 400 ha 2)Upland: —	1)Paddy: 150 ha 2)Upland: 200 ha
Dry season (3rd)	—	Upland：210 ha	Upland：180 ha	Upland：150 ha	—
Total paddy area	700 ha	1,230 ha	1,080 ha	900 ha	1,200 ha
Paddy cropping intensity	67%	137%	120%	100%	114%
Maximum intake volume	1.33 m^3/sec *1)	1.07 m^3/sec	0.97 m^3/sec	0.80 m^3/sec	1.37 m^3/sec
Target reliable year	Corresponding to 3-year reliable low-flows	2-year reliable low-flows	3-year reliable low-flows	5-year reliable low-flows	5-year reliable low-flows

*1): Actual intake water is estimated less than 1.0 m^3/sec.

2-2-1-5 Rehabilitation of Intake Facilities

2-2-1-5-1 Method of Rehabilitating Fixed Weir

Table 2-12 indicates the present situation of the fixed weir and policy of rehabilitation.

Table 2-12 Present conditions of existing fixed weir and policy of rehabilitation

Works	Rehabilitation Policy	Present Situation
1. Existing fixed weir body (constructed in 1972 Portuguese period)	**Policy-1:** Eroded part of the fixed weir should be filled with high-strength concrete, and the surface should be protected.	・ Eroding is observed at the downstream end of fixed weir. But it maintains the required strength (The compressive strength is 32.4 N/mm^2, which is 1.5 times stronger than that of normal concrete, 21.0 N/mm^2.) ・ The surface is not damaged, and minor abrasions are observed.
2. Raising existing fixed weir (raised in 1986 Indonesia period)	**Policy-2:** Raising the weir with high-strength concrete after removing existing raised part, considering required intake discharge and headwater level.	・ About 10m width of central part of raising concrete was washed out during a flood. ・ The strength of existing raising concrete is weak (The compressive strength is 18.5 N/mm^2, which is 0.8 times for that of normal concrete, 21.0 N/mm^2) ・ The adhesiveness with the body of existing fixed weir is poor.
3. Downstream apron (constructed is assumed in 1972	**Policy-3:** Constructing down stream apron with requiring length of down stream apron and creep length, for preventing piping and eroding at riverbed.	・ Debris of washed out apron is observed at 30m - 50m downstream from existing weir. ・ At the present, eroded part with 3 m depth and 15m long at downstream, which works as “water cushion”.
4. Downstream riverbed protection	**Policy-4:** Similarly, constructing riverbed protection for preventing bed erosion by the waterfall over flowing downstream apron.	・ Not constructed: Risk of scouring at the downstream riverbed by drop flown over the fixed weir

In this regard, the details of the above tabulated Policy-1 and Policy-2 are mentioned below;

(1) Selection of surface protection works (Policy-1)

As the surface protection works for the fixed weir, relevance of different works, in terms of abrasion-resistant, shock-resistant, workability and cost-effectiveness, are compared as indicated in Table 2-14. As a result of comparison, "high strength concrete method" is adopted as a method of concrete work [aiming at higher strength of concrete provided with higher rate of cement content (enriched proportion) than normal concrete to reinforce the structure by coating the deteriorated concrete structures]. As to "steel plate method" proposed in the F/S study by the WB, it requires anchor fixation and accompanying measurement to cope with thermal stress, entailing in higher cost.

Comparatively, an effect of surface protection as experienced in the initial fixed weir concrete in Maliana I can be expected in "high strength concrete method", and this method does not require any particular technique, meaning cheaper cost. (reference: Table 2-13 Comparison of surface protection works)

(2) Height of raising (Policy-2)

The top elevation of the upper crest of the fixed weir is calculated in the following, at EL. 254.40m, thus raising 0.70m will be required as mentioned in the request report from MAFF Timor-Leste.

The top elevation at upper crest of the fixed weir = water level required in the main canal + head loss at sediment basin + head loss at intake work + freeboard

= WL. 253.95m + 0.13m + 0.22m + 0.10m

= EL. 254.40m

Table 2-13　Comparisons of surface protection works

Item/Works	Masonry method	Steel plate method	Elastic plate method	Vacuum concrete method	High strength concrete method
Outline	Cut stone, wedge stone and quarry stone are used as usual.　It is constructed filling to substrate concrete.	Steel plate is fixed to bottom concrete by anchor and weld. The steel plate can be removed by thermal stress. It can be waved by the impact of pebble and boulder and abraded partially.	The polyurethane elastic plate is fixed substrate concrete by anchor and weld. Anchor is used to joint with concrete. If anchor was spoiled, protection material can be lost.	It reinforces the strength of concrete with vacuum process that is to reduce the moisture of the concrete after concrete cast in immediately. Usually, the strength and abrasion proof will be increased 20 to 30%.	High strength concrete is low W/C ratio concrete. It needs more cement. It will be more effective to use smaller aggregate.
Abrasion-resistant	If high quality pieces of stone are used and filling to substrate concrete is enough, it shows high abrasion proof. ◎	It shows high abrasion proof with proper fixation of the anchor and measurement to thermal stress. ◎	It shows high abrasion proof with the proper fixation of the anchor. ◎	It has very high strength and good abrasion proof. ○	It has enough strength than ordinal concrete (Fc = 21N/mm^2) comparatively. Abrasion proof is high. ◎
Shock-resistant	If high quality pieces of stone are used and filling to substrate concrete is enough, it shows high impact proof ◎	It shows high impact proof with proper fixation of the anchor and measurement to thermal stress. ◎	It shows high impact proof with the proper fixation of the anchor. ◎	The impact proof of this method is same as non-treat concrete, thus impact proof is poor. △	It has enough strength than ordinal concrete (Fc = 21N/mm^2) comparatively. Impact proof is high. ○
Workability	It is difficult to get skilled labor. Processing of stone is unworkable. △	It is needed to weld the anchor fixation. Workability is not high. △	The anchor is filled in elastic plate in factory, it is not needed to weld at construction site. Therefore workability is high. ◎	To handle not harden concrete, it is needed proper preparation and skill of technicians. Workability is low. △	It can be cracked caused by rich mixed concrete. It needs to treat well after cast in concrete. ◎
Cost-effectiveness	Bit expensive ○	Expensive △	Very expensive △	Cheap ◎	Cheap ◎
Sample	None in recent.	・Minowa head work ・Hanishina head work ・Nisiiwasaki head work ・Kawai-Hanishina head work	・Shin-kinomata head work ・Inuyama head work (Partially Improved)	None in recent	・Kansagawa head work ・Kaisei head work ・Iwasaki head work ・Asuwagawa head work ・Yokoe head work ・Ishibe headwork
General Evaluation	It is expected effective as surface protection. But, skilled labor and good quality stone is difficult to prepare. And recent experience is less. ○	It is needed anchor fixation and measurement to thermal stress. The cost is expensive. ○	The cost is very high. △	The cost is low, but the effectiveness of surface protection is not expected. And it is required special skill for construction. △	Special skill is not required. The cost is also cheap. It is expected to effect as surface protection. ◎

2-2-1-5-2 Countermeasures for Sedimentation

In the light of what is indicated in the Basic policy-1 for implementing the project under the Grant Aid scheme, regarding "the specification and the scale of the facilities that WUA can operate and maintain at economically reasonable basis", the principles to cope with sedimentation is established as follows:

Policy-1: to stabilize gut (line of River-flow inside the stream) of Bulobo River and install a scouring sluice gate in order to secure sufficient water intake.

Policy-2: to reinforce the body of scouring sluice preparing against the collision of boulder flowing down during floods.

Policy-3: to install an intake gate to control inflow of harmful sediment into the main canal at the minimum level, at the same time, the existing sediment settling basin is rehabilitated where the scouring gate is renovated.

Policy-4: to completely renovate the dilapidated canal intake the operation of which is currently difficult.

The following explains the reasons why the above policies are adopted;

(1) Necessity of maintaining gut (line of River-flow inside the stream) and selection of scouring sluice type (Policy-1)

① Necessity of maintaining gut

Currently irrigation water is taken in from Bulobo River by training gut towards the intake weir through a masonry guide wall diagonally traversing the streambed. However, due to water leakage from (dry masonry) guide wall and insufficient cross-sectional area of flow caused by sedimentation inside the present gut, quantity of intake is limited to the extent of only 50 to 70% of total River flow whenever the flow is depleted under the current state of gut. Also, if the guide wall (by dry masonry) is partially demolished by flood and the present gut lane is consequently buried with sediment, the intake will not well function to lead River flow into the canal. This is the reason why a scouring sluice that prevents inflow of sediment has to be installed keep stable intake of irrigation water from the streams like Bulobo River.

② Prevention of sedimentation at intake weir

Flood flow of Bulobo River contains large quantities of harmful silts (above 0.3 mm in diameter), the concentration of which is estimated to reach 0.04% in rainy season and 0.01% in dry season. It follows that irrigation water taken in also contains much silts, and assuming that the designed quantity is taken into canal, quantities of intruded silts taken into the canal is estimated at 2,700m^3 in rainy season,＋210m^3 in dry season, totaling at about = 2,910m^3 (refer to the reference 6-9 on "Examination of sediment control works").

Intrusion of sediment silts cannot be prevented at the existing water intake without scouring sluice gate, so a large quantity of silts is flowing into canal along with the intake of irrigation water. Currently, demolished part of dry masonry guide wall and dredging of gut play complementary role of scouring sluice, thus intruding silts at intake may more or less be reduced, but still fairly large sedimentation is estimated at

80% in rainy season (around 1,520m^3) and at 60% (about 80m^3) in dry season, amounting to an annual total of 1,600m^3 (refer to Appendix 6-9 "Examination of sediment control works").

The weir with a scouring sluice can reduce intrusion of silts by the proper operation of sluice. Thus, sediment intrusion into the intake is estimated at 20% in rainy season (around 540 m^3) and at 7% (about 15 m^3) amounting an annual total of about 555 m^3.

③ Selection of the type of scouring sluice

As shown in Table 2-8 "Comparison of several types of surface protection works" was made among 1) to construct a fixed weir without scouring sluice, 2) to construct fixed weir with a scouring sluice of the gate-type and 3) to construct fixed weir with stop logs scouring sluice, and after comprehensively evaluating these, fixed weir with a scouring sluice of the gate was adopted regarding the following reasons.

(2) Reinforcement work of scouring sluice gate (Policy-2)

Bulobo River is a torrential stream with the horizontal gradient averaged at 1/50 where the flow velocity during flooding reaches about 5.0m/sec. The topography of the bank at the upstream of the weir is subject to scour / collapse where boulders with a diameter of 2.0 m or so are scattered over the riverbed.

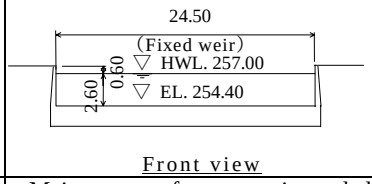
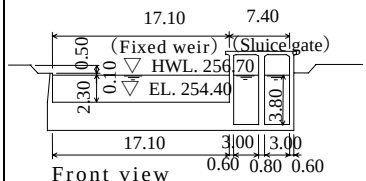
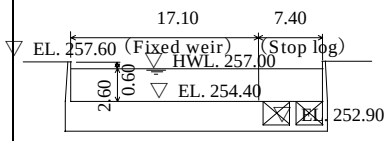
In case of constructing a gate of scouring sluice in such a torrential stream, the gate should be fully open during flooding. If the gate happens to be miss-operated to completely be closed during flooding, flowing boulders may hit the gate giving damages of deform on the gate (skin plate, main beam, roller and its axis) and guide frame. The reinforcement works shall therefore be reinforced preparing against the risk of damages by flowing boulders in the following conditions.

(3) Prevention of harmful sediment inflow into the main canal (Policy-3)

To avoid sedimentation inside the canal, it is necessary to remove silts with its diameter over 0.5mm intruded from the intake by at sediment settling basin. The existing weir without scouring sluice allows large amount of harmful silts to sediment in the sediment settling basin, estimated at around 1,330m^3 in rainy season ＋ in dry season (around 540m^3) and at about 70m^3 = amounting an annual total of approximately 1,400m^3. According to this sedimentation, the frequency of required scouring will be estimated at about 24 times (5 days per scouring) in rainy season＋about 2 times (60 days per scouring) in dry season = totaled at about 26 times / year.

Since the weir equipped with a scouring sluice can scour harmful silts, accumulated sediment in the sediment settling basin will be reduced at around 270 m^3 per annum consisting of 270 m^3 in rainy season ＋ about 0m^3 in dry season. Hence, the frequency of required scouring will be estimated at about 5 times in rainy season (24 days cycle / time) ＋0 time in dry season = totaled at around 5 times / year (refer to the information on "study on scouring sluice").

Table 2-14 Comparison of weir type

Items	1)Fixed weir without scouring sluice	2)Gate type scouring sluice	3)Stop log type scouring sluice
Schematic	 Front view	 Front view	 Front view
Intake of irrigation water	・Maintenance of water gut is needed. ・Intake is estimated 70% of stream flow because maintenance of river gut and guide banks is inadequate. ・Irrigation area：(Paddy rice, 5-year recurrence interval) Rainy season 750ha + Dry season 100ha = 850ha/year	・All stream flow is taken because the gut is stable and enough intake depth is kept. ・Irrigation area：(Paddy rice, 5-year recurrence interval) Rainy season 1,050ha + Dry season 150ha = 1,200ha/year	・Maintenance of water gut is needed. ・Intake capacity is estimated 85% of stream flow because dredging of gut is not enough. ・Irrigation area：(Paddy rice, 5-year recurrence interval) Rainy season 900ha + Dry season 130ha = 1,030ha/year
Design flood	・Design flood stage： HWL257.00m ・HWL is 0.20m higher than the top elevation of existing upstream revetment, so that 0.8m wet masonry protection wall is needed. ・Length of riverbed protection is 12m shorter than these of other plans	・Design flood stage： HWL256.70m ・HWL is 0.10m lower than the top elevation of existing upstream revetment, but 0.5m dry masonry wall is needed. ・Length of riverbed protection is 12m larger than these of fixed weir.	・Design flood stage： HWL257.00m ・HWL is 0.20m higher than the top elevation of existing upstream revetment, so that 0.8m wet masonry protection wall is needed. ・Length of riverbed protection is 12m larger than these of fixed weir.
Sediment inflow	Huge amount 1,610m^3/yaer	Little amount 555m^3/yaer	Huge amount 1,700m^3/yaer
Facilities size (Only comparing work type)	・Rising of fixed weir： 24.5m ・Downstream apron： 24.5m ・Downstream riverbed protection： 370m2 ・Rising of wet masonry protection wall： 105m	・Canal of sluice gate： 28.5m ・Piers of sluice gate： 3 set ・Scouring sluice gate： 2 set ・Rising of Fixed weir： 17.1m ・Downstream apron： 17.1m ・Downstream riverbed protection： 590m2 ・Dry masonry embankment： 105m	・Canal of sluice gate： 28.5m ・Stop log： 2 set ・Rising of fixed weir： 17.1m ・Downstream apron： 17.1m ・Downstream riverbed protection： 590m2 ・Rising of wet masonry protection wall： 105m
Safety	・The gate or the stop log is not set up in the river, and because it is concrete and stone construction, the safety of facilities is high.	・Reinforcing work of skin plate, main beam, roller, and roller axis is needed against boulders at a flood ・Gate full opening operation is necessary at a flood.	・Reinforcing work of stop log is needed against boulders at a flood.
Workability	・The construction of the fixed weir is easy because there is no sluice gate which has complex structure.	・Because the gate has tall gate piers, the construction of this type weir is difficult.	・Not having tall gate pier, the construction of this type weir is easy.
Yearly operation and maintenance (Only comparing work type)	・Dredging of gut： 3 times ・Embankment of guide bank：3 times ・Sand removal of intake sand sediment basin： 26 times ・Sand removal of canal sand sediment basin： 1 time	・Operation of gate： Full year ・Dredging of gut： null ・Embankment of guide bank： null ・Sand removal of intake sand sediment basin： 5 times ・Sand removal of canal sand sediment basin： 2 times	・Operation of stop log： Full year ・Dredging of gut： 3 times ・Embankment of guide bank： null ・Sand removal of intake sand sediment basin： 27 times ・Sand removal of canal sand sediment basin： 1 time
Economical Efficiency (Only comparing work type) million yen)	Weir repair work cost ・Fixed weir repair work： 52.3 ・Scouring sluice construction：0.0 ・Rising of protection wall： 2.9 **Weir repair work cost 55.2** (1.00) O&M cost (Full year) ・Operation of intake gate： 0.64 ・Maintenance of gut and guide bank： 1.58 ・Sand removal of both sand sediment basin： 0.33 ・Repair of facilities： 1.00 **Sum of O&M cost 3.55** (1.45) **Construction cost ＋ O&M cost： 197.2** (1.08)	Weir repair work cost ・Fixed weir repair work： 32.5 ・Scouring sluice construction：51.0 ・Rising of protection wall： 0.8 **Weir repair work cost 84.3** (1.53) O&M cost (Full year) ・Operation of intake gate： 0.77 ・Maintenance of gut and guide bank： 0.00 ・Sand removal of both sand sediment basin： 0.07 ・Repair of facilities： 1.61 **Sum of O&M cost 2.45** (1.00) **Construction cost ＋ O&M cost： 182.3** (1.00)	Weir repair work cost ・Fixed weir repair work： 33.2 ・Scouring sluice construction：33.6 ・Rising of protection wall： 2.9 **Weir repair work cost 69.7** (1.26) O&M cost (Full year) ・Operation of intake gate： 0.77 ・Maintenance of gut and guide bank： 1.08 ・Sand removal of both sand sediment basin： 0.35 ・Repair of facilities： 1.61 **Sum of O&M cost 3.81** (1.56) **Construction cost ＋ O&M cost 222.1** (1.22)
Evaluation	○	◎	△

(4) Necessity of constructing the intake gate (Policy-3)

The intake gate will newly be constructed by the following reasons.

① The flood control

Since water depth during floods at the intake is estimated at 3.1m, a permanently open intake without gate just like the existing one has a risk of damage caused by inflow of flooded water in sediment settling basin ad main canal. It is therefore necessary to control the flood at the intake.

② Prevention of sediment inflow by floods

In the case of the existing intake weir where no intake gate is installed but the intake is always open, there is a risk of inflow of enormous silt accompanied with inflow of flooded water. It is therefore needed to control the intrusion of sediments at the intake. This is the reason why the "steel made slide gate (4-side back sealing)" will be designed for the head-works.

(5) Necessity of construction of the sediment settling basin of headworks (Policy-3)

① The size of existing sediment settling basin (13m long ×12m wide×0.9m deep ×1 set) is as follows.

(a) The depth of sediment settling basin

The effective water depth of the existing sediment-settling basin is 0.5 m, in which the flow velocity is measured at about 0.3 m/sec. This basin is deep enough to set sediment because the marginal flow velocity to allow to precipitate the target silt with particle size ranges 0.5 to 40 mm (around 0.4 m/sec). Nevertheless, the existing basin allows to sediment only 0.2m as mean depth, and the capacity of accommodating sediment is limited to only 35m^3. Naturally, high frequency of scouring follows to evacuate the sediment. To solve this, the mean depth will be designed at 0.4m equivalent to the volume of sedimentation at about 55 m^3, so that the frequency of scouring can be reduced. To achieve this capacity, the elevation of the bottom of the basin will be designed at around 0.3m lower than the bottom of the existing basin.

(b) The width and the number of sets of the sediment settling basin

Because the existing sediment-settling basin has the width of 12.0 m with the flow velocity of 0.2 m/sec, the designed width of the basin can be narrowed down to 6m. On the other hand, the sidewall at the left of existing sediment settling basin has been widely cracked and the cracks should be repaired. It will be designed to construct a new sidewall at 4.0 m forward of the existing left sidewall in order to make the width of the basin at 8m after repairing. Normally, 2 sets of the sediment settling basin are constructed so that intake is made possible even during scouring. However, only one sediment settling basin will be designed similar to the existing one by the following reasons.

1) The gap of water level between the upper- and lower-stream at this intake weir is so wide, 5.4m, that scouring of the sediment settling basin is mainly made by flushing off and complementarily by manual labor. Only one set of basin exists in which it takes about 0.5 day for each scouring. Single

set of basin will therefore do well for scouring from labor and time points of view.

2) Suppose scouring is tried by subdividing the sediment settling basin into more than two sets. In this case, because intake is too little, attractive force for flushing out is also weak, resulting in longer time to scour in the sediment settling basin.

3) As to frequency of scouring, about 5 times of scouring will be needed during rainy season (24 days / 1 scouring) Normally, water loss during the management of irrigation facility is equivalent to about 5% of discharge and it will be increased in rainy season only by 2%. It follows that even if the sediment settling basin is divided into 2 sets, the merit of division hardly leads to the efficient use of irrigation water

4) If the sediment settling basin is designed as more than two sets, two-story structure would be unavoidable from the sectional configuration to accommodate both intake gate and scouring, thus it becomes too difficult to design layout of canal intake gate and scouring gate.

(c) The length of the sediment settling basin

Because the required length of the sediment settling basin to precipitate the target silt diameter 0.5～40mm is estimated at about 9 m, present length of the basin, 13m is enough to meet the requirement.

② The structure of existing sediment settling basin

(a) Main body of sediment settling basin

The structure of existing sediment settling basin consists of wet masonry provided with required strength. The left-side retaining wall has however heavily been cracked by earth pressure from behind. It is therefore designed that the right-side wall is utilized as it is but the left-side wall will newly be constructed in front of the existing retaining wall. Also, as regards the bottom plate to be lowered, the existing one will be removed and newly installed.

(b) The scouring sluice facility of sediment settling basin

The existing scouring gate has been spoilt due to incomplete maintenance through corrosion of gate body and mechanical damage of hoisting roller. Therefore, existing wet masonry of scouring facility will be removed and newly replaced with reinforced concrete structure.

(6) Rehabilitation of canal intake (Policy-4)

Though the strength of concrete at the existing canal intake is sufficient, but it will be wholly rehabilitated by the following reasons;

1) The corrosion is identified at gate body and other parts of the existing intake gate of main canal. In addition, the gate operation is too difficult to adequately operate it.

2) The size of the existing gate is measured at 1.0 m in width×1.0m in height of the gate, whilst the flow velocity through the gate is too fast, 2.3 m/sec, that flowing from sediment settling basin into the main canal cannot be smoothly kept. So, the newly constructed gate is designed at 1.80m in width ×

1.0m in height for controlling the velocity at about 1.4 m/sec.

3) The rehabilitated intake gate of the canal is designed with steel-made slide gate with manual operation to make accurate water management easier.

2-2-1-5-3 Maintaining River Channel Upstream of Weir

(1) Rehabilitating the existing protection wall

The principles shown in Table 2-15 will be applied to rehabilitate the existing protection wall for proper maintenance of River channel upstream of the intake weir.

Table 2-15 Present situation and policy of rehabilitation on river protection retaining wall

Method	Policy of rehabilitation	Present situation
1. General	**Policy-1:** At he rising portion that hasn't enough strength, joint mortar exposing wet masonry will be removed, then that part shall be refilled with new mortar	The strength of the rising mortar (9.8 to 12.6 N/ mm^2) is not enough, equivalent to only half of strength of the normal retaining wall concrete, 18N/mm^2. Lower part has enough required strength (18.7 to 23.7 N/ mm^2).
2. The foundation of River protection retaining wall at upstream of the weir	**Policy-2:** Preventing from scour, crossing type concrete block will be constructed along right side bank foundations as foot protection.	There is considerable scouring by flood debris flow.
3. The River protection retaining wall right bank at upstream of weir	**Policy-3:** Existing wet masonry structure upstream side of the existing crack will be removed and rehabilitated.	It was tilted a bit to River channel and large crack is observed.
4. The River protection retaining wall right bank at downstream of weir	**Policy-4:** It will be repaired with wet masonry.	The dimension of scour is 5m in width × 3.5m in height × 1.5m in length by the dropping water from existing fixed weir.

(2) Raising elevation of the protection wall

The flood level of raised flow when design flood discharge of 310 m^3/sec (100-year reliable flood-flows) occurs is calculated at HWL 256.70 m. As the top of elevation of the existing retaining wall: EL. 256.80m is higher by 0.10m than design flood level of raised flow: HWL. 256.70m, raised portion of River protection retaining wall is not subject to scouring by floods. It is therefore constructed as shown in Figure 2-3 with embankment by earth filling surface cover is needed to avoid scouring by rain at the surface of embankment. Though turf is in general employed for the surface protection, but in this case dry masonry will be adopted because no rain is expected for six months of dry season.

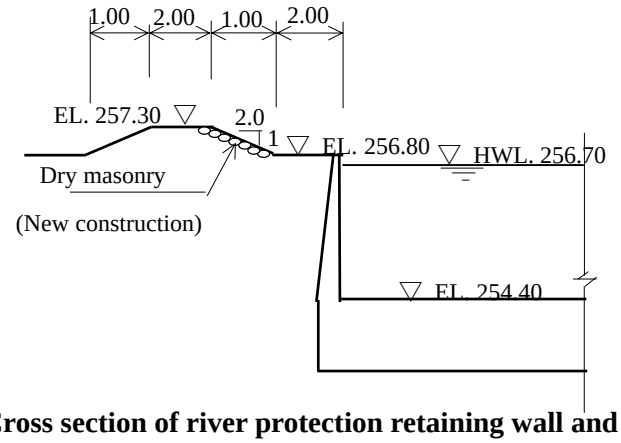


Figure 2-3 Cross section of river protection retaining wall and embankment

2-2-1-6 Length of Rehabilitating Canal and Lining Method

Policy-1: The existing lined canals are rehabilitated with wet masonry mortar method depending on their degree of dilapidation.

Policy-2: The length of lining canals will be determined by verifying the pertinence of what have been requested. As to means of construction, wet masonry mortar will be adopted.

The following is the background of the above policies of rehabilitation.

(1) Requested length of canal rehabilitation and extension

The length of canal lining and corresponding command areas among each block section of command in the request of application for the rehabilitation of the main canal and secondary ones of Ramaskora and Ritabau is compiled in Table 2-16. Of these tabulated sections, 3) and 4) of Ramaskora secondary canal and 2) of Ritabau secondary canal are those additionally requested sections of canals. The existing masonry lined canals are rehabilitated with wet masonry mortar work depending on their degree of dilapidation. As regards the sections of earth canal and additionally requested sections, they need further elaboration.

Table 2-16 Length and command area of each canal

The requested canal section for rehabilitation	Present status	Length	Irrigated command area	Ratio	Remarks
1. Main canal	Lined with masonry works	**1,530m**	1,051ha	100%	To be Rehabilitated
2.Ramaskora secondary canal					
1) Sta. 0+000 to 1+570	Existing masonry lined canal	1,570m	744ha	71%	To be Rehabilitated
2) Sta. 1+570 to 3+020	Earth lining	1,450m	425ha	40%	To be examined
3) Sta. 3+020 to 3+945 (additional request -1)	Earth lining	925m	175ha	16%	To be examined
4) Sta. 3+945 to 4+650 (additional request -2)	Earth lining	705m	120ha	11%	To be examined
Sub-total		**4,650m**			
3.Ritabau secondary canal					
1) Sta. 0 to 2+980	Existing masonry lined canal	2,890m	304ha	29%	To be Rehabilitated
2) Sta. 2+980 to 5+250 (additional request)	Earth lining	2,360m	161ha	15%	To be examined
Sub-total		**5,250m**			
Total		**11,430m**			

(2) Comparison of flow capacity by different lining methods

The results of comparing discharge ability among the works including 1) wet masonry mortar lining, 2) clay masonry lining and 3) earth canal are given in Table 2-17.

Table 2-17 Comparison of flow capacity of each lining work

Items	1) Wet masonry mortar lining	Evaluation	2) Masonry clay lining	Evaluation	3) Earth canal	Evaluation
1.Roughness coefficient	0.025	1.0	0.030	0.83	0.035	0.71
2.Effectiveness of conveyance	0.85	1.0	0.70	0.82	0.65	0.76
General evaluation		**1.0**		**0.68**		**0.54**

Remark) Each evaluation is based on 1.0 as wet masonry mortar lining in flow capacity

As evident from the above table, provided that discharge ability of the canal lined with wet masonry mortar is 100%, those of clay masonry lining and earth canal is lower, at 68% and 54%, respectively. These values are converted into unit water requirements at critical spell (falling on early February) as shown in the Table 2-18.

Table 2-18 Comparison of unit water requirement of each lining work

Wet masonry mortar lining	Clay masonry lining	Earth canal
1.29 liter/s/ha	1.90 liter/s/ha	2.39 liter/s/ha

Then, these are converted into irrigable areas by applying terminal water requirement, as shown in Table 2-19.

Table 2-19 Decrease of irrigation area by adopting other method in replacing of wet masonry

Canal	Block	Length	Maximum irrigation area	Reduced area by different work	
				Clay	Earth canal
1.Ramaskora secondary	1) No lining after earth lining	1,450 m	425 ha	136 ha	195 ha
	2) No lining after additional request-1 (earth lining)	925 m	175 ha	56 ha	81 ha
	3) No lining after additional request-2 (earth lining)	705 m	120 ha	38 ha	55 ha
2.Ritabau secondary	No lining after additional request (earth lining)	2,360 m	161 ha	52 ha	74 ha

Based on the results of comparison by various lining methods as shown in Table 2-20, it was found that the wet masonry lining work showed the best result. Therefore, wet masonry mortar is employed for the design of the whole sections including rehabilitation and extension.

Table 2-20 Comparisons of canal lining works

Items	Mortar wet masonry		Clay wet masonry		Earth canal	
Work	To form cross section by filling the aperture of pebble with mortar	-	To form cross section by filling the aperture of pebble with clay	-	To form cross section by cutting and filling present ground	-
Coefficient of roughness	0.025 (Rough wet masonry)	◎	0.030 (Clayey loam): Canal width is 10 % wider than mortar wet masonry.	○	0.035 (Whole grass): canal width is 20% wider than mortar wet masonry.	△
Effectiveness of convey	0.85	◎	0.70	○	0.65	△
Allowable flow velocity	2.5 m/s (Block wet masonry)	◎	0.9m/s (Clay loam)	○	0.6 m/s (Sandy loam)	△
Workability	Same method of existing canal. It is possible to hire skilled labors.	○	Availability of clayey soil is not confirmed.	○	Fundamentally, same work with the tertiary canal, farmers can construct.	◎
Cost	Little bit expensive.	○	Cheap	◎	Cheap	◎
Maintenance	No needs of maintenance unless broken, but cement is expensive.	○	Easy, if clayey soil is available.	○	The slope may slide, until grass is grown. And it needs frequent weeding.	△
General evaluation	It is easy to maintain and able to be repaired by farmers, because it is the same work as the existing canal.	◎	It is easy to maintain. In case of large fluctuation of the water level, it will be cracked at surface. Check before starting irrigation is needed	○	It needs more requirement water because cross section is wider, irrigation area is narrower and convey loss is increased.	△

From the above results, extension of lining and block is designed as in Table 2-21.

Table 2-21 Methods and length of lining

Canal	Block/ Condition	Mortar wet masonry	Earth canal	Remarks
1.Main canal	All block is lining	**1,530m**		
2.Ramaskora Secondary canal	1) Lining canal	1,570m		
	2) Earth canal	1,450m		
	3) Additional request-1 (earth canal)	925m		
	4) Additional request-2 (earth canal)		705m	To be considered as a tertiary canal
	Sub total	**3,945m**	**705m**	
2.Ritabau Secondary canal	1) Lining canal	2,890m		
	2) Additional request (earth canal)	2,360m		
	Sub total	**5,250m**		
Grand total		**10,725m**	**705m**	**(Total area in application: (11,430m)**

2-2-1-7 Appurtenant Facilities of Irrigation Canals

(1) Diversion facilities

Policy-1: Because the water source is limited to that of Bulobo River, manually operated steel slide gates are installed for the existing turn outs by which efficient and proper water management is feasible.

Policy-2: Partly because deterioration at the portion of mortar develops to the extent that strength of wet masonry structure of the existing turn outs gives about 0.6 times as strong as the ordinary strength of wet masonry, partly because of the necessity of installing slide gates in the existing structure, turn outs will be wholly rehabilitated.

Policy-3: Since present conventional turnouts are just constructed by opening holes of φ100 to 300mm at the masonry sidewall of canals, they have caused heavy leakage, thus making proper water management difficult. Therefore, structure of turn out is designed to trench a guide furrow frame at a side of diversion chamber in which stop logs groove with wooden stop logs can be fitted.

(2) Scouring sluice facility

Policy-1: In order to prevent inflow of harmful sediment (the grain diameter of which is larger than 0.3 mm) into terminal of the irrigated command, it is eliminated with a sluice facility installed in the main canal.

Policy-2: The longitudinal gradient of the main canal at upstream of the scouring sluice gate is so flat, measured at 1/3,500, that scouring of silt accumulated in the main canal is impossible even if the gate were fully opened. Therefore, the longitudinal slope of canal bottom will be adjusted at 1/100 at a section of 70m upstream.

Policy-3: The existing scouring sluice facility has been dilapidated to the extent that its strength is about 0.8 times as strong as that of reinforced concrete, and corrosion is observed over the scouring gate body. It has been difficult to smoothly operate and therefore proper scouring operation is impossible. Judging from such conditions, the scouring gate is wholly rehabilitated.

(3) Drop structure

Policy-1: The existing drops worked with wet masonry the strength of which has been deteriorated have to be rehabilitated, but others with enough strength are used as they are.

Poicy-2: The drops without any existing water cushion floor are wholly rehabilitated.

Policy-3: Because a fatal accident of a child took place at a drop (Ritabau secondary canal, at STA.1+025) installed amidst a residential area, an anti-accident fence will be installed enclosing this drop.

(4) Other appurtenant facilities

Policy-1: The existing concrete bridges are partially repaired since no exfoliated portion is observed over the major body thereof.

Policy-2: A wooden pedestrian bridge (Ritabau secondary canal, at STA.0+580) is wholly be renewed with reinforced concrete accompanying with rehabilitation works on canal since it has been in a dangerous state owing to dilapidation.

Policy-3 : As to the existing drainage crossing works, inlet parts and crossing works (corrugated pipe ϕ =1,000mm) are continuously used as they are, though the outlet parts have to be reinforced with lining by wet masonry works because they are already scoured.

Policy-4: The existing washing basin is continuously used as it is but only the joint mortar of wet masonry and the surface mortar finish are repaired.

2-2-1-8 Wet Masonry Retaining Wall at Aqueduct

(1) The wet masonry retaining wall works of right bank

Policy-1: The upstream section that has been cracked, about 8 km long at right bank, is wholly rehabilitated by the removal of existing wet masonry.

Policy-2: The midstream section that has not been subject to any damage is continuously used as it is.

Policy-3: The downstream section around 7 km long where the wet masonry retaining wall work has been collapsed is wholly rehabilitated by the removal of existing wet masonry.

Policy-4: Foot protection block is newly installed in front of wet masonry retaining wall against scour and subsidence of riverbed.

Policy-5: Back-soil filled at the crest of the retaining wall is covered with wet masonry against scour by overflow at floods.

(2) Wet masonry retaining wall works of left bank

Policy-1: Retaining wall works at left bank is newly constructed with wet masonry for preventing slide on the slope.

Policy-2: Foot protection works (by crossing type concrete block) are newly constructed at left bank to prevent riverbed scour in front of the wet masonry retaining wall.

(3) Aqueduct

Policy-1: Water leaking from the joint at left bank is sealed with elastic sealing work.

Policy-2: The partly broken wooden deck will be restored with new material.

2-2-1-9 Building Facilities

Policy: Out of the building facilities to construct requested from Timor-Leste, the storage depot to accommodate equipment and gate keeper's hut are included in Grant Aid element, while storage house and dry flour are excluded there from.

(1) Storage for O/M equipment: (the requested Japanese assistance)

① Purpose of using storage for O/M equipment

Main purposes of utilizing storage for O/M equipment are shown in Table 2-22.

Table 2-22 Utilization purpose of storage for O/M equipment

Purpose of Utilization	Detail of Utilization
1) A storage for O/M equipment	This depot serves as a storehouse for intake gate-body/key, handles of turnouts, grease, recoating paint for gate body and conventional off-takes etc., and is also used as space to accommodate various manuals, safe to keep collected water fee etc.
2) As space to hold meetings	The building is used as space to hold meetings including the following: ① Holding workshops for deploying planned soft-component, ② Registration works of water fee collection ③ Agreement on the date of beginning irrigation, consultations on water rotation and solution of disputes on water distribution, ④ Consultations / discussions on schedules, methods and burden-sharing of regular drainage works for canals, managerial and maintenance works including weeding ⑤ Consultations / discussions on repairing works of canals/drains, burden-sharing and means of collecting water fee, etc.

② Significance of establishing storage depot for keeping equipment and its multi purpose use

1) The storage for O/M equipment shall function storage space for parts of intake and offtake facilities including intake gate body and key, handles of turnouts, wooden stop log sets of conventional turnouts, grease for O/M, recoating paint for gate body and operation manuals. It shall be built for a facility of accommodating equipment fixtures procured by the Project.
2) MAFF is to establish WUA in response to improvement of Maliana I irrigation facilities complying with t policy for WUA and O/M of Irrigation Facilities (draft)". In addition, IWMD staffs shall have discussion with beneficiaries in collaboration with Governor of Bobonaro district, village chiefs of Maliana I areas for WUA establishment. Board members of WUA will also be elected whenever the agreement is reached with beneficiaries. In other words, in Maliana I Irrigation facilities, water fee will later be collected so that they can be maintained and managed by WUA. This is why the necessity as mentioned in Table 2-22 arises and by this reason it is planned to secure enough scale and structure to provide the space for holding meetings of WUA in addition to the function of accommodating equipment and parts /fixtures.

(2) Gate keeper's hut: (the requested Japanese assistance)

The gate keeper's hut is essential for operation and maintenance for newly installed scouring sluice gate, intake gate, scouring gate of sediment settling basin and canal intake gate. Especially, it is necessary during flooding in rainy season to occasionally open and close them depending on stream flow. Gate keeper's hut shall be established aside diversion weir because the scouring sluice gate is installed in the river channel and it requires stationed operation by gatekeepers to cope with sudden floods during rainy season. Hence, the hut shall be covered under the Grant Aid scheme.

(3) Storage shed: (Out of the requested Japanese assistance)

There are 4 paddy-storing facilities on the scale of 1,500 ton around Mariana I area. While two of them have regularly been used by ASC, another one has been used only during the harvest period in rainy season, the rest of them has been owned by MAFF, but has not been utilized since 2002. Whereas WUA of Marco irrigation scheme in Bobonaro district, payment of water fee in paddy has not been practiced and it doesn't have storage shed either. Accordingly, it is appropriate to exclude establishment of storage shed from target component of Grant Aid scheme by the reasons of uncertain utilization of requested storage shed at the present moment, including possibility of diverted use of existing storage facilities, the fact that WUA is not yet established as of now, pending state as to collection method of water fee.

(4) Drying floor: (Out of the requested Japanese assistance)

It is desirable to establish the drying yard nearest to storage shed because drying yard is to be used to dry paddy before storing it in storage shed. So far as the validity of establishing storage shed is not recognized, drying yard shall also be excluded from Grant Aid scheme.

2-2-1-10 Construction and Equipment Procurement

Policy-1: In collecting aggregates and stone materials, operation and procurement plans are formulated in a way that regulations and traditional habits are observed.

Policy-2: Method of construction is elaborated so as to minimize compensation on crops and land occupation, as well period of breaking irrigation water.

Policy-3: As to the procurement of equipment / material and construction machinery, suppliers / place of procurement are decided in due consideration on the situation prevailing in Timor-Leste with very short period elapsed after independence, the scale, content, kind, quantity, deadline and economy of the works.

Policy-4: Workers to be employed in construction works are planned to combine technically skilled laborers from the third countries with local ordinary workers.

Policy-5: A policy will be followed in procuring / manufacturing steel gates to ask a southeast Asian producer firm to import produced parts of Japanese specification standard from Japan and to assemble them at the site, considering that WUA will maintain and manage them in future.

The following is the background of the above policies of rehabilitation.

(1) Various environmental factors affecting the construction works (Policy-1 and Policy-2)

① Collection of stone materials and production of aggregates for works

Concerning the collection of river aggregate and stone materials, an Environmental Guideline (draft) has been reviewed for its enforcement in Timor-Leste. Out of which, the part related to this Project is in "Guideline No.2: Mechanical extraction of sand and gravel from riverbeds and quarries". This guideline stipulates prohibition of installing a stock yard within the river basin, that of change of watercourse causing a probable bank erosion, boundary identification and notice of area for extraction, restriction in extracting fluvial gravels, etc. Also, prior to sand and gravel extraction, it is required to explain the extraction plan to the personnel of local authorities and communities and to consider the employment of local population for the extraction works of materials.

② Compensation to be occurred by the works

(a) Compensation for agricultural crops and land

It is designed under the policy to minimize the acquisition and occupation of the agricultural land but maximize those of non-cultivated land and/or moorland, however, it is required to make due compensation on the standing agricultural crops in the case that the Project utilizes land under cropping. Also, though it is not necessary to acquire the large-scale land nor to deforest, some agricultural land acquisition and resulted compensation will be inevitable when the access roads are to be constructed for the transportation of equipment and materials for the rehabilitation works, for it was found that the agricultural land has been extended to very edge of the existing irrigation facilities. To minimize the adverse impact on compensation, it is also planned to minimize felling of existing stands and crops as well to employ the manpower in place of mechanical means for the works as far as possible.

At present, in Timor-Leste, laws concerning the land ownership, legal procedure for land acquisition, expropriation and compensation for public works are not well established legally. Moreover, basic data for the legal land ownership, tenancy or usufruct, easement right along with cadastral maps, land registration book and etc. have been lost. Thus, legal rights in terms of land ownership, usufruct / tenant are not legally secured, but land usage and occupation are customarily accepted through agricultural activities. It is understood that the land acquisition and expropriation is needed to proceed case by case, asking Maliana sub-district office or Bobonaro district office of MAFF for necessary mediation whenever necessity thereof arises.

(b) Restricted water supply of agriculture activities and livelihood

The water supplied through existing irrigation canals is used for not only for agriculture purpose but also for livelihood such as washing clothes, bathing, etc. As the length of irrigation canal to be rehabilitated would be so long as around 10km, temporary arrangement of drainage facilities instead would not be realistic.

Thus, the implementation of rehabilitation works is planned to carry out in as much short period as possible with the minimum break of water supply. In the central part of Maliana town, the pipeline for public water supply has been installed underground along the canals to be rehabilitated for the Project. In the implementation plan, proper method shall be considered so as not to cause any damage to those pipeline facilities.

(2) Procurement of material/equipment and labor force for the construction (Policy-3 and Policy-4)

① Transportation routes for the mobilization of materials and equipment

There is a route for the transportation of materials and equipment for the Project from Dili Port to Maliana town, that is the National Road running along the coastal area westward from Dili up to Batugade town located just confronting the boarder of West Timor in Indonesia, then turn southward towards inland over the 500m height highland and then reached to Maliana town. Total distance covers 143 km and it takes for 3.5 to 4 hours by 4WD vehicle. The route has curves with large radius and with less unevenness of surface where 20t-trailer is able to pass through. Hence, no problem is judged to happen as far as transportation from Dili to the construction site is concerned.

② Procurement of materials/equipment

In Timor-Leste, any manufactured products have not domestically been produced but imported and there are small stocks of common construction materials in the market. Those items are imported from Indonesia, Australia and Singapore for the sale in the market. In case large quantity is required, it will be economical to import them directly from abroad. However, this project may require procurement in small quantity or on the spot, and then it would be inevitable to procure materials from local market stock in Timor-Leste. The specific materials and equipment (such as large size section steel materials, steel gates, construction plant, testing instruments etc), which are not usually handled by local suppliers, are planned to import directly from Indonesia or from Japan. Procurement sources shall be determined taking account of the quantity, delivery time and costs based on the market survey.

③ Construction equipment and plant

In the past, as a large number of construction equipment and plants had been imported for the emergency rehabilitation projects, those common civil construction equipment and plants are usually available for rent in the market of Timor-Leste. After the stabilization of chaos on independence, civil construction activities were sharply increased for the implementation of emergency rehabilitation projects and the construction equipment and plants were imported to meet the demand of increased works. At that time due to the lack of rental market, it caused high rental market and high level of rental cost has been maintained up to now.

Taking account of the nature of works and the size (less quantity and short construction period) of the Project, it is appropriate that the common civil construction equipment and plants are planned to procure in local market. As specific equipment and testing instruments will be imported from Indonesia, Australia or

Japan, the procurement source will be determined based on the comparison with delivery time, transportation methods (charter ship or regular liner ship) and transportation cost in each source.

For the specific equipment to be used for only 2-3 months, total equipment cost including overseas transportation cost would come to expensive. Therefore, it is more economical that such equipment, with even a high rental fee, should be procured in local market or from nearby country such as Indonesia.

④ Labor force for construction

As the employment opportunity for young generation of 20-years old and younger who cover 50% of population are quite limited especially in Dili and other cities as well, the job less are increasing. On the other hand, according to the experiences encountered by the contractors who are now implementing or have implemented the project in the past, almost all of experienced engineers and technicians having high technical knowledge or techniques are dominated by Filipino, Chinese and Indonesian and there are quite less experienced local engineers or technicians.

In the local region, there exist strong customary practices in the communities that construction manpower is to be employed from the communities in and around the project area in the manner of rotation. Therefore, the experienced manpower could not be kept employed continuously and the efficiency of work or productivity used to be low. However, this manner can give the job opportunities to the communities in and around the site. Thus, in the plan of the Project, it is proposed to hire experienced foreign technicians in combination with local laborers.

(3) Manufacture and procurement of steel gates

The existing steel gates have been operated for approximately 15 years but at present are not operable because of dilapidation by rusting on gate leaves, guide frames and spindle bars and as well as rusting and damages on gear portions in the hoisting device. Taking account that WUA is responsible for the future O/M of the facilities as a principle of this Project, the proposed gates to be procured should stably be functional, operational and durable as well as economical for O/M. It is decided to plan the gates, which comply with the specification applied in Japan for this project, after comparing the gates that are popular in Japan with those available in South-east Asia having similar function to the existing gates in the intake facilities of Maliana I Weir. The results of comparison are shown in Table 2-23. From the aspect of costs, the steel gate makers operating in South-east Asia could supply the cheaper gates by procuring and assembling body and parts imported from Japan.

Results of surveys for steel gate makers in Indonesia, it is confirmed that the above procurement method is the most appropriate.

Table 2-23 Comparison of function of gates (Japanese and South-east Asia specification)

Items	Japanese Specification	Southeast Asia Specification
Hoisting Device	1)Type：manual with rack type 2)Protection：cast iron enclosed structure 3)Drive method：manual 4)Material：cast iron Rustproof, durable, long-operable, less power for turning, only periodic lubrication for O&M	1)Type：manual with spindle type 2)Protection：open structure 3)Drive method：manual 4)Material：steel Operation becomes worse year by year, 10-15 years duration, frequent lubrication required
Lifting Bar	1)Type：rack bar type 2)Materials：stainless steel Rustproof, durable, long-operable, More than 30 years duration, non-lubrication	1)Type：spindle 2)Materials：mild steel Operation becomes worse year by year, 10-15years duration, frequent lubrication required
Gate Leaf	1)Materials：mild steel 2)Seal holder：stainless steel 3)Water tight seal method：rubber seal Better-paint quality, rustproof, durable, better-water tight sealing, more than 30 years duration	1)Materials：mild steel 2)Seal holder：mild steel 3)Water tight seal method：rubber seal Easily rust, 10-15 years duration, frequent painting required.
Guide Frame	1)Materials：mild steel/stainless steel 2)Rail：stainless steel 3)Water tight seal method：rubber seal Rustproof, durable, better-sealing, more than 30 years duration	1)Materials：mild steel 2)Rail：mild steel 3)Water tights Seal method：rubber seal Easily rust, 10-15 years duration, frequent painting required.

2-2-1-11 Employment of Local Contractors

There are around 10 contractors who possess a numbers of engineers and who are eligible for a main contractor. Among them, there are no companies with 100% of capitals owned by Timor-Leste nationals, but there are those owned by Australian, Singaporean or Indonesian nationals. In addition, as of March 2007, there are 6 Japanese contractors experienced in Timor-Leste, namely Tobishima Corporation, Dai-Nippon Construction Co., Ltd., Toa Corporation, Wakatsuki Construction Co., Ltd., Mirai Construction Co., Ltd and Penta-Ocean Construction Co., Ltd. They have involved in the construction works mainly such as roads, irrigation facilities, ports and schools.

Their head offices are all located in Dili City, having stock of construction equipments (general construction equipment, concrete plants, crushing plants, asphalt plants, etc.) in Dili and mobilizing their construction equipment to the sites depending on the necessity. Materials suppliers and equipment rental companies are also situated in Dili City. For the projects in local region, they set up main project office in Dili city and set up the temporary offices and temporary construction facilities on the site. Japanese construction companies used to employ some of these local contractors for the projects depending on the nature of works. Also in this Project, it is planned to actively employ the suitable local contractors depending on the kinds of works.

2-2-1-12 Ability on Operation and Maintenance of Implementing Agency

Policy: Timor-Leste suffers from shortage of human resources and insufficiency of their capacity in the ministries and other Government organizations since only a short period has elapsed after its independence. Because problems are observed in the way of instructing operation and management

of irrigation facilities and water management to farmers' organizations etc. by MAFF, under such circumstances, it is planned to introduce a soft component plan as an Grant Aid scheme, so as to instruct on the managerial fortification of WUA and methods of water management through the irrigation facilities to be rehabilitated.

IWMD headquarters under MAFF has one(1) water management advisor. Also, Bobonaro agriculture office has three(3) fulltime officers for O&M of the Maliana I irrigation system, i.e. a District Agriculture Coordinator (DAC) as the head, a District Irrigation Officer (DIO), and an officer in charge of WUA strengthening. It is possible to efficiently utilize these human resources.

Nevertheless, these human resources, especially staff working in the Bobonaro agricultural office are not fully equipped with knowledge on strengthening organizations, O/M and water management, in acute need of capacity building. In this context, it will be difficult to secure enough budget to fully instruct them judging from the amount of O/M cost that MAFF will input to Maliana I irrigation system. Under such circumstances, early materialization of the envisaged effect of the rehabilitated irrigation facilities is expected through efficiently strengthening WUA to be established by means of introducing soft component plan into a financial umbrella of the Grant Aid scheme by Japan.

2-2-1-13 Determination of Grades for Facilities and Equipment

The Project aims at rehabilitating the lost, raised portion of the fixed weir of Maliana I intake facilities with a basic policy of rehabilitating the facilities in a proper scale and structure that can economically be managed and maintained by WUA to be established.

As to intake facilities, beneficiary (WUA) has been forced to regular practices including 1) reconstructing and dredging works of dry masonry guide wall, 2) manual evacuation of sediment on account of broken and dysfunctional gate of sediment settling basin and 3) dredging works of excessive sediment accumulated on canal bottom caused by insufficient sediment preventing function at headworks. Therefore, in order to alleviate such heavy labor to a maximal extent, not only a scouring sluice gate is installed but also the existing mal-functioning gates are rehabilitated. As regards manufacture and procurement of gates, appropriate method is adopted in such a way that they are enough workable and durable, saving of labor and cost of O/M can be expected and eventually their operational functions can last for more than 30 years by applying relevant maintenance and management.

As concern canal facilities, the existing lining is planned to rehabilitate with wet masonry mortar works so that WUA can maintain, manage and repair for a long period, along with lining of earth canals for the necessary length by the same method in order to provide a distribution system to efficiently irrigate up to the terminal border of the command area.

2-2-1-14 Construction / Procurement Methods and Construction Periods

Policy-1: Aggregates and stone materials are collected from three streams running near the construction sites.

Policy-2: The maximum average discharge in dry season is taken into account in determining design flood discharge for temporary works.

Policy-3: Existing public roads are utilized as the road for temporary works, keeping access to water intake facilities and irrigation canals, where widening the roads is worked whenever necessity arises.

Policy-4: In order to make the impact on land acquisition of the land along the irrigation canals minimum, the rehabilitation works are designed mainly be means of manual labor, but in the sites where automobiles are accessible, small sized dump trucks (4t class) are used.

Policy-5: To meet the necessity of completing the planned works within a short period, two(2) sections are delineated and three(3) temporary work yards are planned to establish.

Policy-6: Works with coffer dam and temporary diversion channel are employed for the temporary works of intake facilities.

Policy-7: It is planned to establish an aggregate supplying plant to prepare aggregates for concrete works because substantial quantities thereof is required for construction works.

Policy-8: The scale of consolidating infrastructure required for the management of construction works is determined considering the current status of public facilities.

Policy-9: Construction period is determined adopting a plan of efficiently concentrating the works on dry season for those of riverbed structure such as intake weir and rehabilitation of canal facilities.

(1) Procurement of stones and aggregates (Policy-1)

It is planned for the Project that necessary stones and aggregates shall be procured from the Contractors who collect them from nearby three riverbeds. Sand, gravel and stone materials suitable for the Project will be available from three rivers (namely; Bulobo, Sosso and Nunutra Rivers), consisting of kind of limestone and sandstone. Generally in Timor-Leste, the coarse aggregates suitable for the concrete are to be produced by collecting gravel and stone from neighboring rivers and the mechanical screening and crushing, and fine aggregates suitable for the concrete are available from the alluvial bed material by screening smaller size of sands. Surface concrete works with high strength concrete (35 N/mm^2) are planned to design in the revetment surface concrete for the weir body, it is judged possible to domestically manufacture it according to the survey on the performance of concrete casting. Stone materials for masonry works are planned to obtain from these three rivers, as it was found that there are enough quantities with suitable size and shape required for the Project.

(2) Design flood discharge for applying to temporary works (Policy-2)

Dry season in West region where Maliana town is located ranges for 6 months from May to October, with annual rainfall of approximately 2,000 mm. The flow discharge of Bulobo River, required for designing the implementation plan for the temporary cofferdam, temporary diversion canals and etc. are estimated by the following results of floods analysis: Design maximum discharge to be applied to the period of above mentioned works is set at 5.0 m^3/sec with approx. three(3) of safety factor versus mean flood

discharge of 1.4 m^3/sec during the period of temporary works (June to October).

(3) Temporary works

① Temporary roads for the works (Policy-3 and Policy-4)

As to temporary roads, seventy percent of the total length of canals to be rehabilitated is located along the existing public roads, so access to the canals to be rehabilitated is ready for the planned works, but the width is widened as need arises. On the other hand, the rest 30% thereof are located amidst farmland and privately owned land, and necessity arises to pass through these grounds to have access to the canals to renovate. In order to minimize land expropriation and other problems, it will be planned to use as much manual works as possible. Where the construction vehicles are accessible, the small sized dump trucks (4t class) that are popular in Timor-Leste will be used. It is planned that following temporary roads for works are to be constructed considering the size of rehabilitation and repair works.

1) An access road necessary for transportation of equipment and materials to the location of intake weir facilities: It shall be ensured that the width of road shall be enough for allowing 4-ton dump trucks to pass. It is planned to reuse existing earthen roads constructed under Indonesian age with repairing and improving their damaged surface and alignment.
2) An access road for transportation of equipment and materials necessary for rehabilitation works of irrigation canals: It is planned that few access roads are to be constructed covering from the existing public road to above-cited access road to the sites of rehabilitation works. The proposed access roads shall be secured with the enough width for manual transport of materials / equipment.
3) An access road for transportation of equipment and materials necessary for the works of riverbanks and bed protection at aqueduct bridge area: a temporary access road is planned covering the area from downstream abutment of aqueduct to the riverbed to be rehabilitated.
4) Access roads for rehabilitation works of canal around Sta. 600 to 700 in Ritabau secondary canal route: The existing village roads are to be improved and used.
5) For the access to other areas to be rehabilitated than the above, the existing public roads will be used.

② Temporary work yards /temporary buildings (Policy-5)

Proposed rehabilitation and improvement works can be divided into two(2) sections, namely 1) rehabilitation and improvement works of intake weir facilities and main canal, and 2) secondary canals rehabilitation and improvement works and construction works of building, in terms of location, size and nature of works. Likewise, in order to secure the completion of planned works within a short period, it is planned that both temporary yards and temporary facilities with similar content and scale shall be provided at three locations, and out of these three yards, two concrete manufacturing plants are established in two sites so that one of them can be substituted with the other even if any trouble happened in either side.

Temporary yards and temporary facilities are planned at the following locations;

Yard ① To be located at left bank on the upstream side of the head-works. To be used for facility ground including concrete plant, material depot and warehouse.

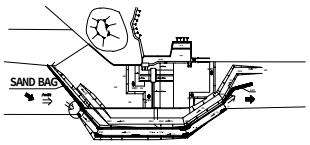
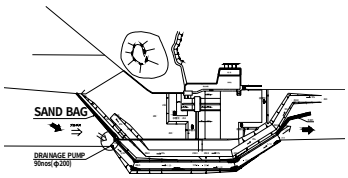
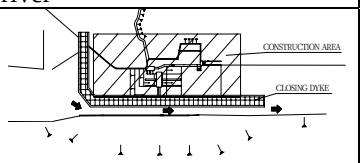
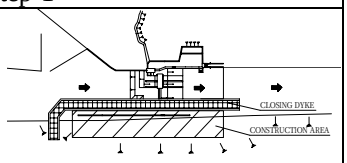
Yard ② To be located around the turnout structure between main canal and secondary canal. To be used for facility ground including concrete plant, material depot and warehouse.

Yard ③ To be located at left bank on the downstream side of the aqueduct. To be used for facility ground including material depot and warehouse.

③ Temporary works for intake facilities (Policy-6)

On the construction for the structures of intake, weir, aprons and scouring sluice gates, it is necessary to dry up riverbed of Bulobo River for securing suitable working condition for the works by providing temporary river closure and diverting river flow. After the comparison with three alternatives as shown below Table 2-24, it is concluded that temporary river closure and diversion canal will be applied because they are more economical and workable method for the implementation. As the works for weir and aprons structures and riverbed protection are expected to conduct below the water level of riverbed, it is planned to provide dewatering systems (shallow sump and dewatering pipes) at both upstream and downstream of the section for works so that water is evacuated with submersible pumps (refer to Figure 2-4).

Table 2-24 Comparison of methods of river closure and river diversion

No / Method	No.1: Temporary closure and diversion canal	No.2: Temporary closure and discharge pumps	No.3: Closing of half width of river
Sectional View			
	Closing temporarily and diverting through canal	Closing temporarily and using pumps	Closing half width of river: Step-1
	Refer to section B-B as attached Figure 2-1-14.1		
	Section of Temporary diversion canal		Closing half width of river: Step-2
Outline	To construct a closure dike crossing river width at upstream of existing weir, and to divert water through the diversion canal to be constructed on the right bank of river	To construct a closure dike crossing river width at upstream of existing weir, and to discharge water using the temporary pumps to downstream of river.	To construct a temporary dike along the center of the river and to lead water to the either side in order to construct one half of weir, then to conduct it alternately.
Workability	Only require common construction equipment, special technique is not required.	Allow quicker construction. Require the dewatering system such as discharge pumps and pipes.	Weir and scouring sluice gate should be constructed at the same time. If not, works could not be finished during the dry season. Therefore, this method is not realistic.
Construction Period	Comparing with No. 2 method, it takes longer time for temporary canal construction.	Comparing with No. 1 method, the construction period would be a little shorter.	
Sureness	If a closure is properly constructed, dewatering would be able to be surely done. As enough working space could be secured, favorable progress of works would be achieved.	Enough capacity of pumps to be placed in order to have suitable performance to meet the river discharge volume. However, in case of failing in pump operation such as power failure, the system would cease operation. Therefore, it is necessary to maintain and control generators and pumps very carefully day and night.	
Cost	*Closure: embankment, sandbags. *Diversion canal: wet masonry, earthwork *Temporary roads, etc. Cost：US$ 51,000.-	*Closure: embankment, sandbags *Dewatering: Piping, pumps, generator, operation cost (period: more than 150 days) *Temporary roads, etc. Cost：US$ 958,000.-	Not acceptable.

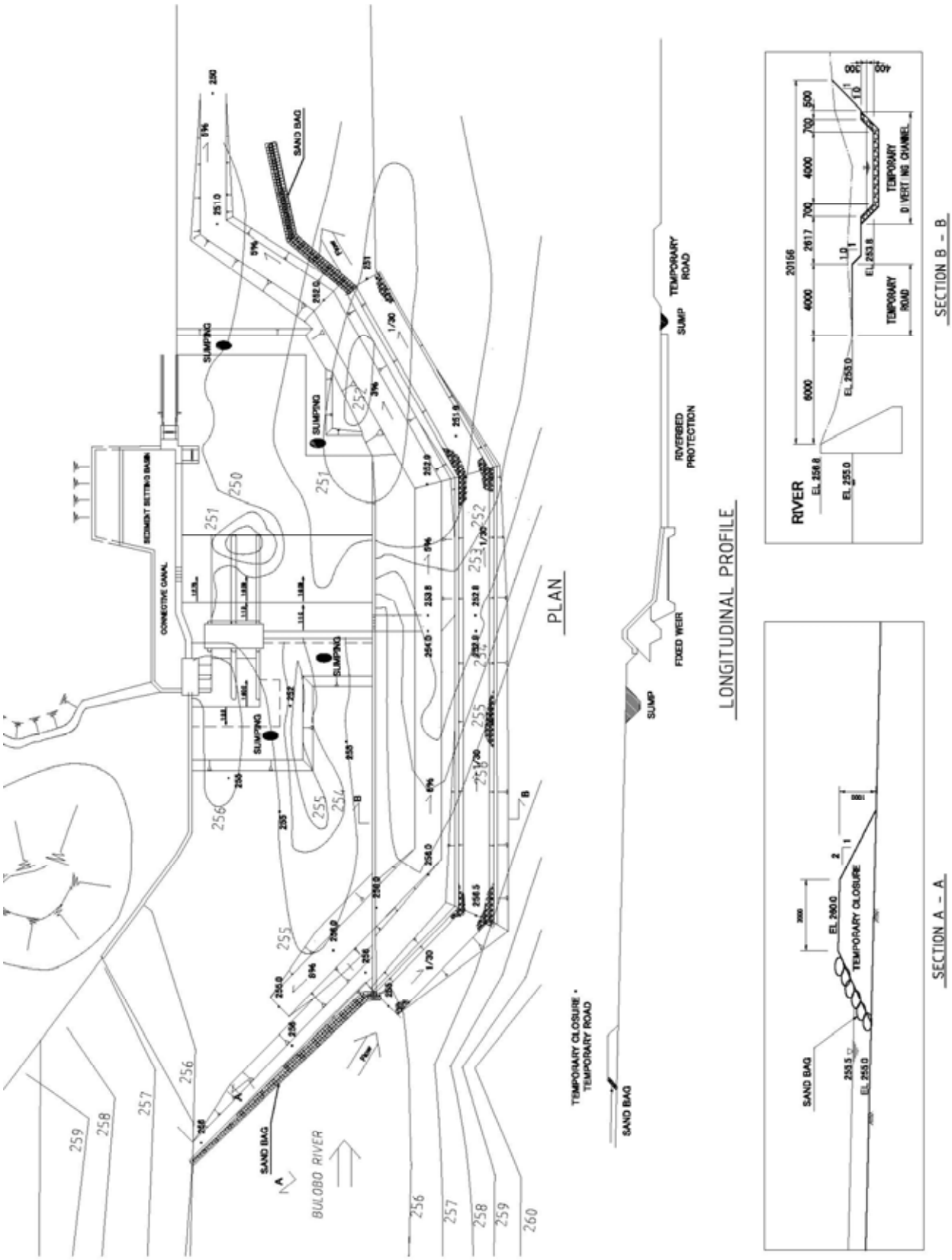


Figure 2-4 Proposed temporary river closure and diversion

④ Concrete plant and stone crushing plant (Policy-7)

As the required volume of concrete for the Project is estimated approximately 4,500 m^3, details of which is shown in Table 2-25, that is considerable amount, the concrete plants are to be set along proposed canal to be rehabilitated to provide aggregate materials. The produced materials will be transported with dump trucks from these plants to 1) the intake weir, 2) to two concrete crushing and grading plants to be installed at around the location of the diversion regulator between the main canal and the secondary ones. Produced concrete at the concrete crushing and grading plant is to be delivered to the site by concrete agitator trucks.

Table 2-25 Work plan of concrete plants

Items	Headworks, main canal, and improvement of bank protection of the aqueduct	Rehabilitation of secondary canals	Construction of building
Concrete volume (estimated)	Approx. 2,000 m^3	Approx. 2,250 m^3	Approx. 250 m^3
Plant	Concrete plant-1)：1 set	Concrete plant-2)：1 set	
Electric power	Generator	Generator	
Transportation	Concrete mixer truck 3 to 4.5 m^3	Concrete mixer truck 3 to 4.5 m^3	
Casting method	Truck crane equipped with a concrete bucket	Truck crane equipped with a concrete bucket	

⑤ Infrastructure services necessary for the works (Policy-8)

As for communication service, there is a fixed telephone line system and it is able to communicate from Maliana town to Capital Dili or to abroad as well though the lines are not readily available because of limited number of lines installed. Now new relay facility is under construction, however, when their services could be opened is not sure yet, nor it is expected to procure a line for the Project. On the other hand, cell phone system has become popular and very convenient. Although sending e-mails and facsimile can be managed using existing lines, it is difficult to expect an exclusive line for this purpose since all the existing lines have already been occupied. Therefore, it is planned that cell phone will be used for daily communication, but facsimile and e-mails will be sent through satellite line.

Regarding public electricity supply, township has a power plant in Maliana town with generators (260kW, 4 units), but all of these generators are out of order, so public electricity is not available at the moment. Therefore, own-generators have commonly been used in private houses. Even the generators are repaired and public electricity supply is resumed, available hours would be limited for 5 to 6 hours during the night only. So far as public electricity cannot be anticipated, it must be planned that the own-generating system shall be prepared for the Project.

As to public water supply, it is planned that the river water and public water as well could be used for the construction purpose according to test results of the water quality. Domestic water can be availed from the public water supply, but it is supplied only in the limited hours and available water quantity used to be significantly reduced during dry season, causing troubles in supply operation. Therefore, it is planned to dig own well to secure own water supply for domestic use for the Project.

Table 2-26 Conditions of infrastructure services for the work sites

	Place	Communications	Electricity	Water Supply
Dili liaison office	Inside Dili city	Cell phone, satellite phone (e-mail, fax)	Public electricity, stand-by generator	Public supply water
Site office/Laboratory	Maliana town and area nearby	Cell phone, Satellite Phone (e-mail, fax)	Public electricity, stand-by generator	Public supply water and own-well
Site accommodation	Maliana town and area nearby	Cell phone	Own generator	Public supply water and own-well
Temporary yard intake /Plants /Work sites	Maliana town and area nearby	Cell phone	Own generator	River water
Work sites along the canal	Maliana town, and area nearby	Cell phone	Own generator	Irrigation water

(4) Project implementation period (Policy-9)

Climate in Maliana district is divided into dry season between May and October and wet season between November and April. 80% of annual rainfall is concentrated in wet season, keeping rainfall continuously for 3 to 4 days for a week, falling heavily in the afternoon. As water discharge in rivers is rapidly increased, construction works in the river during rainy season is hard with higher risk. Besides, workable hours in wet season are shorter, equivalent to 30% of dry season, proving inefficient. In addition, because paddy is cultivated between December and April, it is required to avoid any interruption of water supply caused by the works of the Project during this period. On the contrary, almost no rain occurs during dry season, entailing to change streams into dried-up state. Further interruption in water supply is judged possible during the period from May to November judging from the farming performance observed in the past. Taking these and the volume of planned works into consideration, a principle is applied so that works can intensively be concentrated during dry season, including intake, weir and apron structure as well as rehabilitation and improvement works of canals, in formulating construction schedule of the Project.

2-2-2 Basic Plan

2-2-2-1 Overall Plan

(1) Target and extent of the requested Japanese assistance

① The command area of irrigation under the Japanese assistance

The command area of irrigation by canal shown in Table 2-27 is calculated from the results of reconnaissance survey in Maliana I and topographic map provided by Chinese assistance. Thus, the total target area of the Project is calculated at 1,314 ha. The total command area of 1,314 ha represents the gross area in which the residential lots, roads, waterway etc. are included which is equivalent to about 20% of the total command area, hence the net irrigated command area is around 1,051 ha (= 1,314 ha × 0.8).

Table 2-27 Irrigation areas by canals (unit: ha)

Name of canal	Area irrigated by existing turnout	Area to be irrigated by newly established turnout	Total gross command area	Net irrigation area
Main canal	0	5	5	4
Ramaskora secondary	398	531	929	743
Ritabau secondary	179	201	380	304
Total	**577**	**737**	**1,314**	**1,051**

② Target beneficiary

The targeted irrigated area by village in Maliana I is estimated in Table 2-28 (based from the data provided by Bobonaro district agricultural office and the results of the Baseline survey) with a total of 1,424 households (about 7,400 family members). As concern target farm households, MAFF is providing a list of beneficiary households for the election of board members of WUA, through Bobonaro district agricultural office, in which the number of target households will eventually be about 1,500 (approx. 7,800 family members, as of January, 2006).

Table 2-28 Number of target farm households and land holding

Name of village	Farm household *1) (member per household)	Target command Area (ha)	Unit land holding area (ha/household)
1) Lahomea	542 (4.9)	267	0.49
2) Raifun	272 (4.9)	384	1.41
3) Ritabou	336 (5.4)	407	1.21
4) Odomau	169 (5.1)	103	0.61
5) Holsa	105 (7.0)	153	1.46
Total	**1,424 (5.2 members)**	**1,314**	**0.92**

Source: 1) Bobonaro district administration office (2003)

③ Outline of the Japanese assistance

As for Maliana I irrigation facilities, the Grant Aid components consist of intake facilities, the main canal, secondary canals and building facilities such as storage depot and a gatekeeper's hut. The contents of the major aid component facilities are tabulated in Table 2-29.

Table 2-29 Outline of the request and Japanese assistance

Facility	Outline of the request	Outline of Japanese assistance
1. Intake facilities	1) Rehabilitation and surface protection of raised 0.7 m portion of the fixed weir with steel plate and concrete, 2) Rehabilitation of scouring gate at sediment setting basin, off-take gates along canals etc.	1) Rehabilitation and surface protection of raised 0.7 m portion of the fixed weir with high strength concrete coating, 2) Installation of scouring sluice gates, rehabilitation of intake gate, scouring gate at sediment setting basin and off-take gates etc.
2. Main canal	1) Canal lining extension 1,527m 2) Installation of steel slide gate etc.	1) Canal lining extension 1,527m 2) Installation of steel slide gate etc.
3. Ramaskora secondary canal	1) Canal lining extension 4,650m 2) Installation of steel slide gate etc.	1) Canal lining extension 3,945m 2) Installation of steel slide gate etc.
4. Ritabau secondary canal	1) Canal lining extension 5,250m 2) Installation of steel slide gate etc.	1) Canal lining extension 5,250m 2) Installation of steel slide gate etc.
5. Building facilities	1) Storage for O/M equipment 2) Gate keeper's hut 3) Storage shed 4) Drying floor	1) Construction of storage for O/M equipment 2) Construction of Gate keeper's hut
6. Others	Strengthening of the capacity of WUA	Implementation of soft component plan

(2) Outline of facility plan

The facility plan comprises of the following structures: 1) intake facilities, 2) irrigation canals, 3) wet masonry retaining wall as protection embankment of aqueduct and 4)building facilities are described in Table 2-30 to Table 2-33.

① Intake facility

Table 2-30 Design parameters of the headworks of Maliana I to be rehabilitated

Subject	Scale of facilities etc	Remarks
1) Design discharge at intake	Rainy season: 1.37m^3/sec, Dry season: 0.46m^3/sec	Include 0.015m^3/sec of intake water for domestic water supply
2) Irrigable area	Rainy season: Paddy 1,050 ha, Dry season: Paddy 150 ha, Other crops: 200 ha	
3) Fixed headworks	Type of headwork: Floating type, Elevation of the crest: 254.40 m, Width: 17.10 m, Height: 5.40 m, Length: 8.50 m, Length of downstream side of face: 10.0 m, Maximum thickness of face: 2.1 m, Length of riverbed protection: 12m	Raised by 0.7 m with high strength concrete.
4) Scouring sluice	Width of scouring sluice: 7.40m, Gate type: Manual rack type, Scouring sluice gate: width 3.0m x height 1.5m × 2 gates	
5) Intake structure	Gate type: Manual rack type Intake gate: Width 1.5m × height 1.0m × 2 gates	
6) Sediment settling basin	Sediment settling basin: width 8.0m × length 13.0m Scouring gate: width 1.6m × height 1.5m × 1 gate	
7) Canal intake	Canal intake gate: width 1.8 m × height 1.0 m × 1 gate	
8) Retaining wall	a) Left bank Upstream: Inverse-T type, Height 4.1m×Length 47.5m Midstream: Inverse-T type, Height 4.5m×Length 10.9 m Downstream: Inverse-T type, height 4.5m×Length 25.9 m b) Right bank Upstream: Gravity type, Height 3.0m × Length 20.8 m Midstream: Repair of joints of existing masonry wall, height 2.0～7.8m × length 60.0 m Downstream: Bank protection (dry masonry), height 3.0m×length 23.0 m	Apply embankment and dry masonry to the raised part of the retaining wall.

② Irrigation canal

Table 2-31 Planned parameters of the Main and Secondary canals to be rehabilitated

Name of canal	Main canal	Ramaskora secondary	Ritabau secondary
1) Scale			
Design discharge:	1.37～1.35 m^3/sec	0.96～0.16 m^3/sec	0.39～0.17 m^3/sec
Canal length:	L = 1,527m Existing canal: 1,570m Existing lined section:1,527m	L = 3,945m Existing canal: 1,570m Extension lining: 2,375m	L = 5,250m Existing canal: 2,890m Extension lining:2,360m
2) Typical cross section			
Type of canal:	Open lining canal by wet masonry lining	Open lining canal by wet masonry lining	Open lining canal by wet masonry lining
Width of canal invert: Height of side wall: Width of canal top:	1.60m～5.70m 0.90m～1.80m 1.60m～7.10m	0.40m～1.60m 0.30m～0.80m 1.00m～3.20m	0.40m～1.10m 0.40m～0.80m 0.80m～2.30m
3) Appurtenant structures	Total 25 places	Total 48 places	Total 79 places

③ Plan of bank protection retaining wall for aqueduct

Table 2-32 Design parameters of retaining protection wall of Aqueduct to be rehabilitated

Subject	Right bank	Left bank
1) Retaining protection wall		
Structure type	Wet masonry	Wet masonry
Extension	72.5m	34.0m
Height	3.0～4.5m	4.5m
2) Block for riverbed foot protection	345m^2	252m^2

④ Building facilities

Table 2-33 Proposed building facilities

Description	Gate keeper's hut	Storage for O/M equipment
1) Location	Upstream side of the left bank of Maliana I headwork	Near Sta. 3+360, station of Ramaskora secondary canal
2) Structure type	One story house of RC beam, block wall, concrete foundation	One story house of RC beam, block wall, concrete foundation
3) Building area	4.2m × 3.5m = 14.7 m^2	10.5m × 6.5m = 68.3 m^2

2-2-2-2 Plan of Facilities

2-2-2-2-1 Intake Facility Planning

(1) Design of fixed weir

The designed cross section of the fixed weir part of intake facility is shown in Figure 2-5.

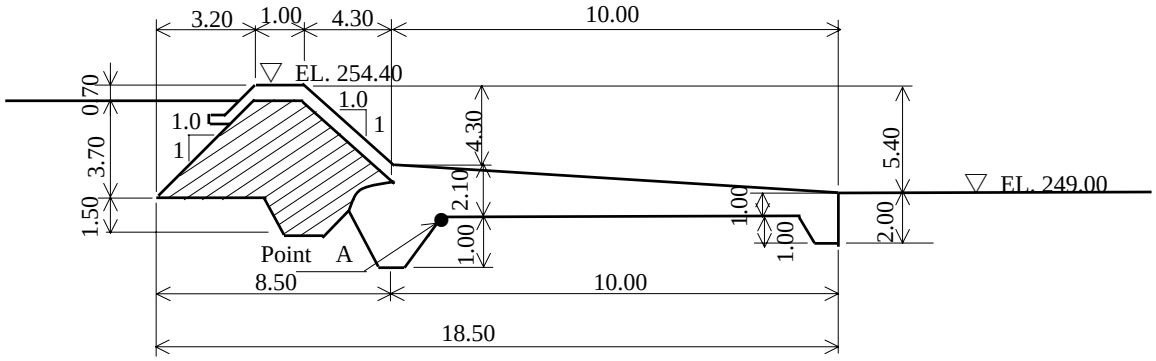


Figure 2-5 Cross section of proposed diversion weir

① Fixed weir body

Both slope gradients of fixed weir are examined to keep the stability of full sediment weir body at full water level and/or a flood. According to examples in Japan, slope gradient for upstream side is vertical and downstream side is 1:1.0. Judging from that the slope gradient is 1:1.0 at both upstream and downstream, existing fixed weir had sufficient safety against external force (inclusive of lateral water pressure and sediment pressure etc. from upstream.

Partial concrete at retaining wall of existing fixed weir has been washed out by floods due to collapse of downstream apron and scouring of downstream riverbed. Its scale is about 2.0 m in width, 2.0 m in depth and 1.0 m in height. The repair of washed out concrete is designed by treatment with high strength concrete at the period of repairing downstream apron.

② Reinforcement work of scouring sluice gate

(a) Design flood discharge

The reinforced scouring sluice gate is designed to withstand against collision of boulders brought about by flood during the targeted flood of 100-year probability. Considering the discharge of 305 m^3/sec obtained in the flood discharge analysis at the review in the WB F/S report the and the discharge of 319 m^3/sec obtained in the flood discharge of observed maximum flood of 100-year reliability, the design flood discharge is set at 310 m^3/sec (probability of 100-year flood), the same as the result of the WB F/S report.

(b) Assumed size of boulders

Velocity of flood flow

With the design flood elevation set at HWL.256.7 m after rehabilitation, the relationships among

designed level of the intake weir sill, crest and water level are shown in Figure 2-6 (Appendix 6-10 Design of fixed weir, scouring sluice and bank protection retaining wall, 6-10.3 flood level at the upstream of the intake weir after the rehabilitation). From the following parameters, the velocity of flow at scouring sluice during a flood is calculated at 5.0 m/sec.

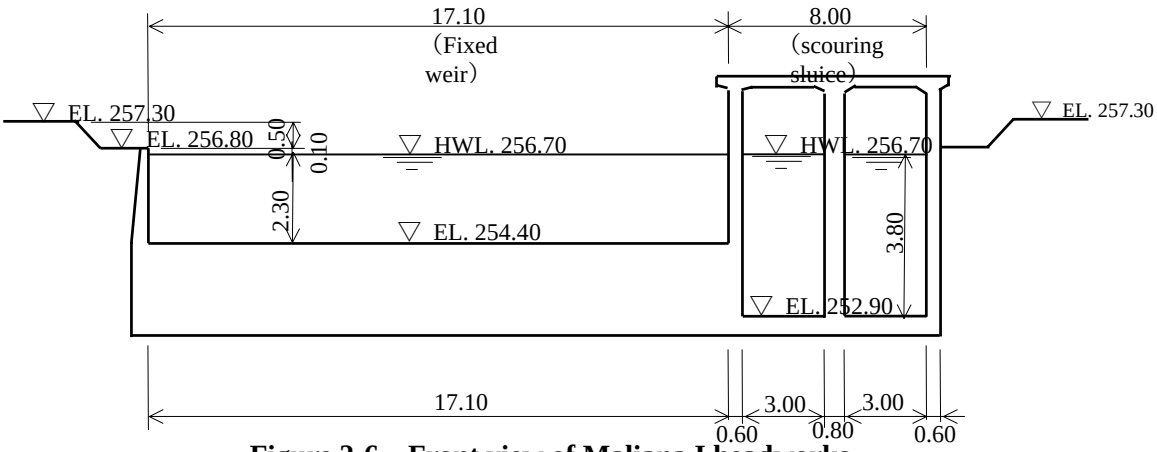


Figure 2-6 Front view of Maliana I headworks

Parameters of scouring sluice gate (Concrete portion)

Water depth	:	hs = HWL. 256.70 m - EL.252.90m = 3.80 m
Cross-sectional area of flow	:	As = 3.00 × 3.80 × 2 = 22.80m^2
Wetted perimeter	:	Ps = (3.00 + 3.80 × 2) × 2 =21.20 m
Hydraulic mean depth	:	Rs = 22.80 / 21.20 = 1.075m
Roughness coefficient	:	n_s = 0.020
River gradient	:	Is = 1 / 100
Velocity of flow	:	Vs = 1/0.020 × 1.075$^{2/3}$ x (1/100)$^{1/2}$ = 5.00 m/sec

The size of flowing boulder

The maximum size of flowing boulders is estimated by the following numeric formula.

$D = V^2 / 20 = 5.00^2 / 20 = 1.25$ m

where, D : The maximum diameter of boulder
V : flow velocity during flood, V = 5.00 m/sec

The maximum diameter of flowing boulders during floods is therefore estimated at around 1.25 m.

(c) Impact load of colliding boulders

During a flood, the movement of boulders flowing into scouring sluice before collision against the gate is predicted in a way "The colliding boulders will begin to attenuate its velocity at 0.75 m, or 1/2 of the height of the gate, before colliding against the gate."

The mass of a colliding boulder

$$M = \frac{4}{3} \cdot \pi \cdot r^3 \cdot \rho = \frac{4}{3} \times 3.14 \times 0.625^3 \times 2.65 = 2.71 \text{ ton}$$

where, M： Mass of flowing boulder（ton）

r ： The radius of boulder r = 1.25 / 2 = 0.625m

ρ ： The density of boulder ρ = 2.65 t/m^3

The time required for the movement of boulder from reducing velocity to collision at the gate

$$L = \frac{1}{2} \cdot a \cdot t^2 = \frac{1}{2} \cdot \frac{V_1 - V_2}{t} \cdot t^2$$

$$t = \frac{2 \cdot L}{V_1 - V_2} = \frac{2x0.75}{5.0 - 0.0} = 0.3 \text{ sec}$$

where, t ： the time from reducing velocity to collision at the gate （sec）

L ： the distance between reducing velocity and the gate L = 1.50 × 0.50 = 0.75m

a ： acceleration $a = \frac{V_1 - V_2}{t}$

V_1：velocity of boulder before collision V_1 = 5.00m/sec

V_2：velocity of boulder at the collision against the gate V_2 = 0.00m/sec

Impact load of colliding boulder against the gate

$$F \cdot t = M \cdot V_1 - M \cdot V_2$$

$$F = \frac{M \cdot V_1 - M \cdot V_2}{t} = \frac{2.71x5.0 - 2.71x0.0}{0.3} = 45.17 \text{ N}$$

where, t, M, $V_1$and V_2 = the time as defined in (b)

F = Impact of boulder in Newton

(d) The determination of reinforcement work of scouring sluice gate against collision of boulder

From the result of examining reinforcement work of scouring sluice gate against collision of boulder flown by a flood of 100-year probability, the following specification has been determined.

1) The skin plate of the gate：thickness 19mm (12mm as usual)
2) The main beam of the gate：H-section steel H-250 × 250 × 12 × 16
   (as usual：channel-200 × 80 × 7.5 × 11)
3) The main roller: diameter of the roller φ300mm (usually : φ250mm)
4) The main roller axis: diameter of the axis φ75mm (usually : φ50mm)
5) The guide frame: H-section steel H-150 × 75 × 5.5 × 9.5 (as usual : H-125 × 60 × 6 × 8)
6) The total weight of the gate (Sum of the mass of gate, guide frame and operation accessory) : 7 ton (usually 2.9ton)

③ Downstream apron of fixed weir

(a) Length of downstream apron

The downstream apron is designed to prevent scour of downstream riverbed caused by the action of afflux water formed upstream of the fixed weir during occurrence of flood. In this regard, the length of downstream apron is designed following “design criteria of headworks, MAFF, Japan” (refer to Appendix 6-10 Design of fixed weir and scouring sluice).

(b) Creep length

The creep length along foundation of weir and revetment protection wall is designed to prevent piping of riverbed materials beneath the foundation. The secured creep length is adopted selecting the larger value calculated by (i) Bligh's method or (ii) Lane's method (refer to design criteria of headworks, MoAFF in Japan).

In this calculation, maximum difference in water level between upstream and downstream is based on the assumption that downstream water depth is 0 on the safe side. Also, to reduce uplift pressure, weep hole is set up at the cut-off at the end of downstream apron. Therefore, creep length doesn’t include that of cut-off at downstream end.

(c) Thickness of downstream apron

The thickness of downstream apron is calculated from the formula regarding balance of uplift (refer to design criteria of headworks).

④ Riverbed protection of fixed weir

(d) Riverbed protection length

The riprap protection is provided in addition to downstream apron, because there is risk of scour at downstream riverbed by overflow from fixed weir. In this installation, the length of riverbed protection is designed after “design criteria of headworks, MAFF, Japan”.

(e) Size of Riprap

The size of riprap must bear with enough weight and resistance to keep stability against water flow. The study team designs weight of a riprap block as per the design criteria of headworks, MAFF, Japan).

⑤ Design Parameter of Fixed Weir

From the design results of fixed weir, the design parameters are determined as in Table 2-34 (refer to Appendix 6-10 design of fixed weir and scouring sluice).

Table 2-34 Design parameters of proposed fixed weir

Design item	Design condition	Required parameter	Design parameter	Note
1.Fixed weir body	Weir body height: H = 4.3m	Slope gradient Upstream: vertical Downstream: 1:1.0	Slope gradient Upstream: 1:1.0 Downstream: 1:1.0	・It's the same as that of existing weir referring to examples in Japan.
2.Apron length	Dam up height: H=5.4m Bligh efficiency (gravel): C = 4	Required length： la = 5.57m	Design length： la =10.0m	・Creep length is secured ・Fit into apron length of scouring sluice
3.Creep length	Dam up height: H = 5.4m Bligh: C = 4 Lane: C' = 2.5	Bligh：S = 21.60m Lane：L = 13.50m	Bligh：S = 27.20m Lane：L = 14.87m	・Creep length is designed by Lane method
4.Downstream apron thickness	Water level difference： ⊿H = 5.4m Head loss: Hf = 3.41m	Required thickness： ta =1.97m	Design thickness： ta = 2.10m	・Necessary thickness to uplift is secured ・Fit into thickness of scouring sluice
5.Riprap length	Flood discharge： q = 11.22m^3/s/m Dam up height: H = 5.4m	Required length： L = 10.86m	Design length： L = 12.0m	・4 lines × @ 3.0m
6.Riprap block	Velocity: V = 5.25m/sec Impact area: A = 1.35m^2/block	Cast-in-place cross concrete block Required weight： W = 7.16ton	Cast-in-place cross concrete block Design weight： W = 8.75 ton	・ Select blocks are locally procured ・ Block：2.7m (width) × 2.7m (length) × 1.0m (height)

(2) Design of scouring sluice and revetment retaining wall

① Width of scouring sluice

The width of scouring sluice is decided assuming the velocity of about 0.4 m/sec at taking in ordinary water level of rainy season (about 2.0 m^3/sec).

② Longitudinal slope of scouring sluice

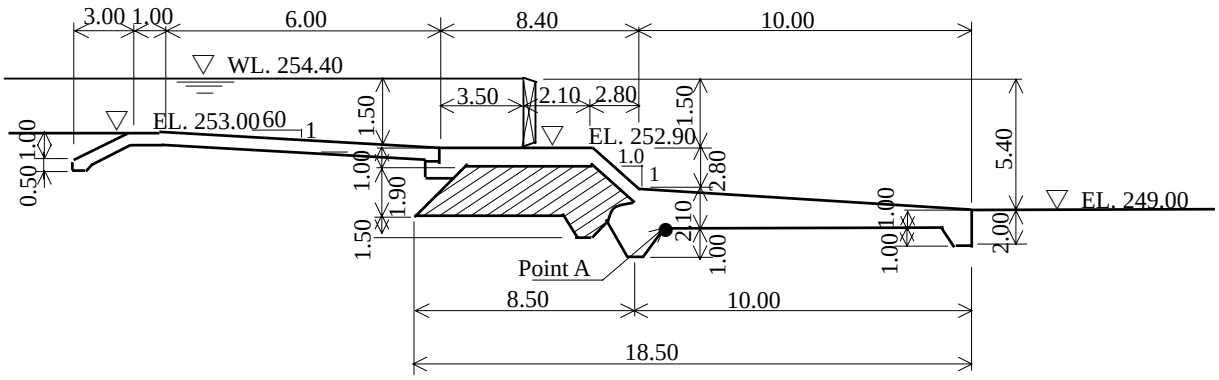


Figure 2-7 Cross section of proposed scouring sluice

Flow in scouring sluice at ordinary discharge is supercritical flow. Scouring sluice is designed so that target maximum grain (d_{max} = 40 mm) can be washed out at full gate operation. In this design, longitudinal slope of scouring sluice must be made equal to or steeper than the existing downstream slope of river.

③ Downstream apron of scouring sluice

(a) Length of downstream apron

The downstream apron is constructed for preventing scouring of downstream riverbed, because there is risk of scour at downstream riverbed by overflow water of scouring sluice. And, the length of downstream apron is designed referring to "design criteria of headworks, MAFF in Japan" (refer to Appendix 6-10 design of fixed weir and scouring sluice).

(b) Creep length of scouring sluice

To protect against piping, creep length along foundation of weir and back of revetment protection wall must be secured. The larger value calculated by (i) Bligh method or (ii) Lane method is adopted for securing creep length (refer to design criteria of headwork MAFF in Japan). In this design, the maximum difference of water level between upstream and downstream is calculated assuming that downstream water depth is 0 on the safe side. Also, to reduce uplift pressure, weep hole is set up at the cut-off at the end of downstream apron. Therefore, creep length doesn't include the cut-off at the downstream end.

(c) Downstream apron thickness of scouring sluice

The thickness of downstream apron is calculated from the formula regarding balance of uplift pressure (refer to design criteria of headworks, MoAFF in Japan).

④ Riprap of scouring sluice

(a) Riprap length

The riprap is installed in addition to downstream apron, because there is risk of scour at downstream riverbed by overflown water of scouring sluice. In this case, the length of riprap is designed referring to "design criteria of headworks, MAFF in Japan".

(b) Riprap block

The riprap block must bear resistance and stability against water flow. The study team designed weight of one riprap block (refer to design criteria of headworks, MoAFF in Japan).

⑤ Design parameter of scouring sluice

From the design result of scouring sluice, design parameters are decided as in Table 2-35 (refer to Appendix 6-10 Design of fixed weir and scouring sluice).

Table 2-35 Design parameters of proposed scouring sluice

Design item	Design condition	Required parameter	Design parameter	Note
1.Width of scouring sluice	Grain size: d = above 1mm Discharge: Q = 2.0m^3/sec Settling velocity：V = 0.4m/sec	Required width: B = 5.6m	Designed width: B = 6.0m	・ Scouring sluice gate: 3.0m x 1.5m (2 sets)
2.Lengitudinal slope	Maximum grain size: d=40mm Sand removal discharge: Q = 2.0m^3/sec Sand removal velocity: V = 0.89m/sec	Required slope: I = 1/109	Designed slope: I = 1/60	・ Existing riverbed slope of downstream: Fit into 1/60
3.Apron length	Dam up height: H = 5.4m Bligh efficiency (gravel):C=4	Required length: la = 8.37m	Designed length: la =10.0m	・ Secure creep length
4.Creep length	Intake water height: H = 5.4m Bligh efficiency: C = 4 Lane efficiency: C' = 2.5	Bligh: S = 21.60m Lane: L = 13.50m	Bligh: S = 26.40m Lane: L = 14.07m	・ Design creep length by Lane method
5.Thickness of downstream apron	Water level difference: ⊿H=5.4m Head loss: Hf = 3.35m	Available thickness: ta =2.02m	Designed thickness : ta = 2.10m	・ Secure necessary thickness to uplift
6.Riprap length	Flood discharge: q=19.97m^3/s/m Dam up height: H = 5.4m	Required length: L = 26.85m	Designed length: L = 27.0m	・ 9 lines × @ 3.0m
7.Riprap block	Velocity: V = 5.25m/sec Impact area: A = 1.35m^2/block	Crossing type concrete block Required weight: W = 7.16 ton	Crossing type concrete block Designed weight: W = 8.5 ton	・Blocks are procured locally ・Block: 2.7m (width) x 2.7m (length) x 1.0m (height)

⑥ Durability of scouring sluice pier and gate

(a) Scouring sluice pier

The concrete of scouring sluice pier constructed in rapid stream has a risk of damage by sediment flow mixing boulder during flood. By adopting "High strength concrete construction method" for surface protection work, the durability of scouring sluice pier can be secured.

(b) Scouring sluice gate

Numerous examples of the scouring sluice gate constructed in rapid stream exist in Japan. The main trouble of the gate is caused by the presence of boulder in rapid river flow during flood.

At the diversion weir for irrigation, the sluice gate can be kept full open because no intake is needed during flood. It follows that the gate is never damaged as long as it is operated to keep it open during flood (as mentioned in the regulation of gate operation).

In preparation for miss-operation of gate during flood, the gate leaf (skin plate, main beam, roller and roller axis) subject to damage shall be designed considering tolerable protection works against impact of boulder.

⑦ Riprap and retaining wall

Bank protection retaining wall need to be raised by 0.5 m based on the design flood elevation HWL.256.7 m and the following hydraulic conditions.

(a) Hydraulic conditions

Design flood discharge： Q = 310 m^3/sec（100-year flood）
Length of fixed weir ： L_1 = 17.1 m
Width of scouring sluice： L_2 = 3.0 m × 2 sets

(b) Flood level of upstream side

Assumed flood water level： HWL. 256.70 m
Overflow discharge of fixed weir： Q_1 = 192.0 m^3/sec
Scouring sluice flow： Q_2 = 119.8 m^3/sec
Total flow discharge： Q = 192.0 + 119.8 = 311.8 m^3/sec 310 m^3/sec

Based on the above, flood level of upstream after repair of diversion weir is set at HWL. 256.70 m.

(c) Raising height of protection wall

The raising height of both left and right banks is decided as follows.

Crest elevation of dike= Design flood level + Protection wall freeboard
= HWL. 256.70 m + 0.60 m
= EL. 257.30 m
Raising height of wall = Design protection wall crest elevation + Existing riprap crest elevation
= EL. 257.30 m - EL. 256.80 m
= 0.50 m

(3) Design of intake, sediment settling basin, and canal intake work

① Intake

(a) Intake sill level

At intake, almost all the sediments in the scouring sluice consist of bed load (sediment that rolls or bounds along riverbed). Taking this into consideration, the intake sill level is designed to be 0.70m higher than sill level of the scouring sluice, (half of the depth in scouring sluice of 1.40m), to prevent inflow of sediment into the intake structure.

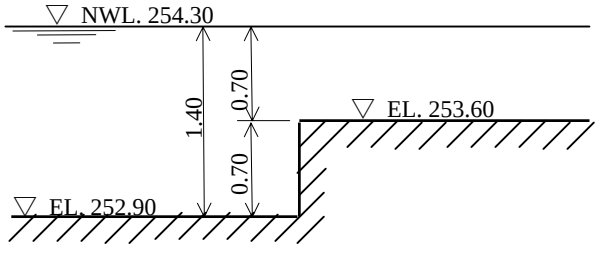


Figure 2-8 Intake sill level

・ Intake sill = EL. 252.90 m + 0.70 m = EL. 253.60 m

(b) Intake velocity

The standard intake velocity should be kept in a range 0.6 - 1.0 m/sec to prevent inflow of sediment to the intake structure.

- Inflow velocity = 0.6 to 1.0m/sec

(c) Intake width

The intake width is calculated by the following formula, considering the inflow depth calibrated from intake sill level and the designed intake level as well as intake velocity.

$$B = Q / (h_1 \cdot V) = 1.37 / (0.70 \times (0.6 \text{ to } 1.0)) = 1.96 \text{ to } 3.26 \text{ m}$$

Where, B : Intake width (m)
Q : Design intake discharge: Q = 1.37 m^3/sec
h_1 : Inflow water depth: h_1 = NWL. 254.30m - EL. 253.60m = 0.70 m
V : Inflow velocity: V = 0.60 to 1.0 m/sec

Although the intake width ranges from 1.96 m to 3.26 m, it is designed at 3.0 m so that the intake velocity can be maintained at low level, assuming the case that the gate can hardly be operated during the night in Bulobo River. In addition, the regulating gate is needed for flood protection at intake. The flood-regulating gate is designed as 1.5m W × 1.0 m H × 2 sets of gate leaf (4-side back sealing slide gate) in order to make the operation easier.

② Sediment settling basin

(a) Hydraulic conditions

The hydraulic conditions of sediment basin are as follows.

- Design discharge： Q = 1.37m^3/sec
- Target grain size： d = 0.5 - 40.0 mm（the grain diameter of 10～100% filtered is adopted from the results of geological survey and grain size analysis of riverbed materials）
- Velocity in sediment basin： V = 0.4 m/sec, by rough estimation
- Water depth in sediment basin：h = 0.6 m, roughly estimated water depth of main canal

(b) Examination of existing sediment settling basin

Hydraulic conditions of existing sediment basin

- Effective width： B = 6.0m
  （existing width is 12.0m, but, effective width is about 6.0m due to drift current）
- Water depth： h = 0.6 m, roughly estimated from water depth of main canal,
- Target grain size： d = 0.5～40.0 mm（the grain diameter of 10～100% filtered is adopted

from geological survey and grain size analysis of riverbed materials）

・Velocity in basin： V = 1.37 / (6.0 × 0.60) = 0.38 m/sec

・Critical settling velocity： Vg = 0.049 m/sec（velocity to minimum grain size $d_{min.}$ = 0.6 mm）

Sedimentation ditch length of existing settling basin

The length of sedimentation ditch is calculated by the following formula.

L = K・h/Vg・V = (1.5～2.0) × 0.60/0.049 × 0.38 = 7.0～9.3 m < existing length：13.0 m

where, L ： Sedimentation ditch length (m)

K ： Safety coefficient: K = 1.5～2.0

h ： Effective water depth: h = 0.60 m

Vg： Critical settling velocity: Vg = 0.049 m/sec (minimum diameter：$d_{min.}$ = 0.5 mm)

V ： Velocity in basin: V = 0.38 m/sec

Therefore, the sedimentation ditch length of 13 m at the existing sediment basin has sufficient sediment function.

③ Canal intake

(a) Hydraulic design conditions and hydraulic profile

Hydraulic design conditions

1) Design intake discharge： Q = 1.37 m^3/sec
2) Design headwater level： NWL. 254.30 m
3) Design intake width： W = 1.50 × 2 + 0.60 = 3.60 m
4) Intake sill level： EL. 253.60 m
5) Hydraulic condition of beginning point of main canal：

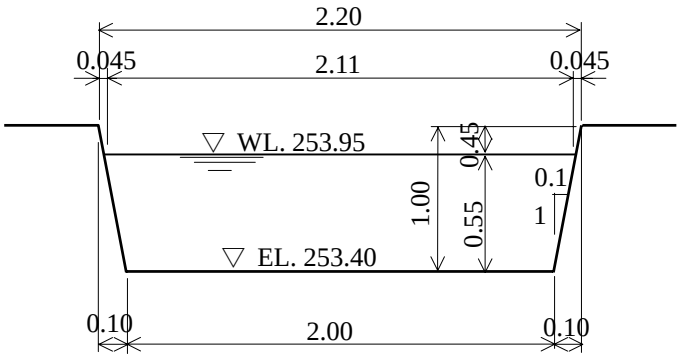


Figure 2-9 Cross section of beginning point of Main canal (Sta. 0 + 030)

(b) Hydraulic profile

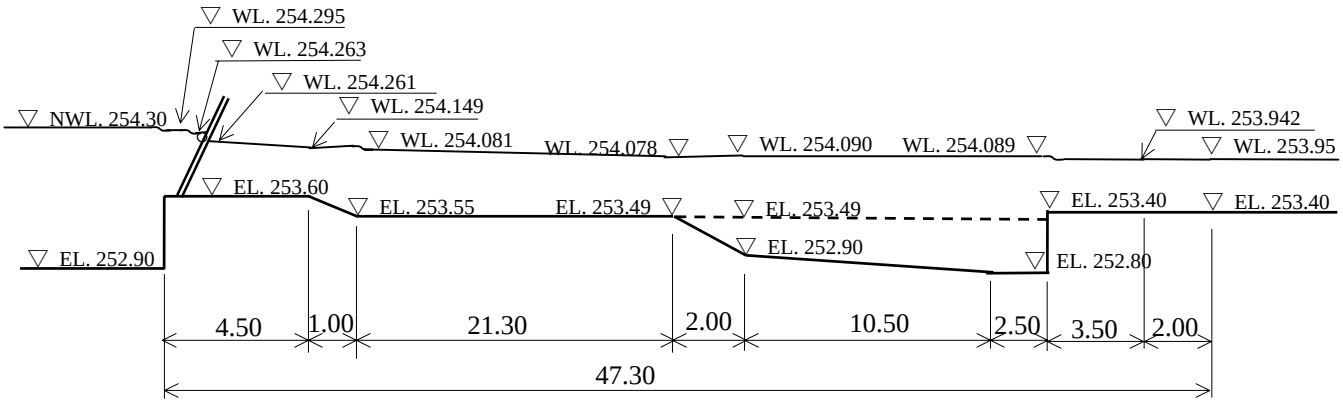


Figure 2-10 Hydraulic profile of intake and sediment settling basin

(c) Hydraulic computation

The water level decline where located at intake (inflow, step, friction, pier, and screen), link canal (bend, link canal), sediment settling basin (inlet, friction), and canal intake work (inflow, transition) is as shown in Table 2-36 (reference 6-11 "design of canal intake works").

Table 2-36 Hydraulic water level decline at canal intake

Design item	Design conditions	Water level decline	Elevation after decline	Note
1.Inside of scouring sluice	Intake discharge： Q=1.37m^3/sec Water depth in scouring sluice：h = 1.40m Approaching velocity： V = 0.0m/sec	—	Design headwater level： NWL.254.300m	･Approaching velocity is disregarded
2.Water level decline by intake inflow	Water depth after inflow： h = 1.395m Velocity after inflow： V = 0.27m/sec	Water level decline： 0.005m	Water level after inflow： WL.254.295m	･Shape of intake：rectangular & circle ･Inflow coefficient of head loss：fc = 0.2
3.Water level decline by step	Water depth after passing step：h = 0.676m Velocity after passing step： V = 0.56m/sec	Water level decline： 0.019m	Water level after passing step ：WL.254.276m	･Ratio of flow area： A_2/A_1 = 0.48 ･Coefficient of head loss：f = 0.44
4.Water level decline by pier	Water depth after passing pier：h = 0.663m Velocity after passing pier： V = 0.69m/sec	Water level decline： 0.013m	Water level after passing pier ：WL.254.263m	･Shape of pier：Circle ･Coefficient of head loss：C = 0.92
5.Water level decline by screen	Water depth after passing screen：h = 0.661m Velocity after passing screen：V = 0.69m/sec	Water level decline： 0.100m	Water level after passing screen： WL.254.163m	･Shape of screen：rectangular & circle ･Coefficient of head loss：fr = 0.09
6.Water level decline by intake friction	Water depth of downstream end：h = 0.549m Velocity of downstream end： V = 0.83m/sec	Water level decline： 0.014m	Water level of downstream end at intake： WL.254.149m	･Mean gradient： I = 0.000575
7.Water level decline by intake bend	Water depth of downstream end：h = 0.531m Velocity of downstream end： V = 0.81m/sec	Water level decline： 0.068m	Water level of upstream end at link canal： WL.254.081m	･Bend angle：90 ° ･Coefficient of head loss：fb = 1.0
8.Water level decline by link canal	Water depth of downstream end：h = 0.588m Velocity of downstream end： V = 0.73m/sec	Water level decline： 0.003m	Water level of downstream end at link canal： WL.254.078m	･Mean gradient： I = 0.000436
9.Water level decline by inlet portion of sediment basin	Water depth of upstream end：h = 0.600m Velocity of upstream end： V = 0.29m/sec	Water level decline： - 0.012m	Water level of upstream end at sediment basin： WL.254.090m	･Expansion of cross section ･Coefficient of head loss：ft= 0.50
10.Water level decline by friction of settling basin	Water depth of downstream end：h = 0.639m Velocity of downstream end： V = 0.27m/sec	Water level decline： 0.001m	Water level of downstream end at sediment basin： WL.254.089m	･ Mean gradient： I = 0.000073
11.Water level decline at inlet of canal intake	Water depth after inflow： h = 0.542m Velocity after inflow： V = 1.40m/sec	Water level decline： - 0.147m	Water level after inflow： WL.253.942m	･Shape of intake：Angle ･Coefficient of loss： ft = 0.50
12.Water level decline by transition	Water depth of main canal： h = 0.550m Velocity of main canal： V = 1.27m/sec	Water level decline： - 0.008m	Water level of upstream end at sediment basin： WL.254.090m	･Expansion of cross section ･Coefficient of loss： ft = 0.20
13.Total water level decline		Total of water level decline：0.350m		

2-2-2-2-2 Irrigation Canal Facility Planning

(1) Design conditions of irrigation canal

① Design discharge of irrigation canal

The maximum irrigation water is required in puddling period of rainy season that irrigation area expanded to the maximum. Design discharge of irrigation canal in this period is decided as total of puddling water for 1,050 ha paddy field and requirement for water supply.

1) Main canal： 1.37～1.35 m^3/sec
2) Ramaskora secondary canal： 0.96～0.16 m^3/sec
3) Ritabau secondary canal： 0.39～0.17 m^3/sec

② Mean velocity formula

The mean velocity of irrigation canal is calculated by Manning's formula.

$V = 1/n \cdot R^{2/3} \cdot I^{1/2}$

$V = 1/n \cdot R^{2/3} \cdot I^{1/2}$

where, V ：Mean velocity (m/sec)

n ：Roughness coefficient

Aqueduct steel or concrete canal： 0.015

Mortar finished flume canal： 0.020

Wet masonry lining canal： 0.025

Earth canal (clayey loam)： 0.030

Earth canal (grass canal)： 0.035

R ：Hydraulic mean depth (m)

I ：Canal slope

③ Allowable maximum and minimum velocity

The allowable maximum velocity is decided in consideration of the durability of irrigation canal lining. Besides, allowable minimum velocity is decided in consideration of velocity that refrains from sedimentation in the irrigation canal and overgrowth of submerged plant that may affects water flow shown in Table 2-37.

Table 2-37 Allowable maximum and minimum velocity

Lining type	Allowable min. velocity (m/sec)	Allowable max. velocity (m/sec)
Earth canal (loam)	0.70	0.70
Wet masonry canal	0.70	2.50
Concrete canal	0.70	3.00
Steel canal	0.70	4.50

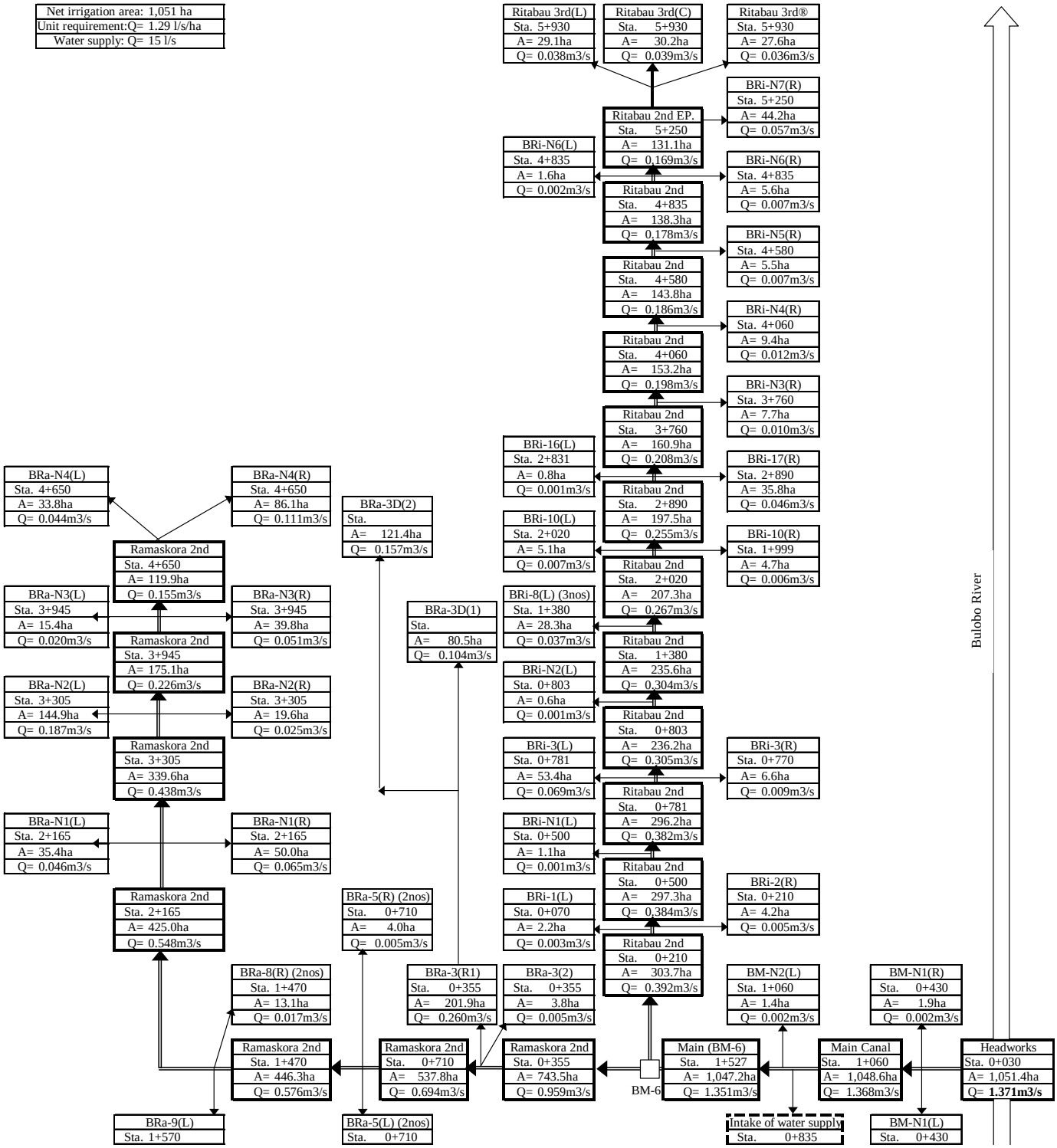


Figure 2-11 Irrigation water distribution plan at peak season (rainy season: 1st half of Feb.)

(1) Main canal

The dimension of proposed main canal is given in Table 2-38, in line with the principles of rehabilitating length of canals, lining method and rehabilitating appurtenant facilities of irrigation canals.

Table 2-38 Design parameters of proposed Main canal

Item		Facilities scale etc.
1) Facility scale	Design discharge: Length:	Q_{max} = 1.37～1.35 m^3/sec L = 1,527m (All sections：lining canal)
2) Standard cross section	Canal type: Canal Bottom width: Side wall height: Crest width:	Wet masonry lining trapezoidal open 1.60m - 5.70m 0.90m - 1.80m 1.60m - 7.10m
3) Related structure	Aqueduct bridge: Side ditch spillway: Sand removal facility: Turnout: Small-scale turnout: Drop structure: Cross drain work: Drainage inlet: Concrete bridge: Concrete foot bridge: Wooden foot bridge: Washing basin:	1 place(W: 1.60m × H: 1.80m × L: 40.00m) 1 place (W: 2.10m × H: 1.00m × L: 2.50m) 1 place (W: 1.00m × H: 1.00m × 2 sets) 1 place (W: 1.00m × H: 0.80m × 2sets) 4 places (PipeD100 - 300mm) 2 places (H: 0.75 - 0.90m × W: 1.6 - 2.1m) 4 places (cross pipe, D1,000 mm × 1 - 2 sets) 1 place (W: 1.00m × H: 0.7m) 1 bridge (W: 2.5m × L: 3.0m) 1 bridge (W: 0.5m × L: 4.5m) 7 bridges (W: 0.3 - 1.0m × L: 2.5 - 4.5m) 12 places (L: 1.0 - 4.5m ×⊿H: 0.3 - 0.45m × 1 - 3 steps)

(2) Secondary canal

① Ramaskora secondary canal

The dimension of proposed Ramaskora secondary canal is indicated in Table 2-39 in accordance with the principles of rehabilitating length of canals, of lining method and of rehabilitating appurtenant facilities of irrigation canals.

Table 2-39 Design parameters of proposed Ramaskora secondary canal

Item	Facilities scale etc.	
1) Facility scale	Design discharge： Length： Existing lining section： Proposed lining section：	Q_{max}= 0.96 - 0.16 m^3/sec L = 3,945m 1,570m 2,375m
2) Standard cross section	Canal type： Bottom width： Side wall height： Crest width：	Wet masonry lining trapezoidal open canal 0.40m - 1.60m 0.30m - 0.80m 1.00m - 3.20m
3) Related structure	Turnout： Small-scale turnout： Drop structure： Cross drain work： Drainage inlet： Concrete bridge： Farm road bridge： Wooden foot bridge： Washing basin：	14 places 8 places 2 places (⊿H: 1.2 - 1.4m × W: 0.9 - 2.1m) 1 place (cross pipe, ϕ1,000 mm × 1 set) 1 place (W: 0.5m × H: 0.8m) 13 bridges (W: 1.9 - 7.5m × L: 2.0 - 4.0m) 1 bridge (W: 5m × L: 0.8m) 31 bridges(W: 0.3 - 2.5m x L: 2.5 - 3.5m) 27 places (L: 0.8 - 7.0m × ⊿H: 0.2～0.45m × 1 - 5 steps)

② Ritabau secondary canal

The dimension of proposed Ritabau secondary canal is given in Table 2-40.

Table 2-40 Design parameters of proposed Ritabau secondary canal

Item	Facilities scale etc.	
1) Facility scale	Design discharge：	Q_{max} = 0.39 - 0.17 m^3/sec
	Length：	L = 5,250m
	Existing lining section：	2,890m
	Proposed lining section：	2,360m
2) Standard cross section	Canal type：	Wet masonry lining trapezoidal open canal
	Bottom width：	0.40m - 1.10m
	Side wall height：	0.40m - 0.80m
	Crest width：	0.80m - 2.30m
3) Related structure	Turnout：	15 places
	Small-scale turnout：	11 places
	Chute work：	1 place (W: 1.0m x H: 1.0m × L: 47.5m)
	Drop structure：	17 places (⊿H: 0.3 - 1.6m × W: 0.7 - 1.0m)
	Drainage inlet：	5 places (W: 0.1 - 0.6m × H: 0.4 - 0.7m x L: 5.0m)
	Concrete bridge：	13 bridges (W: 1.5 - 6.0m × L: 2.0 - 4.0m)
	Wooden foot bridge：	81 bridges (W: 0.3 - 2.6m × L: 2.0 - 3.5m)
	Washing basin：	27 places（L: 1.0 - 2.3m x ⊿H: 0.2 - 0.35m x 1 - 3 steps）

(3) Appurtenant facilities of irrigation canal

The related facilities to the above-tabulated irrigation canals needed to be refit or to be repaired are compiled in Table 2-41.

Table 2-41 Appurtenant facilities of irrigation canal

Related facility	Number of Places				Rehabilitation or repair
	Main canal	Ramaskora secondary canal	Ritabau secondary canal	Total	
1. Turnout	1	13	15	29	Rehabilitation the whole
2. Small-scale turnout	4	0	1	5	Rehabilitation partially
	0	8	10	18	Rehabilitation all or new
3. Drop structure	2	2	17	21	Rehabilitation the whole
4. Side ditch spillway	1	0	0	1	Repair partially
5. Washing basin	12	24	27	63	Repair the whole
6. Sand removal facility	1	0	0	1	Rehabilitation the whole
7. Chute work	0	0	1	1	Repair partially
8. Cross drain work	4	1	0	5	Rehabilitation partially
9. Concrete bridge	0	0	1	1	Rehabilitation the whole
	0	0	7	7	Repair partially

2-2-2-2-3 Design of Wet Masonry Protection Wall for Aqueduct

In compliance with the policies of rehabilitating wet masonry protection wall of the Aqueduct, the wall will be refitted as follows:

(1) Wet masonry protection wall of right bank

The design parameters of proposed wet masonry protection wall of right bank is shown in Table 2-42.

Table 2-42 Design parameters of proposed Aqueduct -Wet masonry protection wall at right bank

Item	Facilities scale etc.				Total
	Upstream	Midstream	Downstream (Upper level)	Downstream (Lower level)	
1)Riprap and retaining wall					
Structure type	Wet masonry (refit)	Wet masonry (existing)	Wet masonry (refit)	Wet masonry (new construction)	Wet masonry work
Length	17.0m	7.5m	22.0m	26.0m	72.5m
Height	4.5m	4.5m	4.5m	3.0m	—
Slope gradient	1 : 0.5	1 : 0.5	1 : 0.5	1 : 0.5	—
2)Riverbed protection					
Structure type	Crossing type concrete block	Crossing type concrete block	Crossing type concrete block	Crossing type concrete block	—
Each block size	2.7m×2.7m×1.0m	2.7m×2.7m×1.0m	2.7m×2.7m×1.0m	2.7m×2.7m×1.0m	—
Length/ Width	17.0m × 6.0m	7.5m × 6.0m	18.0m × 3.0m	24m × 6.0m	—

(2) Wet masonry protection wall of left bank

The design parameters of proposed wet masonry protection wall of left bank is shown in Table 2-43.

Table 2-43 Design parameters of proposed Aqueduct -Wet masonry protection wall at left bank-

Item	Facilities scale etc.	Total
1)Riprap and retaining wall		
Structure type	Wet masonry (New construction)	Wet masonry (New construction)
Length	34.0m	34.0m
Height	4.5m	—
Slope gradient	1 : 1.0	—
2)Riverbed protection		
Structure type	Crossing type concrete block	Crossing type concrete block
Each block size	2.7m×2.7m×1.0m	2.7m×2.7m×1.0m
Length / Width	42.0m × 6.0m	42.0m × 6.0m

2-2-2-2-4 Building Facility Planning

(1) Gate keeper's hut

The design parameters of proposed gatekeeper's hut is shown in Table 2-44.

Table 2-44 Design parameters of proposed Gate keeper's hut

Item	Facility scale etc.	Note
1) Location	Upstream side of left band of Maliana I weir	・Left bank just upstream of weir is proper for gate operation and land reservation is easy
2) Structure type	1-storied RC column-beam structure, wall block, concrete foundation	・Adopted structure type had many achievements in the country
3) Total building area	4.2m × 3.5m = 14.7m^2	・Space for gate administrators are able to resident in day time

(2) Storage for O/M equipment

The dimension of proposed storage for O/M equipment is given in Table 2-45.

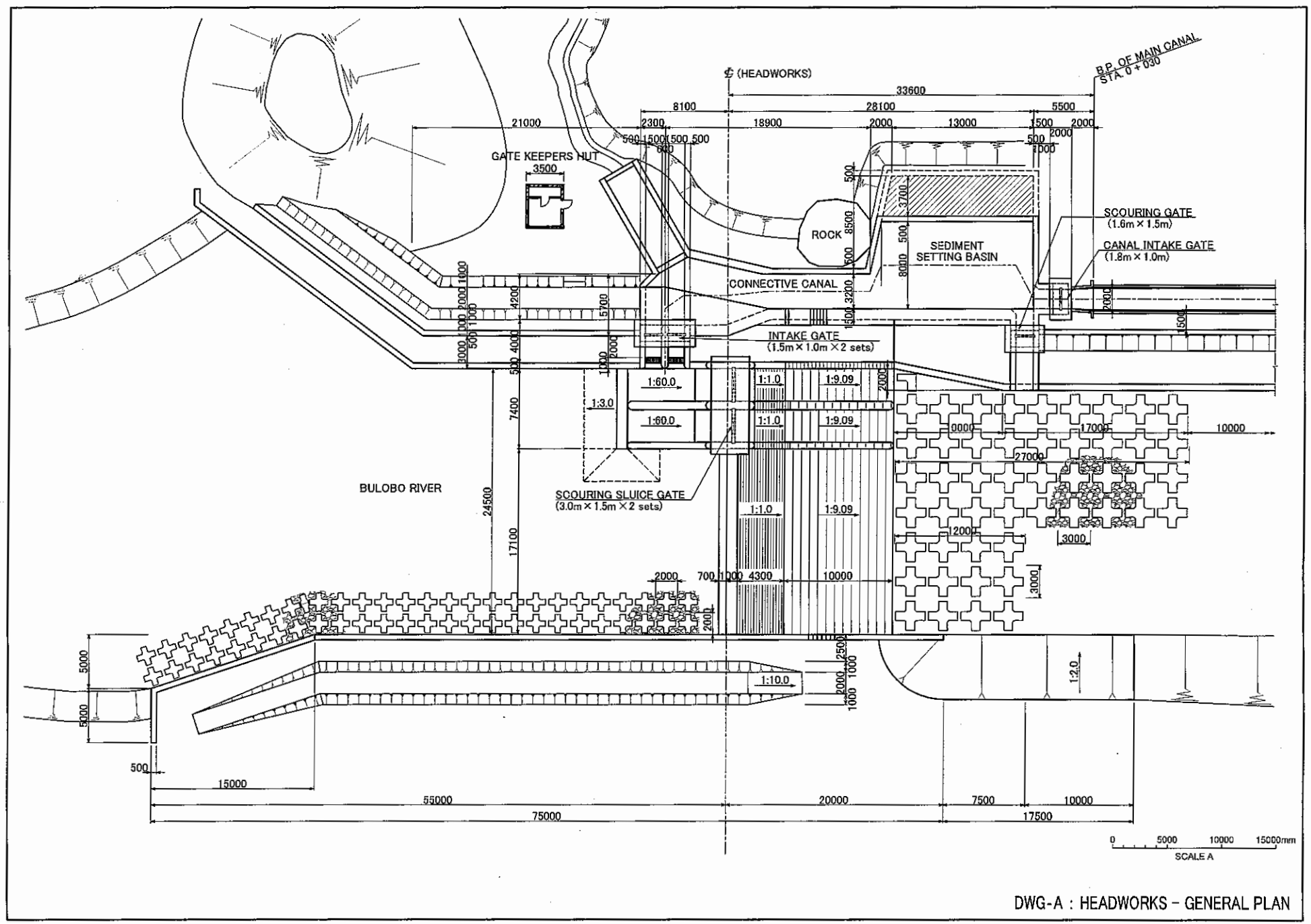
Table 2-45 Design parameters of proposed storage for O/M equipment

Item	Facilities scale etc.	Note
1) Location	Ramaskora secondary canal (vicinity of Sta. 3+360 point)	・Site was selected where land is readily available, locating at almost the center of the irrigation area with easy access from existing road
2) Structure type	1-storied RC column-beam structure, wall block, concrete foundation	・Adopted a structure type with many other achieved performances in this country
3) Total building area	10.5m × 6.5m = 68.25 m^2	・Meeting room, lavatory, store and corridor are laid out to accommodate about 30 members

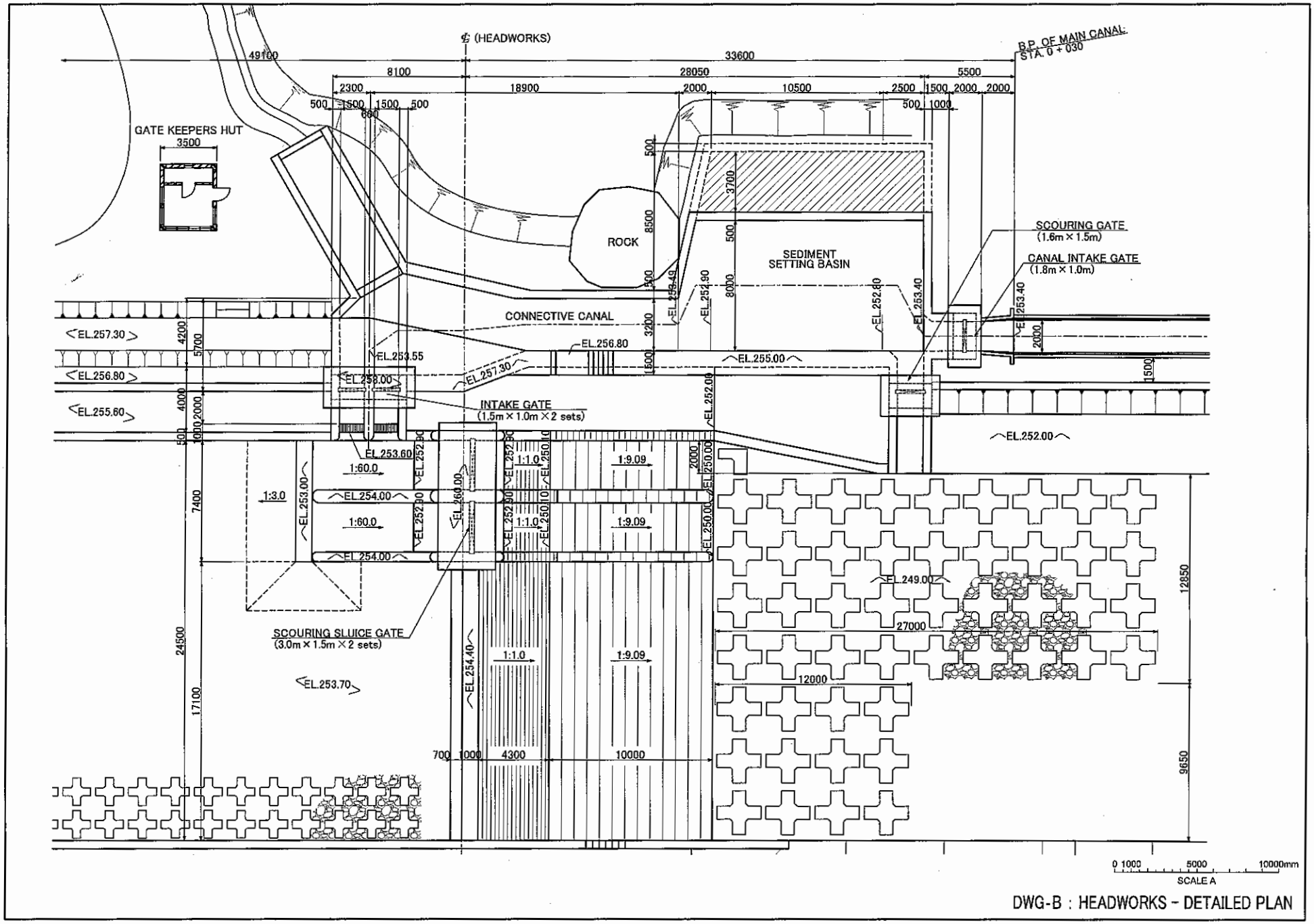
2-2-3 Basic Design Drawing

Table 2-46 List of drawings

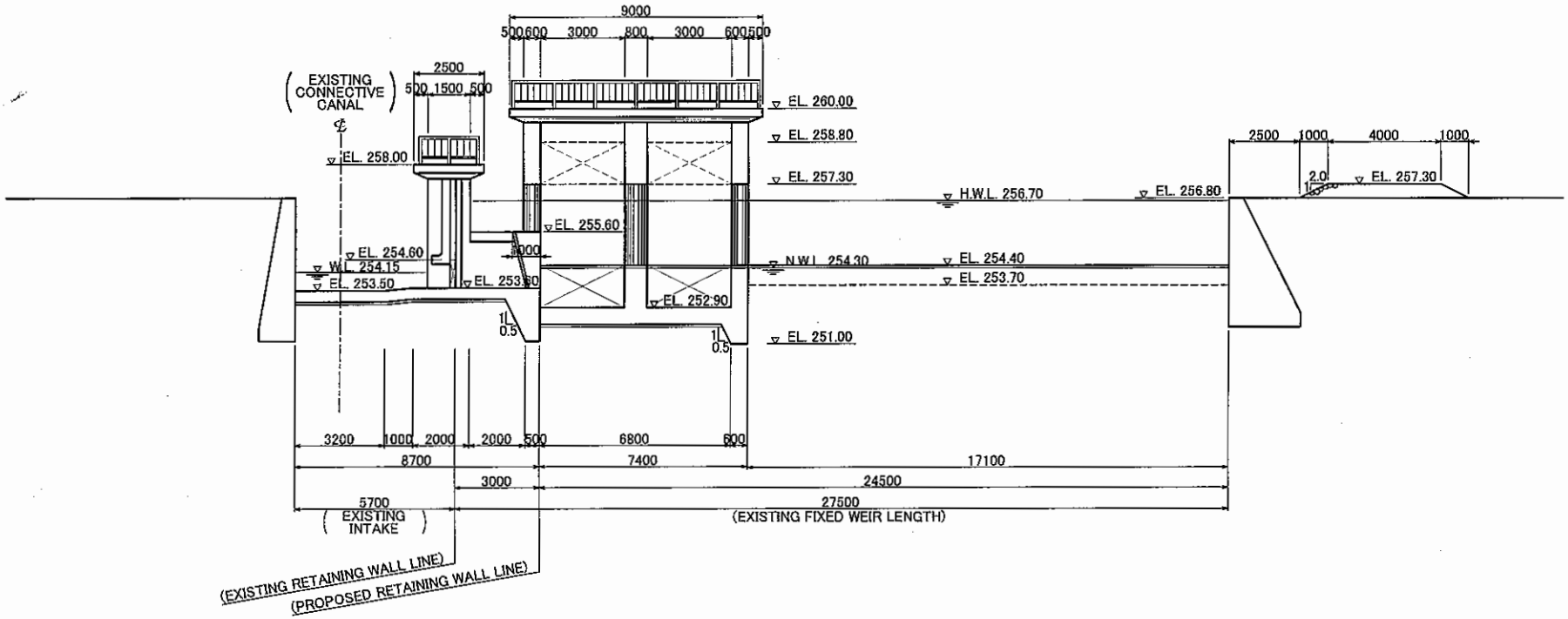
Drawing No.	Title of Drawing
DWG-A	Headworks – General Plan
DWG-B	Headworks – Detailed Plan
DWG-C	Headworks – Elevation
DWG-D	Headworks – Longitudinal Profile of Scouring Sluice and Typical Cross Section of Fixed Weir
DWG-E	Main Canal – Plan and Longitudinal Profile (1/3)
DWG-F	Main Canal – Plan and Longitudinal Profile (2/3)
DWG-G	Main Canal – Plan and Longitudinal Profile (3/3)
DWG-H	Main Canal – Typical Cross Section
DWG-I	Main Canal – Plan of Scouring Gate
DWG-J	Main Canal – Structural Sections of Canal Scouring Gate
DWG-K	Main Canal – Plan of Turnout
DWG-L	Main Canal – Structural Sections of Turnout
DWG-M	Main Canal – Structural Sections of Drop Structure
DWG-N	Aqueduct – Structural Sections of Wet Masonry Protection Wall
DWG-O	Storage for O/M Equipment – Structural Sections



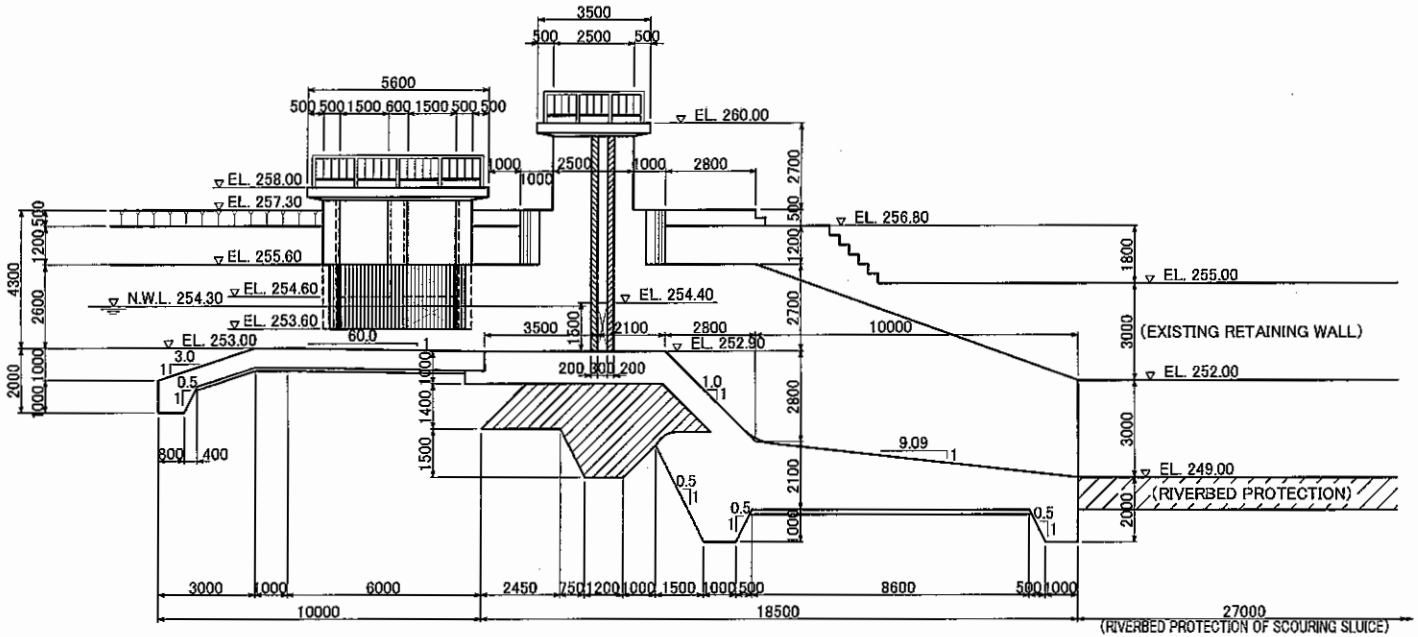
DWG-A : HEADWORKS – GENERAL PLAN



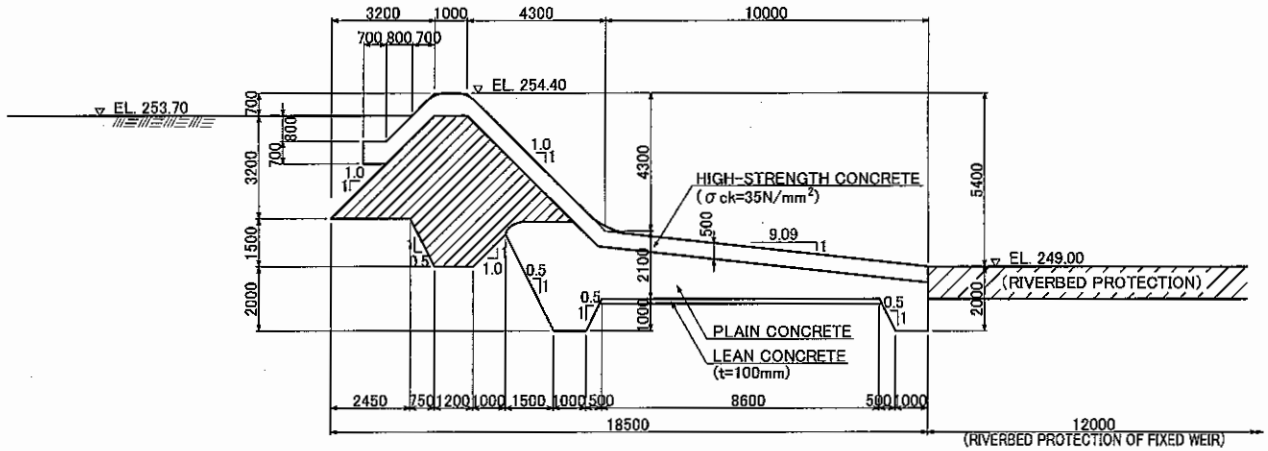
DWG-B : HEADWORKS - DETAILED PLAN



DWG-C : HEADWORKS - ELEVATION



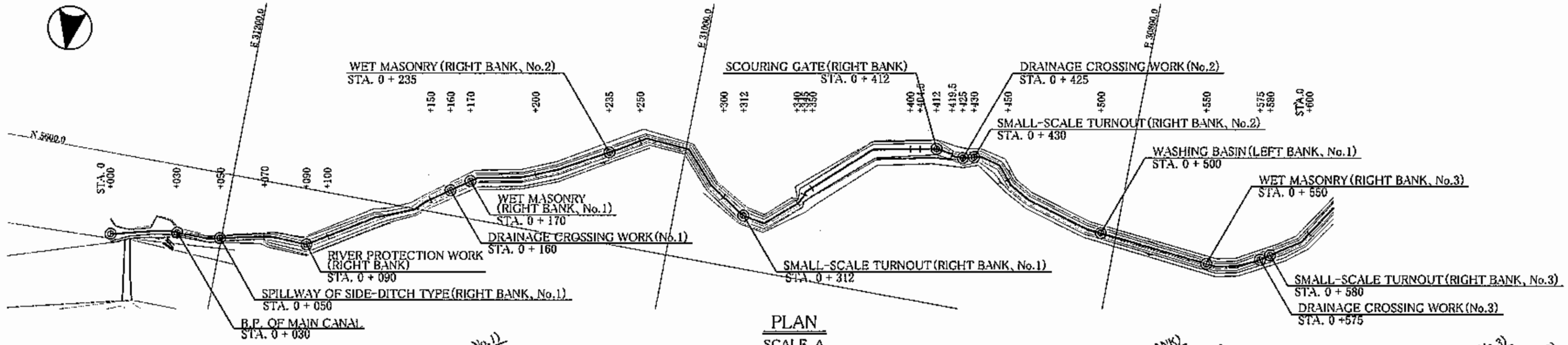
LONGITUDINAL PROFILE OF SCOURING SLUICE



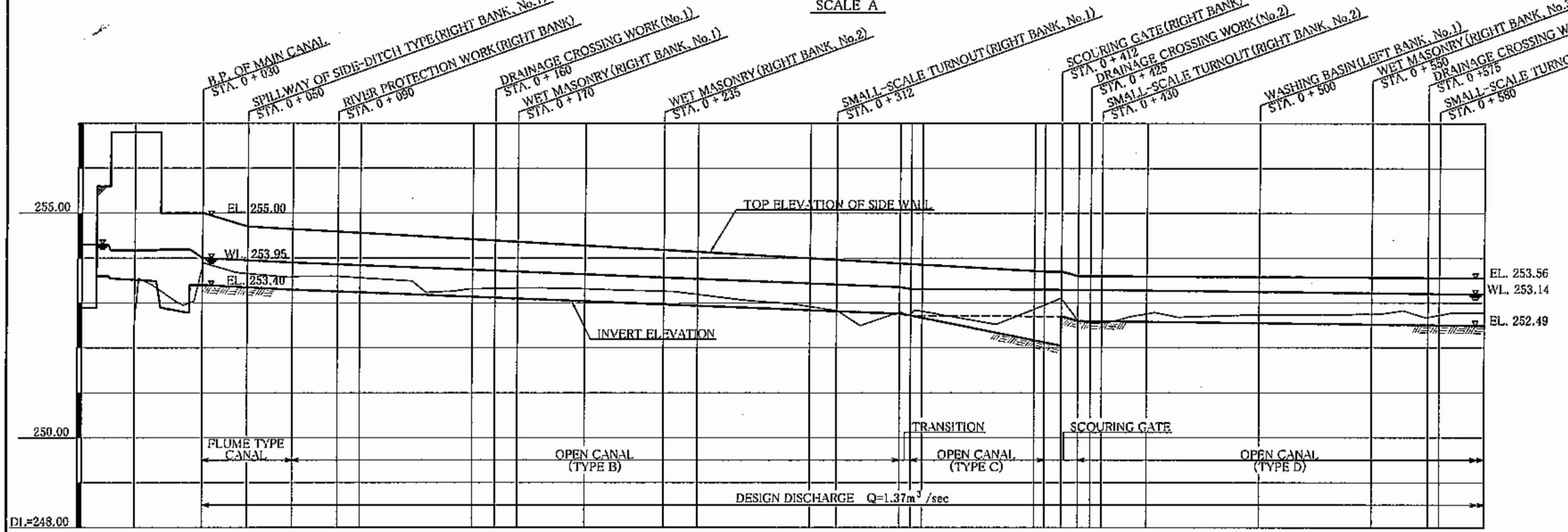
TYPICAL CROSS SECTION OF FIXED WEIR

0 1000 2500 5000 7500mm
SCALE A

DWG-D : HEADWORKS - LONGITUDINAL PROFILE OF SCOURING SLUICE AND TYPICAL CROSS SECTION OF FIXED WEIR



PLAN
SCALE A



LONGITUDINAL GRADE: I = 1 / 400; I = 1 / 500; I = 1/125; I = 1 / 100 (I = 1/3,500); I = 1 / 75; I = 1 / 1,600

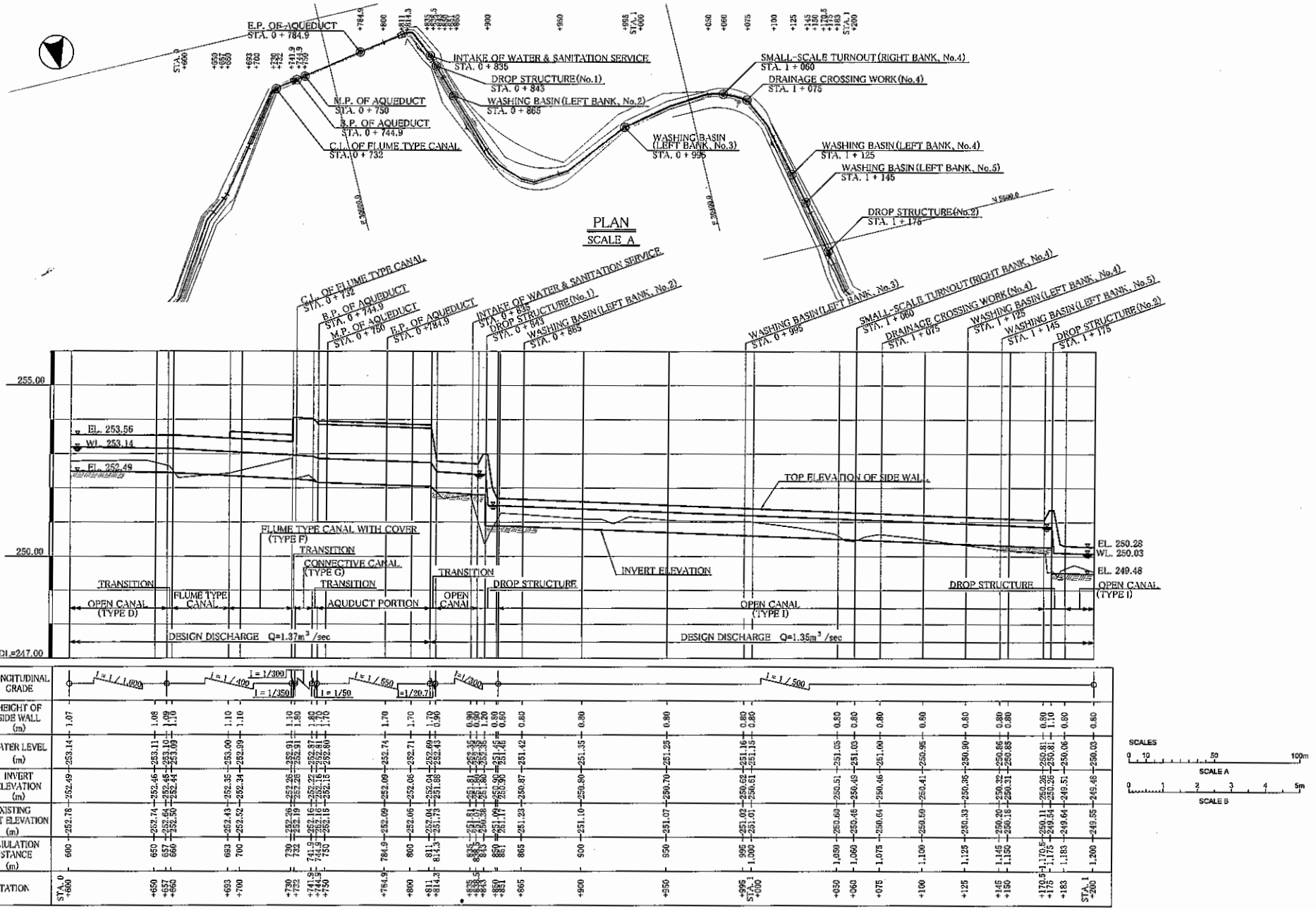
	STATION	STA.0 +000	+030	+050	+070	+090	+100	+150	+160	+170	+200	+235	+250	+300	+312
PROPOSED	HEIGHT OF SIDE WALL (m)		1.60	1.35	1.34	1.33	1.32	1.28	1.27	1.26	1.24	1.21	1.20	1.16	1.14
PROPOSED	WATER LEVEL (m)		253.95	253.90	253.85	253.81	253.79	253.69	253.67	253.65	253.59	253.52	253.49	253.39	253.37
PROPOSED	INVERT ELEVATION (m)		253.40	253.35	253.30	253.26	253.24	253.14	253.12	253.10	253.04	252.97	252.94	252.84	252.82
	EXISTING INVERT ELEVATION (m)		253.70	253.66	253.30	253.60	253.57	253.32	253.33	253.34	253.32	253.26	253.19	252.92	252.83
	CUMULATION DISTANCE (m)		30	50	70	90	100	150	160	170	200	235	250	300	312

	STATION	+340	+345	+350	+400	+404.5	+412	+419.5	+425	+430	+450	+500	+550	+575	+580	STA.0 +600
PROPOSED	HEIGHT OF SIDE WALL (m)	1.12	1.15	1.18	1.54	1.57	1.65	1.00	1.00	1.01	1.01	1.03	1.05	1.06	1.06	1.07
PROPOSED	WATER LEVEL (m)	253.31	253.27	253.79	253.29	253.25	253.25	253.25	253.25	253.24	253.23	253.20	253.17	253.15	253.15	253.14
PROPOSED	INVERT ELEVATION (m)	252.76	252.72	252.67	252.17	252.13	252.05 / 252.70	252.60	252.60	252.59	252.58	252.55	252.52	252.50	252.50	252.49
	EXISTING INVERT ELEVATION (m)	252.81	252.75	252.81	252.87	252.95	253.10	252.61	252.56	252.56	252.76	252.73	252.75	252.67	252.72	252.78
	CUMULATION DISTANCE (m)	340	345	350	400	404.5	412	419.5	425	430	450	500	550	575	580	600

SCALES
0 10 50 100m
SCALE A
0 1 2 3 4 5m
SCALE B

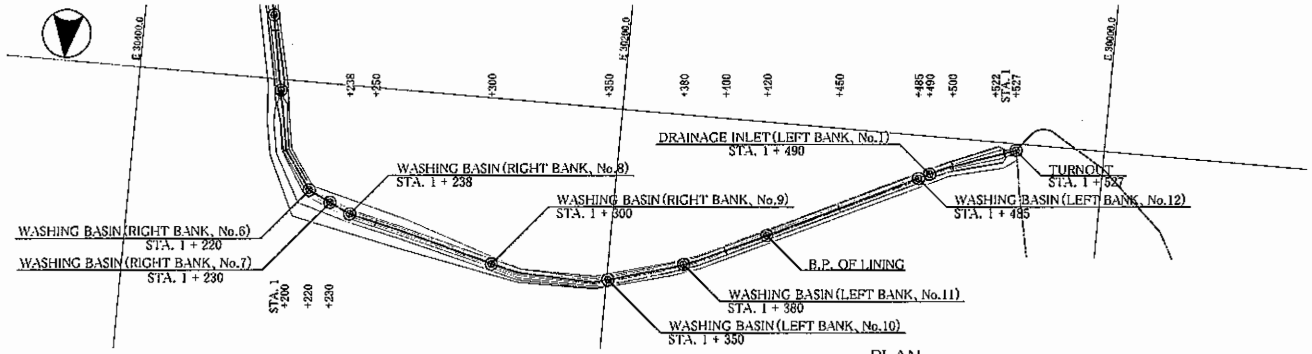
LONGITUDINAL PROFILE
V = SCALE B, H = SCALE A

DWG-E : MAIN CANAL - PLAN AND LONGITUDINAL PROFILE (1/3)

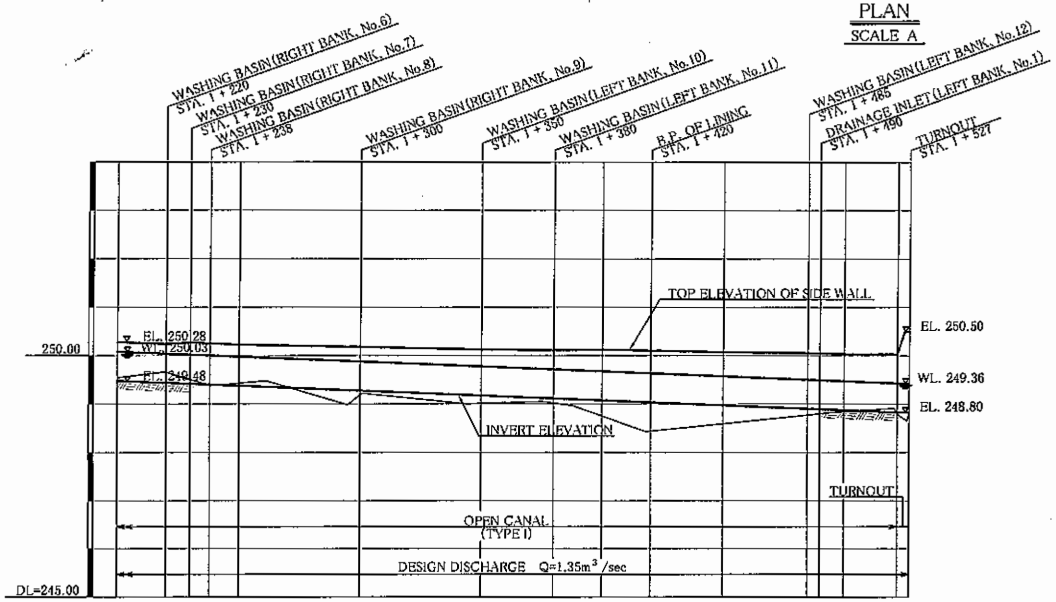


LONGITUDINAL PROFILE
V = SCALE B, H = SCALE A

DWG-F : MAIN CANAL – PLAN AND LONGITUDINAL PROFILE (2/3)



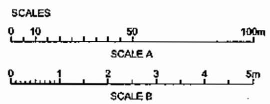
PLAN
SCALE A



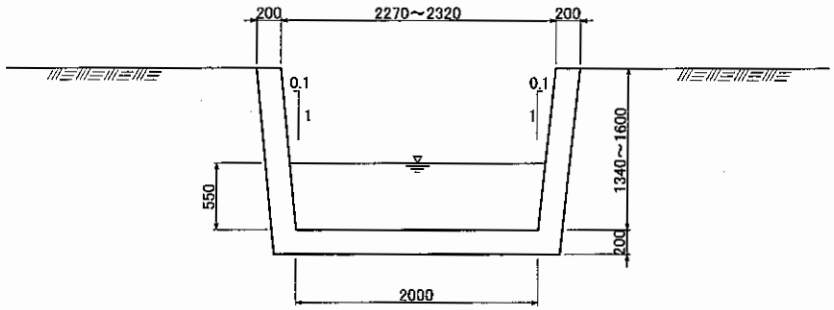
		STATION	STA. 1 +200	+220	+230	+238	+250	+300	+350	+380
PROPOSED	LONGITUDINAL GRADE		I = 1 / 500							
PROPOSED	HEIGHT OF SIDE WALL (m)		0.80	0.80	0.85	0.85	0.85	0.90	0.95	1.00
PROPOSED	WATER LEVEL (m)		250.03	249.99	249.97	249.95	249.93	249.83	249.73	249.67
PROPOSED	INVERT ELEVATION (m)		249.48	249.44	249.42	249.40	249.38	249.28	249.18	249.12
EXISTING INVERT ELEVATION (m)			249.55	249.66	249.51	249.39	249.43	249.19	249.01	249.02
CUMULATION DISTANCE (m)			1,200	1,220	1,230	1,238	1,250	1,300	1,350	1,380

		STATION	+400	+420	+450	+485	+490	+500	+522	STA. 1 +527
PROPOSED	LONGITUDINAL GRADE								I=1/167	
PROPOSED	HEIGHT OF SIDE WALL (m)		1.05	1.05	1.10	1.15	1.15	1.15	1.20	1.70
PROPOSED	WATER LEVEL (m)		249.63	249.59	249.53	249.46	249.45	249.43	249.39	249.36
PROPOSED	INVERT ELEVATION (m)		249.08	249.04	248.98	248.91	248.90	248.87	248.83	248.80
EXISTING INVERT ELEVATION (m)			248.75	248.44	248.59	248.77	248.80	248.84	248.82	248.81
CUMULATION DISTANCE (m)			1,400	1,420	1,450	1,485	1,490	1,500	1,522	1,527

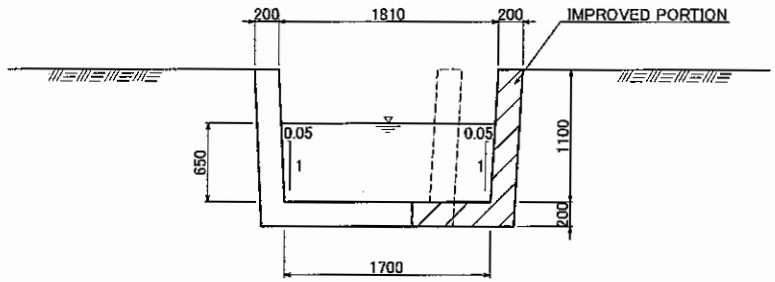
LONGITUDINAL PROFILE
V = SCALE B, H = SCALE A



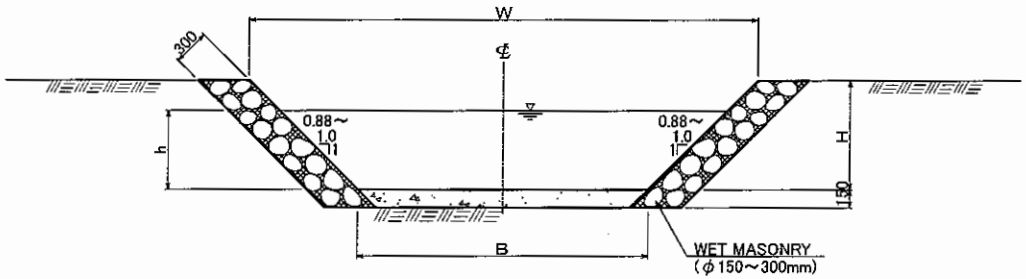
DWG-G : MAIN CANAL - PLAN AND LONGITUDINAL PROFILE (3/3)



TYPICAL CROSS SECTION OF FLUME TYPE CANAL(TYPE A)

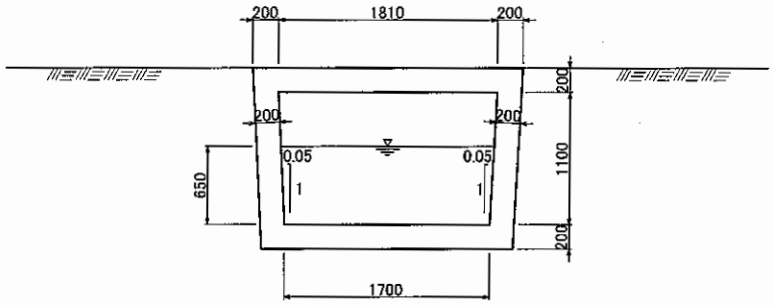


TYPICAL CROSS SECTION OF EXPANDED FLUME TYPE CANAL(TYPE E)

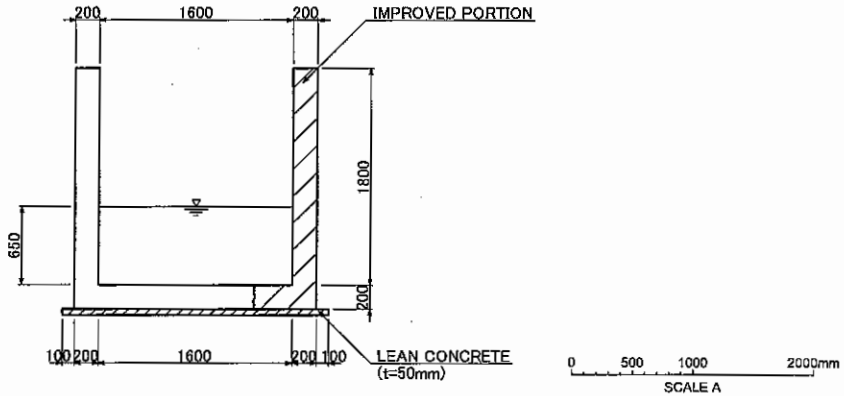


TYPICAL CROSS SECTION OF OPEN CANAL

TYPE	STATION	WIDTH OF CANAL INVERT B	WIDTH OF CANAL TOP W	HEIGHT OF SIDE WALL H	WATER DEPTH h
TYPE B	STA.0+070 ~ STA.0+340	2100	4340~4780	1120~1340	550
TYPE C	STA.0+345 ~ STA.0+404.5	5700	7720~8460	1150~1570	550
TYPE D	STA.0+419.5 ~ STA.0+657	2900	4900~5080	1000~1090	650
TYPE H	STA.0+814.3 ~ STA.0+838.5	1600	3400	900	550
TYPE I	STA.0+851 ~ STA.1+522	2100	3700~4500	800~1200	550

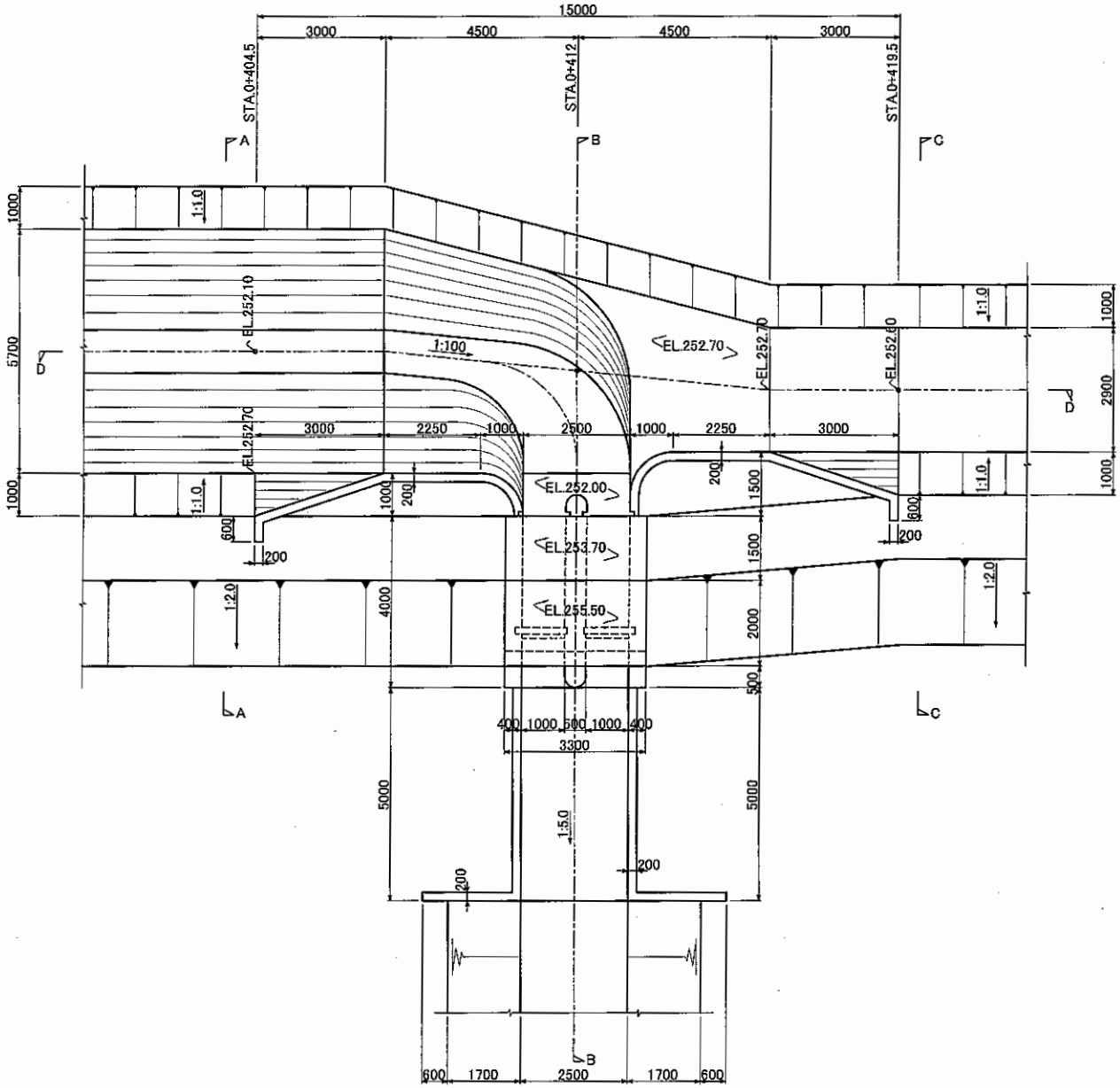


TYPICAL CROSS SECTION OF FLUME TYPE CANAL WITH COVER (TYPE F)

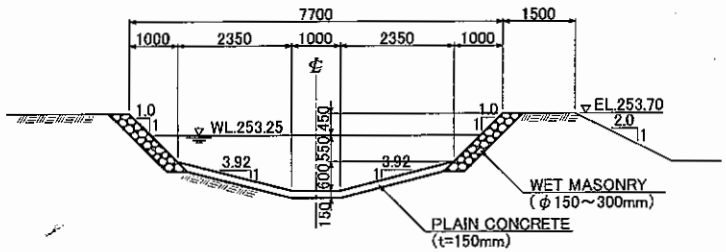


TYPICAL CROSS SECTION OF CONNECTIVE CANAL(TYPE G)

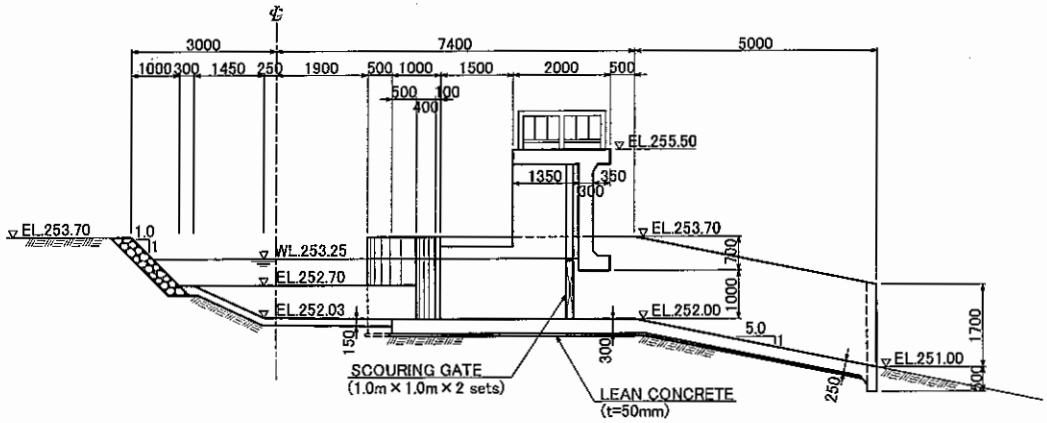
DWG-H : MAIN CANAL - TYPICAL CROSS SECTION



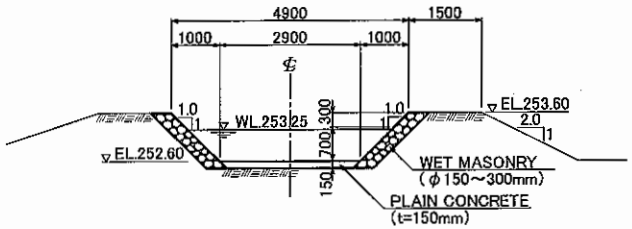
DWG-I : MAIN CANAL – PLAN OF SCOURING GATE



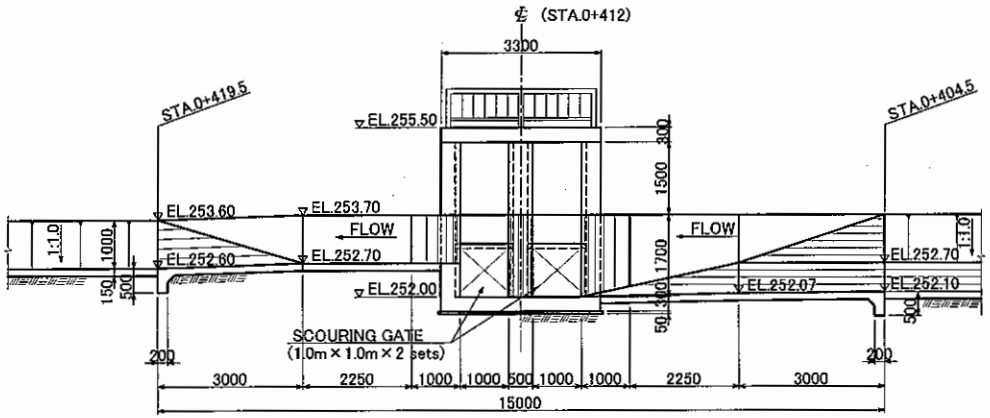
SECTION A-A



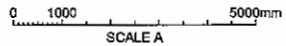
SECTION B-B



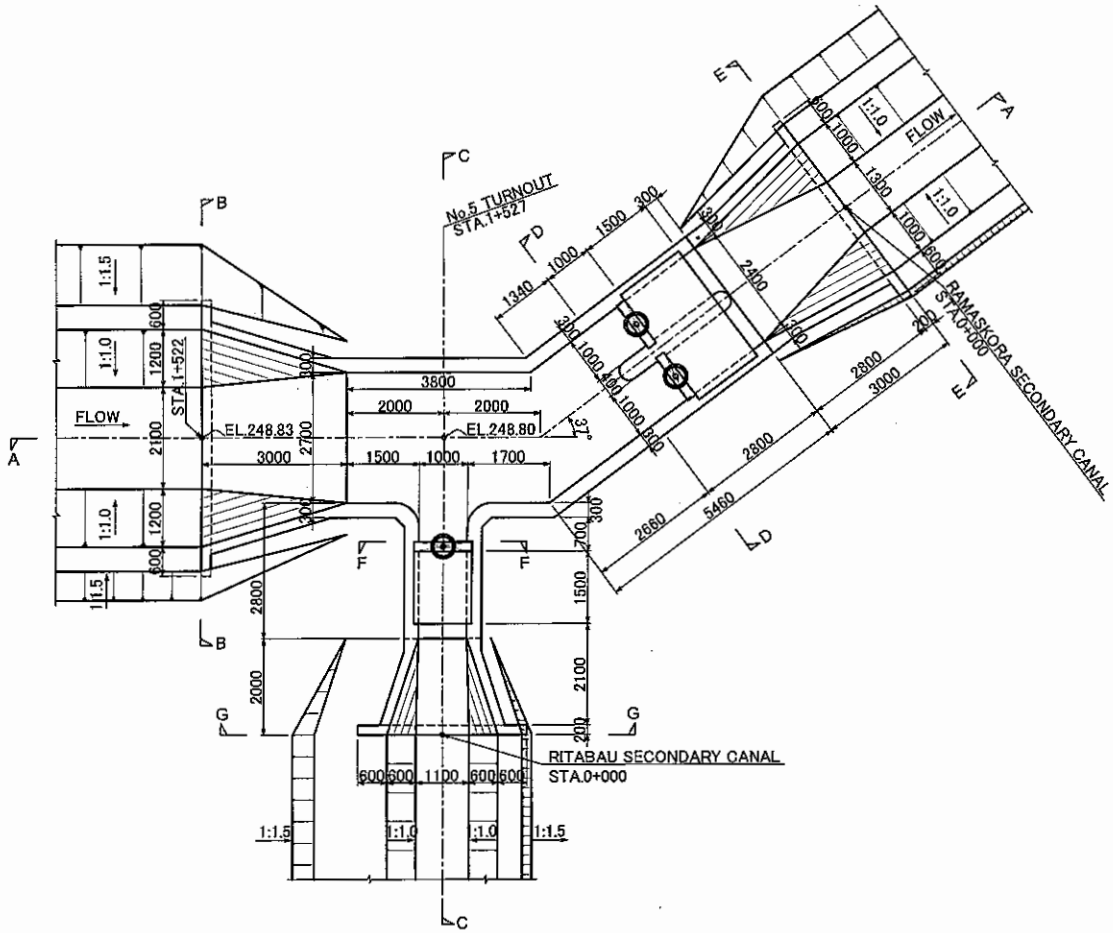
SECTION C-C



SECTION D-D

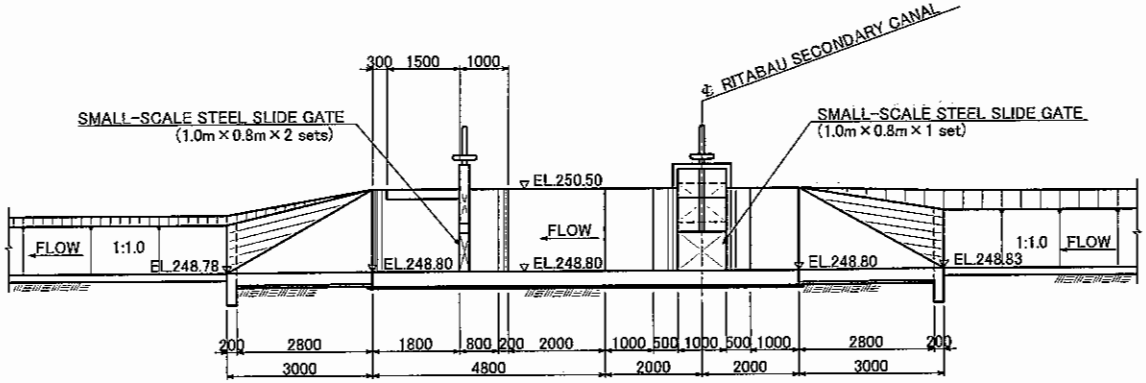


DWG-J : MAIN - STRUCTURAL SECTIONS OF CANAL SCOURING GATE

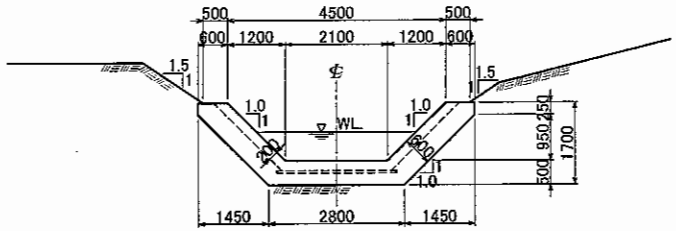


0 1000 5000mm
SCALE A

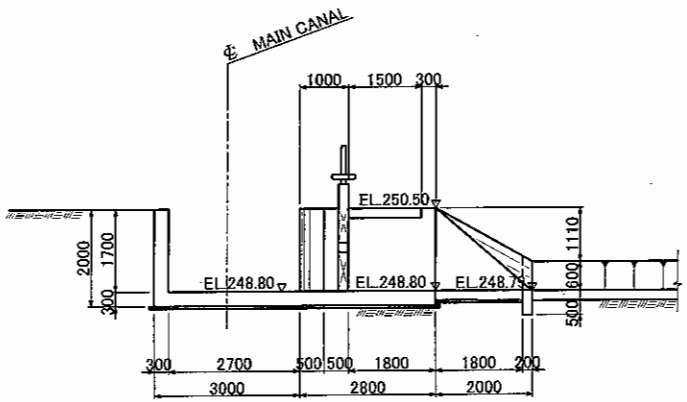
DWG-K : MAIN CANAL - PLAN OF TURNOUT



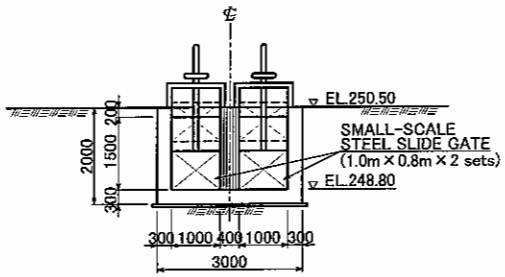
SECTION A-A



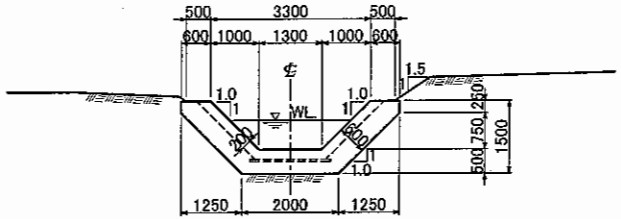
SECTION B-B



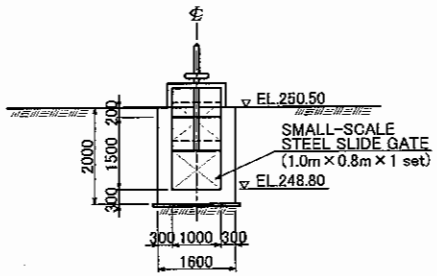
SECTION C-C



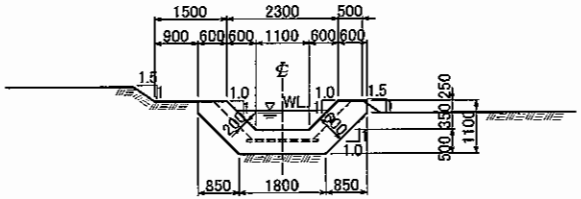
SECTION D-D



SECTION E-E



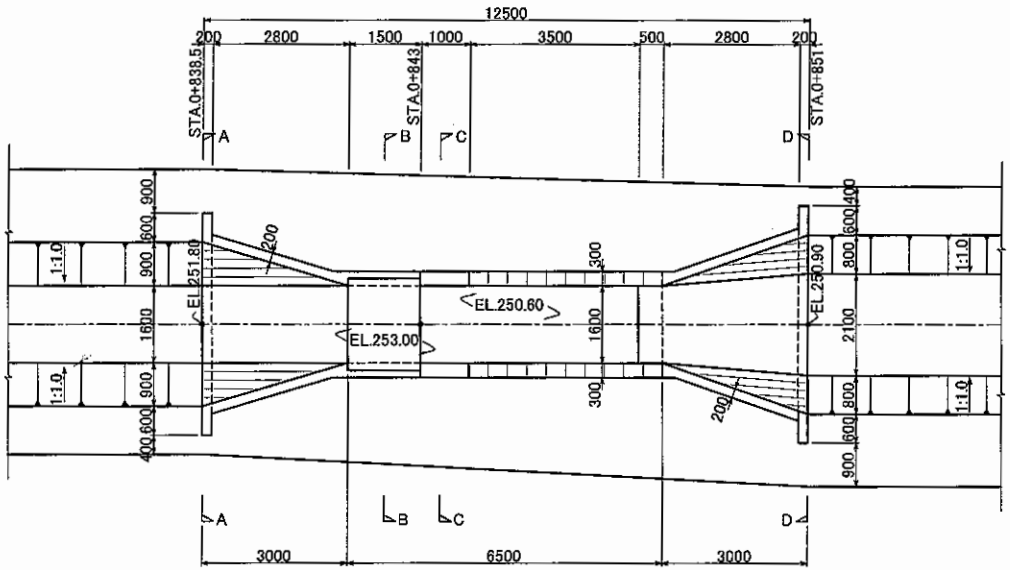
SECTION F-F



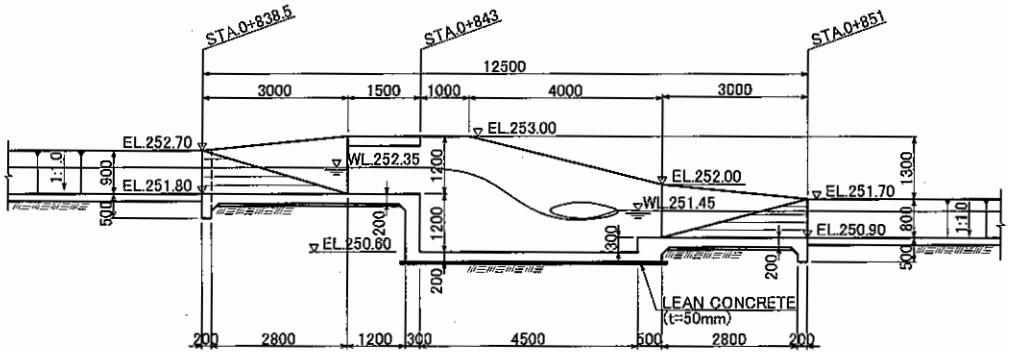
SECTION G-G

0 1000 5000mm
SCALE A

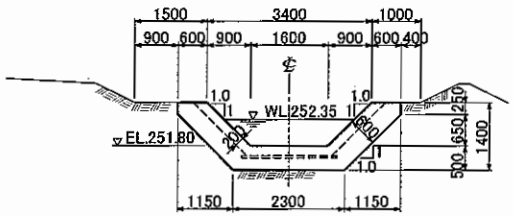
DWG-L : MAIN CANAL - STRUCTURAL SECTIONS OF TURNOUT



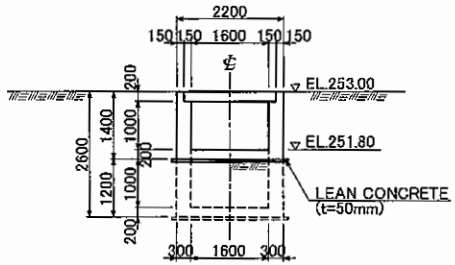
PLAN



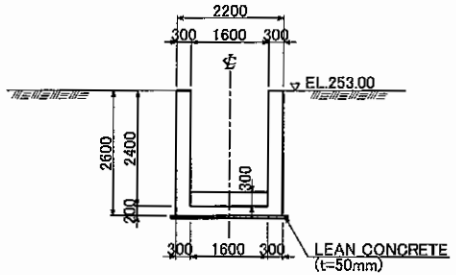
LONGITUDINAL PROFILE



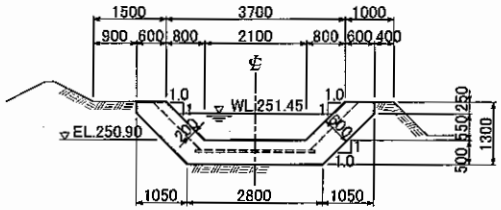
SECTION A-A



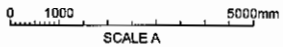
SECTION B-B



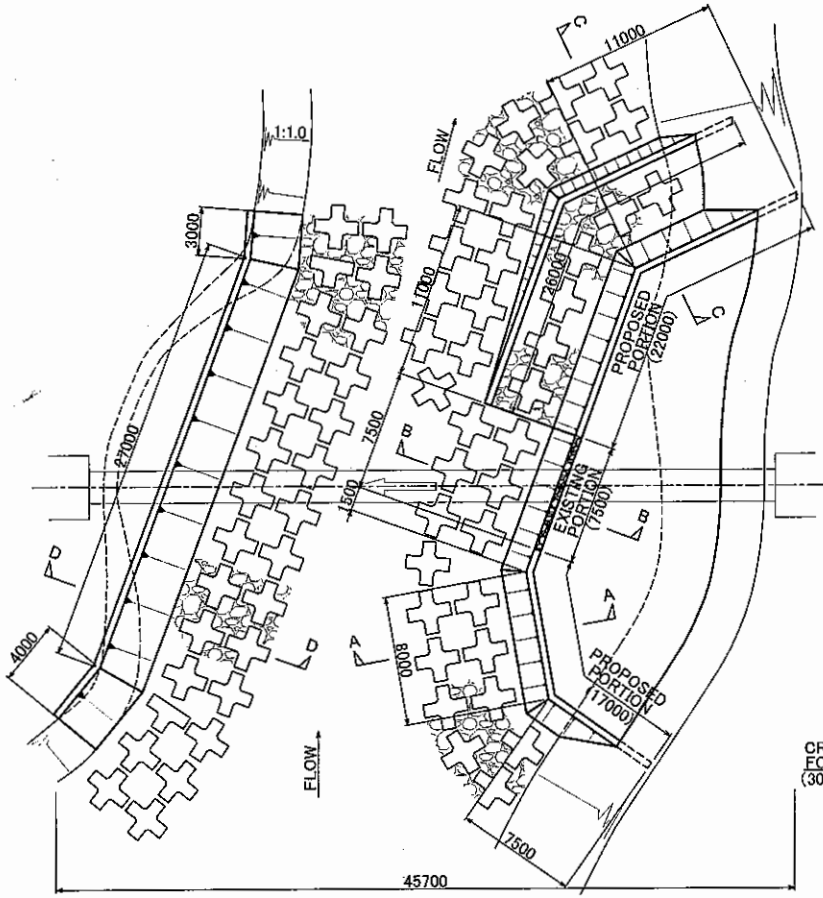
SECTION C-C



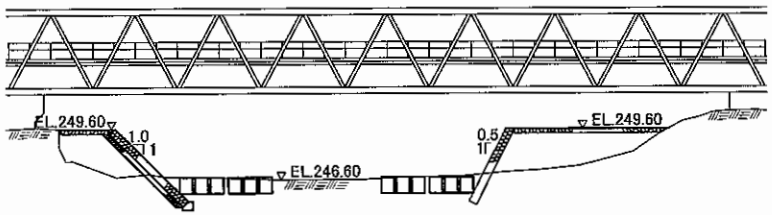
SECTION D-D



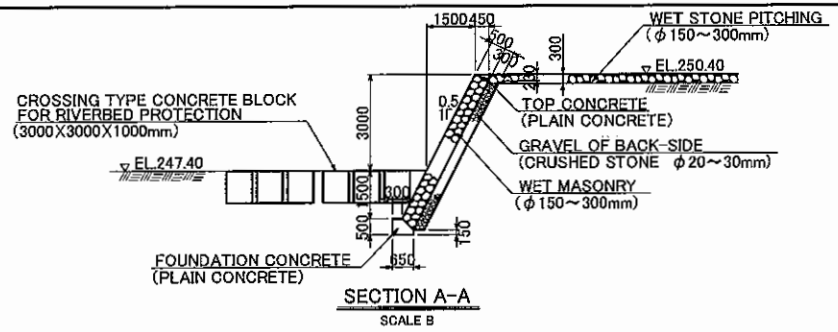
DWG-M : MAIN CANAL - STRUCTURAL SECTIONS OF DROP STRUCTURE



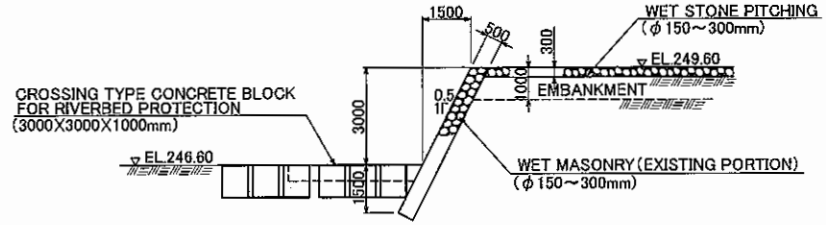
PLAN
SCALE A



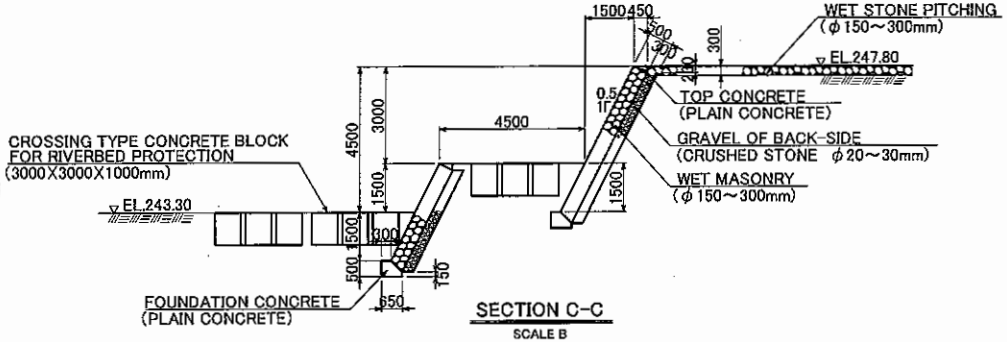
ELEVATION
SCALE A



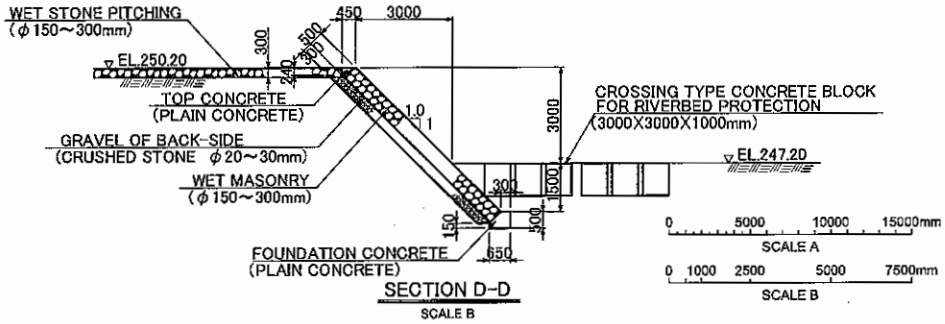
SECTION A-A
SCALE B



SECTION B-B
SCALE B

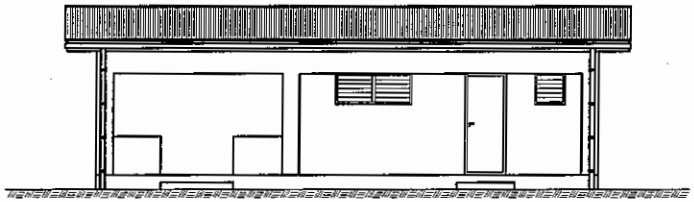


SECTION C-C
SCALE B

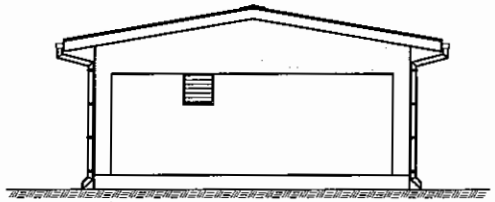


SECTION D-D
SCALE B

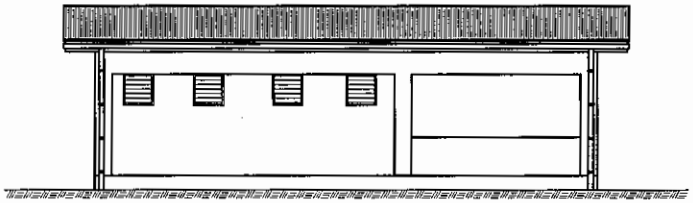
DWG-N : AQUEDUCT - STRUCTURAL SECTIONS OF WET MASONRY PROTECTION WALL



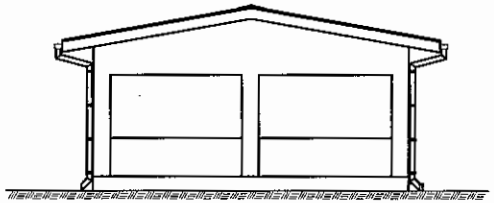
FRONT VIEW ELEVATION



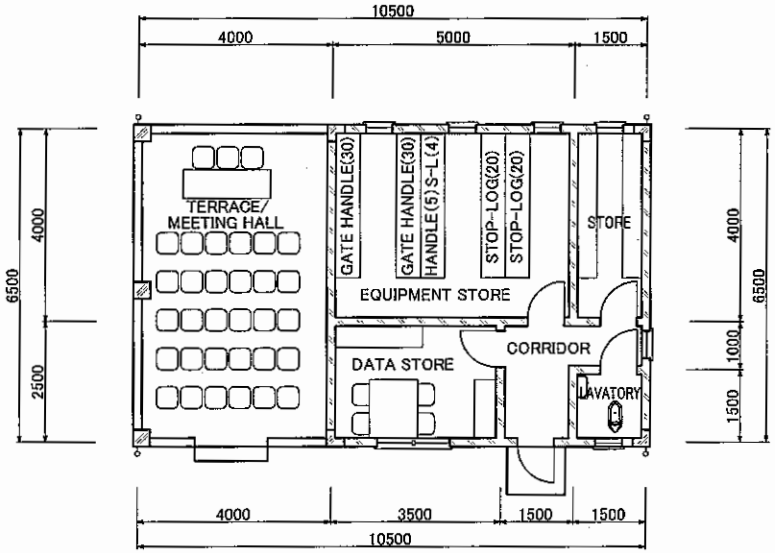
RIGHT SIDE VIEW ELEVATION



BACK VIEW ELEVATION



LEFT SIDE VIEW ELEVATION



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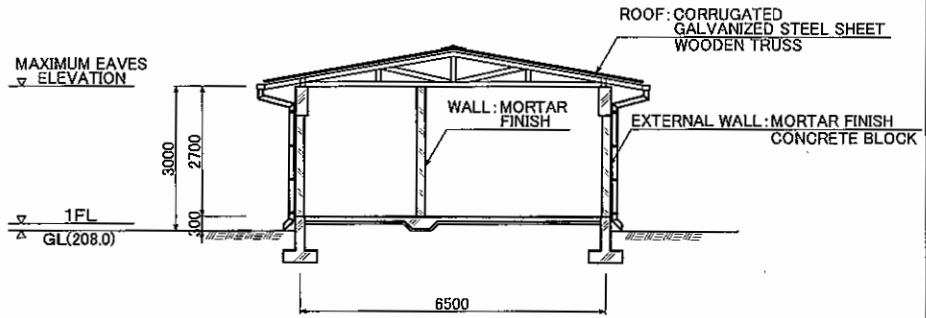

SECTION

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DWG-O : STORAGE FOR O/M EQUIPMENT - STRUCTURAL SECTIONS

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

The Project has objectives of rehabilitating irrigation facilities of Maliana I in Bobonaro district including intake and canals, as well of procuring and installing steel gates including scouring sluice of intake weir, intake gate, scouring gate of sediment settling basin, turnout gates and diversion at irrigation canals etc. MAFF is the responsible organization for project implementation, while Bobonaro District Agricultural Office takes charge of implementation at the site. Since the Project is an engineering constructing scheme, a lump sum and representative subcontract system shall be employed.

Construction equipment and materials such as construction machinery including steel gates shall be procured from Timor-Leste, Japan and a third country, Indonesia. Local constructors shall be employed in implementing civil works and gate installation, while Japanese engineers will be dispatched to take charge of schedule and quality control. Also, civil engineers, architectural engineers and those of machinery, electric facility and land survey will be dispatched from the third country.

2-2-4-2 Implementation Conditions

(1) Extraction of aggregate and stone materials for the Project

Prior to starting construction works, a permit from the government of Timor-Leste is required to extract gravel for concrete aggregate at riverbeds. The Ministry of Traffic and Common Public Works issues permission from the standpoint of flood control/river training and the Secretary of State for Environmental Coordination, Terrestrial Ordering and Physical Development (SSECTOPD), and Department of Forest and Water Resources of MAFF is in charge for the royalty of quarry. In addition, it needs to explain the gravel-extraction plan to nearby autonomous authorities and residents to ask for their consent to the plan.

(2) Compensation for standing trees and lands

The project needs to compensate for standing trees and lands for acquiring lands for temporary works and additional lands necessary for improvement design. Based on the basic design and detailed design studies, the Timor-Leste side must complete the necessary compensation and acquire necessary lands prior to construction works

(3) Interruption of supply for irrigation water and domestic water

In this project, due attention should be done to minimize disturbance of farming activities of Timor-Leste people in order to accomplish the project efficiently. However, the authority of Timor-Leste is required to coordinate all the stakeholders on the following matters; The supply of irrigation water is planned to terminate at the end of April. After the completion of construction works, water distribution is resumed from December. During the period from May to November water distribution for both irrigation and domestic use will completely be interrupted. It is therefore required for the authority to coordinate among all the stakeholders so that they can be prepared to do farming activities without water, and also they

can manage to secure domestic water from other sources during this interrupted period.

(4) Procurement control of such equipment / materials as steel gates

With regard to procurement of steel gates to be installed at intake facilities and irrigation canals, the parts of gates are imported from Japan and they are manufactured and assembled in such third countries as Indonesia. As the implementation of the Project is scheduled within a single dry season from May to October, procurement control is prerequisite so that construction machinery and equipment / materials can smoothly and properly be procured and delivered, taking particular importance on the installation of steel gates that affects the completion of construction works.

2-2-4-3 Scope of Works

(1) Demarcation of works

Table 2-47 shows the demarcation of works between Japan and Timor-Leste sides for the implementation of the Project.

Table 2-47 Demarcation of works for the Project implementation

Item	Japan side	Timor-Leste side
1) Construction of architectural facilities (Access roads, storage depot for equipment accommodation)	Site creation, access road construction, construction of storage depot for equipment accommodation, and gate keepers hut	To secure all lands required, including standing trees and land compensation. To provide furniture and appliances for architectural facilities
2) Improvement of irrigation infrastructure	Construction of irrigation infrastructure	ditto
3) Widening canals	Widening and improvement of canals	ditto
4) Maintenance roads built along with canals	Construction of maintenance roads	ditto
5) Construction work of the aqueduct-bridge bank protection	Construction of bank protection structures, construction & removal of temporary work yards and access roads	ditto
6) Temporary works (material depot, temporary building, temporary road, diversion canal)	Embankment, shaping and rehabilitation of lands required for temporary works. Construction and removal of material depot, temporary building, temporary road, diversion canal.	To secure all lands required (private lands, nationally-owned land) including standing trees and land compensation.
7) Temporary roads and work sites for canal improvement (along with both sides of canal)	Construction and rehabilitation of temporary roads and work sites	ditto
8) Gates, fences	Construction of gates and fences of architectural facilities	-
9) Proposed portion of tertiary canals	Basic plan and design	Construction of the proposed portion of tertiary canals
10) Irrigation water	-	During the interruption period of irrigation water delivery from the beginning of May to the end of November, take an alternative water delivery measures if /when necessary.
11) Water supply	Construction and removal of temporary water intake facilities (the water is construction purpose, and river water or groundwater is used.) Water supply system in architectural facilities	To take alternative measures to water cut-off due to construction work. Construction of water supply system to architectural facilities from outside water sources.
12) Electric supply	Installation and removal of construction-purpose private electric power generators. Electrical works in architectural facilities.	Electrical works to architectural facilities from an outside source.
13) Communication facilities / equipment	Installation and removal construction-purpose temporary communication facilities / equipment.	Installation of communication equipment in architectural facilities and communication lines to O&M facilities from outside
14) Sewerage systems	Sewerage systems in architectural facilities	Sewerage systems around architectural facilities and connection to public sewage systems
15) Bank account Opening and payment charge	-	AP advice charge. Payment charge
16) Import custom clearance of products	Air or sea transportation cost from Japan / the third country to an airport or seaport of Timor-Leste, and transport cost from the port of discharging to the project site.	Procedures of duty exemption at the port of discharging for products imported, and assistance for import custom clearance.
17) Duty and tax imposed on products and services	-	To exempt Japanese from duty and tax imposed on products and services
18) Proper use and O&M of facilities improved	-	Proper use and O&M of facilities improved by this grant aid.
19) Soft components plan	Dispatch of experts of gate operation for water control, and provision of materials and equipment necessary for instruction.	Establishment and management of WUAs, IWMD WUA advisors, people in charge of WUAs, DIO staff, gate keepers (2), cadres of WUA (4) and other applicants

(2) Procurement plan of materials and equipment

The demarcation of procurement is shown in Table 2-48.

Table 2-48 Demarcation of procurement

Item	Demarcation			Basis of demarcation	Remarks
	Timor -Leste	Japan	Third country		
1. Materials for construction					
1) Reinforcing bars*	○			Cost & quality	Made in Indonesia
2) Cement	○			Cost & quality	Made in Indonesia
3) Fine aggregate &coarse aggregate	○			Cost & quality	
4) Admixture		○		Cost & quality	
5) Stone	○			Cost & quality	
6) Wood / timbers	○			Cost & quality	
7) Plywood	○			Cost & quality	Made in Indonesia
8) Steel scaffold & scaffold board		○		Small quantity	
9) Materials for form		○		Small quantity	
10)	○			Cost & quality	
11) Brick	○			Cost & quality	
12) Steel handrail		○		Cost & quality	
13) Water stop & joint filler		○		Small quantity	
14) Tile & wooden door	○			Cost & quality	
15) Materials for interior works	○			Cost & quality	
16) Waterproof material of roof	○			Cost & quality	
17) Electric cables & pipes for water supply	○			Cost & quality	
18) Gasoline, diesel oil	○			Cost & quality	
19) Steel gates (headworks, scouring sluice)			○	Cost & quality	Parts made in Japan, assembled in Indonesia.
20) Steel gates (turnouts, diversion facilities)			○	Cost & quality	
2. Construction machinery					
1) Heavy machinery for excavation and loading	○			Short-term use	Rented at/near the construction site
2) Trucks / dump trucks	○			Short-term use	
3) Passenger vehicles & 4x4 vehicles	○			Short-term use	
4) Cranes, etc	○			Short-term use	
5) Compactors and rollers (embankment / pavement)	○			Short-term use	
6) Concrete plant	○			Short-term use	Rented at/near the construction site, 15m^3/h
7) Concrete mixer truck	○			Short-term use	Rented at/near the construction site
8) Concrete vibrator	○			Short-term use	
9) Concrete breaker	○			Short-term use	
10) Water pump		○		Unprocurable in Timor-Leste	
11) Generator (45 to 150 KVA)		○		Unprocurable in Timor-Leste	
12) Generator (2 or 5 KVA)		○		Unprocurable in Timor-Leste	
13) Reinforcing bar cutters and benders	○			Short-term use	Rented at/near the construction site

Remarks) *The quality standards of procurable Indonesia-made reinforcing bars are ASTM40[300] and ASTM60[420], which are equivalent to SD295 and SD390 of Japanese standards.

2-2-4-4 Consultant Supervision

(1) Terms of references of consultants, personnel plan

① Personnel plan for design and construction control

The Terms of References of consultants in the stage of implementation design are given as follows: The planned personnel consists of 8 staff including a chief engineer who summarizes overall multi-disciplinary designs, three(3) engineers in charge of hydraulic structures / detailed design (D/D), an engineer in charge of machinery maintenance, an architectural engineer, an engineer in charge of estimation and procurements, an engineer in charge of tender documents and a cartographer in charge of detailed drawings.

1) Site survey required for D/D and detailed design,
2) Review and revision of estimates performed in the Basic design, and
3) Provision of detailed drawings and tender documents, etc.

② Construction control

The services by consultants in construction control include the below-listed items. In this supervising system, a construction controller is responsible for overall supervision, and he appoints a permanent controller in charge of the overall construction management throughout the implementing period. Besides, he also appoints those who supervise on particular spots, an engineer for machinery installation who inspects installation and adjustment tests of gates and an inspector who witness the completion inspection at the completion of the construction works. These 4 engineers are dispatched from Japan. In addition, as supporting personnel to the above-mentioned consultants, it is planned to dispatch 2 assistant engineers from the third countries.

1) Deputized actions for bidding procedures, witness to bidding evaluation and contract negotiations, consultations with the implementer,
2) Approval of implementation drawings and provision of standard specifications of gates,
3) Management of schedule, quality and safety during construction works,
4) Inspection of installation of steel gates, and
5) Inspections of completed work items, on the completion of contracted works, on defects warranting etc.

(2) Plan and system of construction supervision

The construction work is designed to accomplish planned improvement of existing irrigation infrastructure within a single dry period, by fully mobilizing construction machinery, materials and equipment. Installation of steel gates procured from outside Timor-Leste is critical and implemented under careful supervision, work progress control and quality control.

In this connection, the project establishes a site management office and a dormitory in Maliana town or

near the site to administer the overall rehabilitation works, procuring the existing private house on a rental basis in order to smoothly establish an implementation system for a short-period completion. Also, the project has a liaison office functioning liaison and coordination between each of rehabilitation sites and the parties concerned in Dili including related government offices of Timor-Leste, responsible offices of implementation, permanent representative office of JICA in Timor-Leste and Embassy of Japan, as well for procurement of equipment and materials in Dili.

(3) Plan of security control

The Bobonaro district area where Maliana town lies is adjacent to Indonesia, and the area between highway and the international border to Indonesia is forbidden to enter in the vicinity of Bolobo town. The public security is good and stable because UN Peace Keeping Forces (PKF) has been stationed in the north of Maliana town and UN and Timor-Leste police forces are deployed in the town. Cell phones will be prepared to secure the emergency communication means. As a route for retreating, a national highway is available, going to southward to reach Suai town, or to northward to reach the capital, Dili city. As for medical care, there is a hospital with four English-speaking doctors (Timor-Lesteese and Russian) for medical treatment for non-serious diseases or injury. In the case of serious sickness, it can be treated in a hospital in Dili city or the patients can be sent by air to Darwin, Australia, or Singapore for cutting-edge medical treatment.

2-2-4-5 Procurement Plan

Considering the significance of quality and durability, manufacturers in the third countries will design steel gates based on the basic design provided by the consultant, will procure parts of steel gates from Japan and assemble them. Likewise, such equipment and materials that would be difficult to procure in Timor-Leste or in the third countries as shape steel, scaffold materials and water stop will be procured in Japan. As to the procurement of construction machinery, those that are available in Timor-Leste on rental basis such as transport, carriage vehicles, cranes and concrete agitator trucks will be procured in Timor-Leste except for time-consuming machinery for procurement such as submersible pumps and generators.

2-2-4-6 Quality Control Plan

Quality control of construction materials such as concrete shall be performed in a laboratory built in near the construction site, where hired local or third-country civil engineers plus local staff are stationed for conducting tests. Local or third-country civil engineers in charge of construction works are stationed in each site for checking product quality and dimensions, while Japanese engineers in charge of overall work progress and quality control are staffed to each engineering block as shown in Table 2-49.

Table 2-49 Contents of quality control

Type of work	Item	Methodology
1. Cutting and filling	Slope gradient, degree of compaction	Naked eye inspection, measurement of size, height etc., tests on particle size distribution, site consolidation
2. Concrete	Materials (stones and aggregates)	Particle size tests, measurement of specific gravity
	Cement	Inspection on quality guaranteeing documents
	Concrete filling	Slump, air content, water / cement ratio
	Strength of concrete	Methods of curing, compression strength test, crack
3. Works with form	Location of installing forms	Location of fixing, location identification method
4. Reinforcing works	Strength of reinforcing bar, distribution	Stretching strength, inspection on distribution of bars
5. Wet masonry	Stone materials, mortar	Size of quarry materials, mixing proportion of sand/ cement
6. Installing steel-gates	Accuracy of installation, functions	Measurement of installed position, operational tests
7. Finished structures	Size of completed structures	Measurement of completed structure's size, photographing
8. Environment	Environment management plan (EMP)	Check on the observance of EMP

2-2-4-7 Operation Guidance Plan

While all gates of scouring sluice, intake, scoring gate for sediment settling basin, etc. at headworks and diversion gates of canals are manual, operation of them is simple, so that engineers from Japanese contractor shall guide how to use them through on-the-job-training (OJT) when rehabilitated facilities are handed over to WUA. Further, a water management expert through the soft component plan will instruct the linked adjustment of intake volume by operating scouring sluice and intake gate s to MAFF staff and WUA.

2-2-4-8 Soft Component Plan

(1) Background of Soft component planning and issues to be solved

① Strengthening of Water Users Associations (WUA)

Maliana I WUA was established in March 2006 in line with "Policy for WUA and O/M of irrigation facilities (draft)" and MAFF intends to transfer all the maintenance, management of irrigation facilities thereto from the 11th year after the rehabilitation. It follows that necessity arises for WUA to cover its O/M cost by collecting itself water user's fee. This is the reason why strengthening of managerial capacity of WUA should be urged.

WB has been conducting APR 3 since 2004, as a component of APR with a view of creating a system and nurturing human resources for strengthening WUA. In this connection, the proposed process of organizing and strengthening WUA is shown in Figure 2-12.

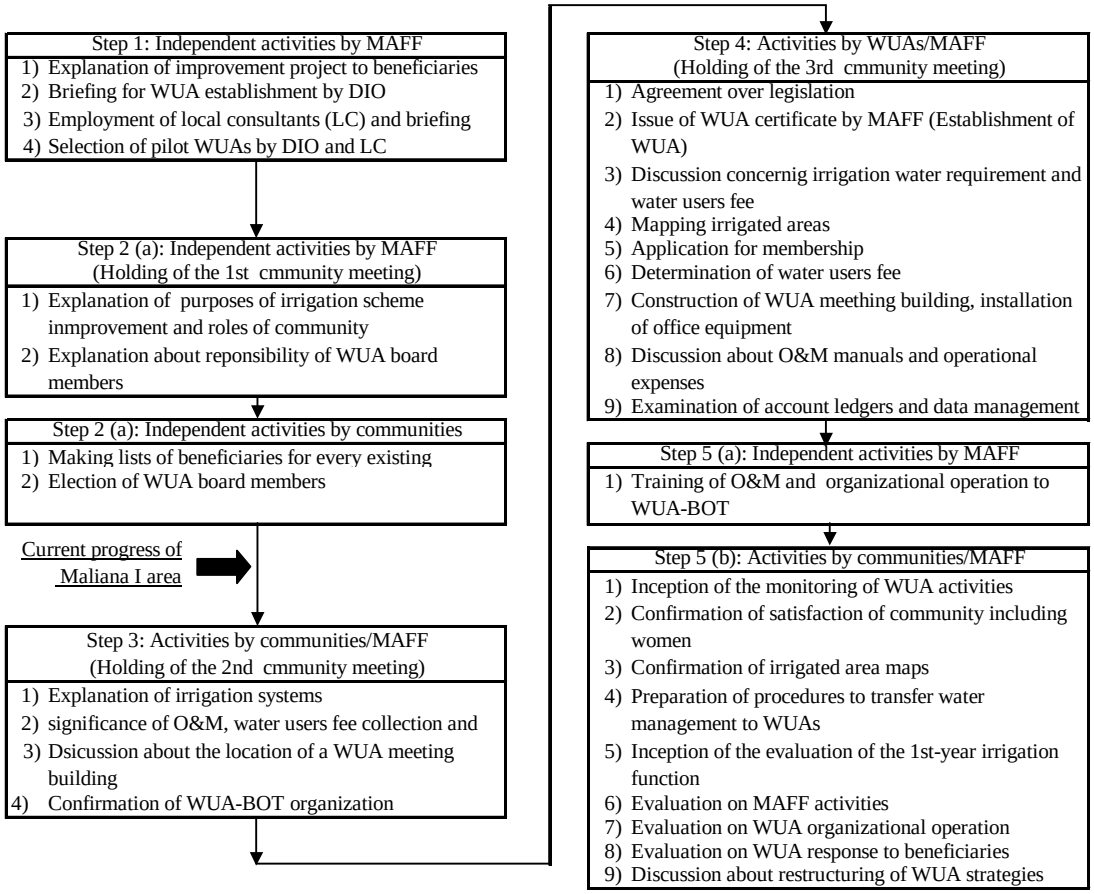

Figure 2-12 Process of establishments and strengthening of WUA proposed by WB (ARP3)

MAFF also intends to establishes and strengthens WUA through this process in which progress has currently been made at the completing stage of the Step 2 (as of March 2006).

② Lessons learned from the emergency rehabilitation project of the Laclo Irrigation System

The emergency rehabilitation project of the Laclo irrigation system, implemented by UNOPS funded by Japan, started in November 2000, before the independence of Timor-Leste and ended in December 2003. The Project organized WUAs, strengthened the management capability and implemented trainings for gate operation by a WUA organization expert and an O/M expert.

However, it is pointed out that proper water management has not been executed because of 1) lack of consensus with beneficiaries attributable to prior incomplete prior explanation on the significance of establishing WUA, details of facilities, method of managing account and that operative function of gates has not been sufficient due to 2) insufficient practical training after the rehabilitation works, leading to failure of relevant water management.

(2) Necessity of Soft component plan

① Necessity of enlightenment activities on O/M of the facilities

Feeble concept of organizing WUA and poor awareness of own initiative to manage intake facility and

O/M of the facilities among beneficiaries despite the completion of renovative works of irrigation facilities is considered stemming from the fact that most of the O/M cost had been borne by the government in Indonesian age. Hence, it's essential to explain and enlighten newly established WUA the function of rehabilitated irrigation facilities, principles of O/M, significance of managing WUA and benefits from the project, thus creating consensus at the earlier stage among the beneficiary people on the method of collecting (water user's) irrigation fee, the charged amount, system of managing organization and by-laws of WUA.

② Maintenance of facilities newly constructed and procured

1) The purposes of introducing new scouring sluice gate, intake gate are a) to remove the sediments in front of intake effectively, b) to reduce sediment inflow into sediment settling basin, c) to prevent sedimentation by excessive intake, d) to control the sedimentation inflow at flood (flood control). One of the objectives of constructing the gate is to mitigate the burden of the O/M of WUA. This is the reason why sufficient assistance for adequate instruction on gate operation for headworks and scouring sluice shall be required
2) Existing gates for sediment settling basin and for turnout to be refit have not been operational due to past inadequate maintenance, likely caused by lack of knowledge and information about O/M. Therefore, it is indispensable to instruct how to operate and manage each facility after rehabilitation.
3) In order to assure the effective water distribution of a limited amount of Bulobo River water to the command of beneficiaries, it is necessary to instruct proper water management conformed to planned irrigation rotation, which is going to be planned from now on, using new slide gates installed along main and secondary canals.

(3) Goal of Soft component

MAFF decided to reduce the disbursement of the subsidy to WUA to 30% of the required amount for O/M from the 6th year of facility management. In this regard, it is indispensable to verify the adequacy of the amount of water fee collected in the past and that of subsidy by MAFF by evaluating the state of activities of WUA after its establishment and of O/M performances. If the new water fee's collection system begins to be applied from the 6th year, it may be necessary to agree with WUA on this application within the 5th year. It follows that evaluation for the previous 3 years must be carried out in the 4th year. By this reason, the target year is set at the 3rd year to attain the goal of soft component in compliance with the evaluation period described above. The contents of the goal to be fulfilled during three years after the completion of this Grant Aid scheme are as follows;

a) By soundly strengthened WUA b) by means of sustained collection of water fee and properly manage and maintain the irrigation facilities, c) efficient water intake / management is implemented.

Besides, understanding on WUA's organizational management and water management as well as capacity of instructing WUA will be improved provided that the contents of the activities are explained to the implementing organizations (MAFF, IWMD and Bobonaro agricultural office) during the process of

technically assisting for soft component plan and instruction towards beneficiary people can be conducted through the leading role of the government implementing organizations.

(4) Contents and scale of the activities in Soft component

① Soft component activities (Input contents)

The activities required for achieving the effects (direct effects) of the soft component is planned in Table 2-50.

Table 2-50 Effects and activities of the Soft component

Effect of the soft component (Direct effect)	Contents of required activities
(1) Disciplinary in terms of organizational management	
① Necessity of proper use and O/M of irrigation facilities is recognized and accepted	1) Interviewing on current state of existing organizations with workshops to elucidate methods of O/M, water management, problems of water rotation and social conditions, 2) Definition and responsibility of WUA, significance of organizational management are explained to the beneficiaries through orientation and 3) WUA manual (draft) is provided.
② Affordable amount of water (user's) fee and method of collection are established	1) An inquiry survey on the necessary amount of water fee to be collected is conducted, 2) Managing organization is grouped for tertiary canal construction, 3) PCM workshop for discussing method of collection and amount of water fee is held and 4) Workshop for instructing financial balance, data management and method of accounting.
(2) Disciplinary in terms of water management	
① Gates installed at sediment scouring sluice, water intake, sediment settling basin and canal intake turnouts are properly operated in a linkage	1) Study tour is organized to visit Laclo irrigation scheme (4 WUA board members, 2 gate operators and other volunteers are assumed), 2) Operational field training on water management is conducted.
② Irrigation water is distributed to tertiary canals	1) Maps covering the entire irrigation perimeter and command under tertiary canals are drawn, 2) Problems on cropping and water rotation are extracted through workshop and water distribution plan is formulated, 3) Operational field training on water management is conducted.
③ Pragmatic water management manual available to WUA members is provided	1) Water management manual (draft) is provided, 2) Utilizing the manual (draft), adding revision by extracting problems on the said manual (draft) through the outcome of field training to complete water management manual.

Also, the process from the establishment to monitoring of WUAs is composed with the following steps.

A. Preparation and basic agreement for WUA establishment (done),
B. Setting working groups (WG) for WUA establishment (done),
C. Election of WUA board members (done in March 2006),
D. Enlightenment to strengthen organizational management and of necessity of O/M (at D/D),
E. Establishment of WUAs, completion of WUA bylaw manuals (at the beginning of rehabilitation works),
F. Water management, understanding operation of gates and facilities, strengthening organization, developing ownership (during rehabilitation works),
G. Field training (immediately after rehabilitation works), and
H. Collection of water (user's) fee, monitoring, organizational improvement step of WUAs, according to the World Bank program.

The soft component plan of this project intends to include D (partly), F and G of the above steps. In this connection, a water management expert (Japanese consultant) for 2.3 MM and an organizational management expert (Local resource) for 2.0 MM, in total 4.3 MM are planned for the input.

② Implementation schedule and input plan

The following figure shows implementation schedule and input plan. Soft component activities are planned at three stages after completing the election of board members of WUA (March 2006, already completed), namely, 1) at detailed design (D/D), 2) at the completion of O/M facilities and 3) when farmers begin irrigation immediately after the completion of improvement of the Maliana I irrigation system. The planned amount of inputs from Japan and Timor-Leste are 4.3 MM and 108.5 M/M, respectively.

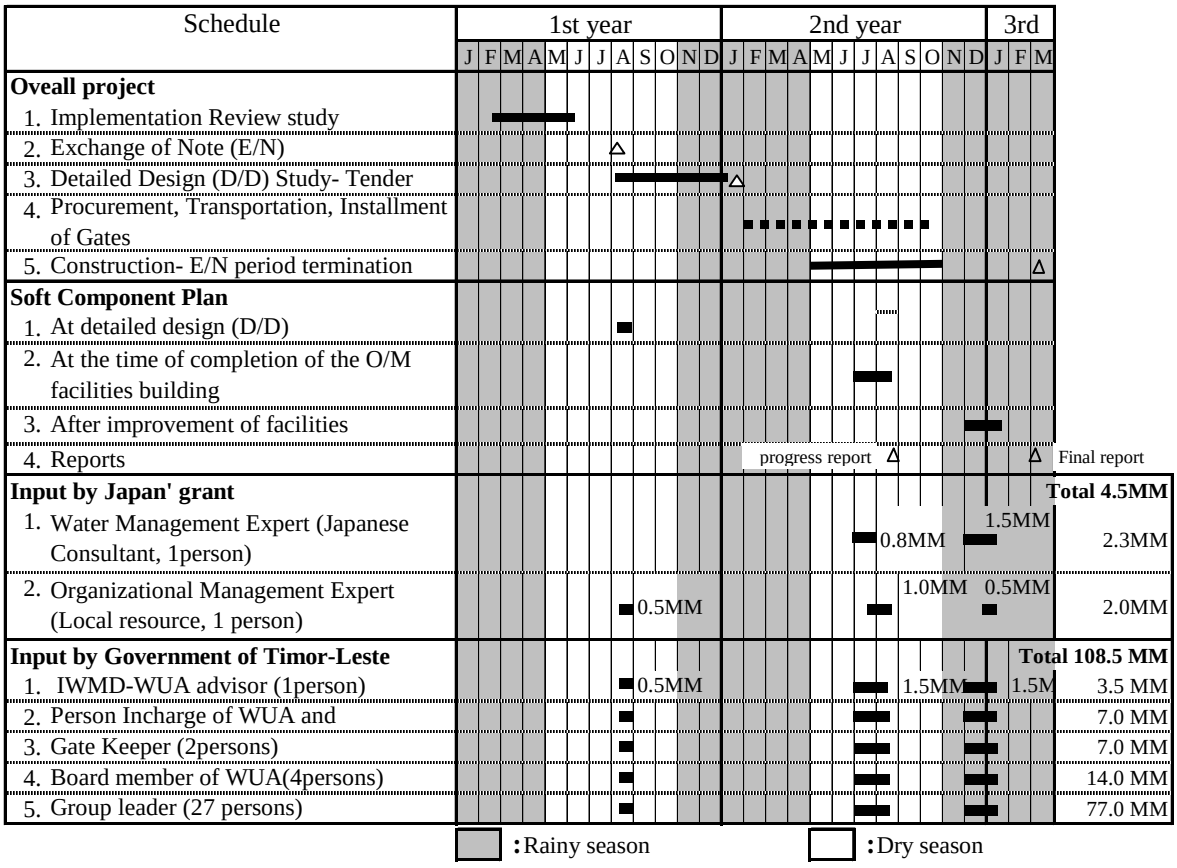

Figure 2-13 Implementation schedule and input plan of Soft component

③ Implementation system and target beneficiary of Soft component

Assumed implementation arrangement and target beneficiary are shown in Figure 2-14. MAFF and IWMD are leading implementation organization and Japanese consultant (one person) and NGO (one person) shall support the implementation of the project. Direct target beneficiary shall be board members of WUA; president of WUA, vice-president (1 person), treasurer (1 person), secretary (1 person), gate keeper (2 persons), group leader of Ramaskora secondary canal (16 persons), Ritabau secondary canal (11 persons), 33 persons totally.

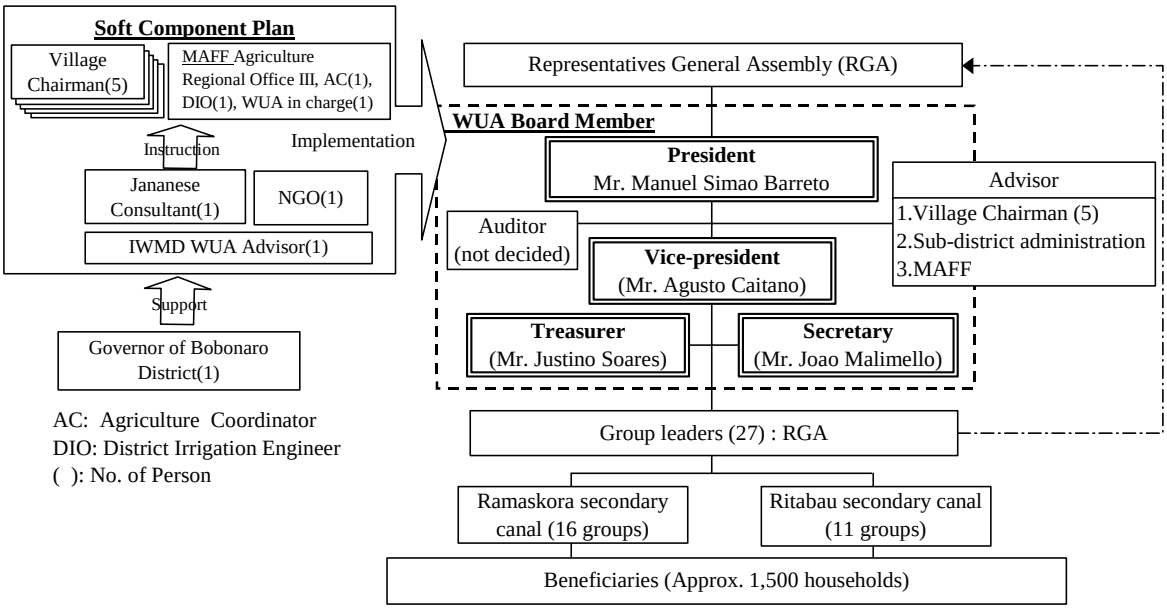

Figure 2-14 Implementation structure of Soft component

2-2-4-9 Implementation Schedule

Major construction work involving headworks in the Bulobo River and canals is scheduled to implement during dry season ranging May to November to stop irrigation water, during which construction resources will concentrated so that efficient rehabilitation of the intake weir and canal structures can be completed (see next page 2-90, Figure 2-15 Project implementation schedule).

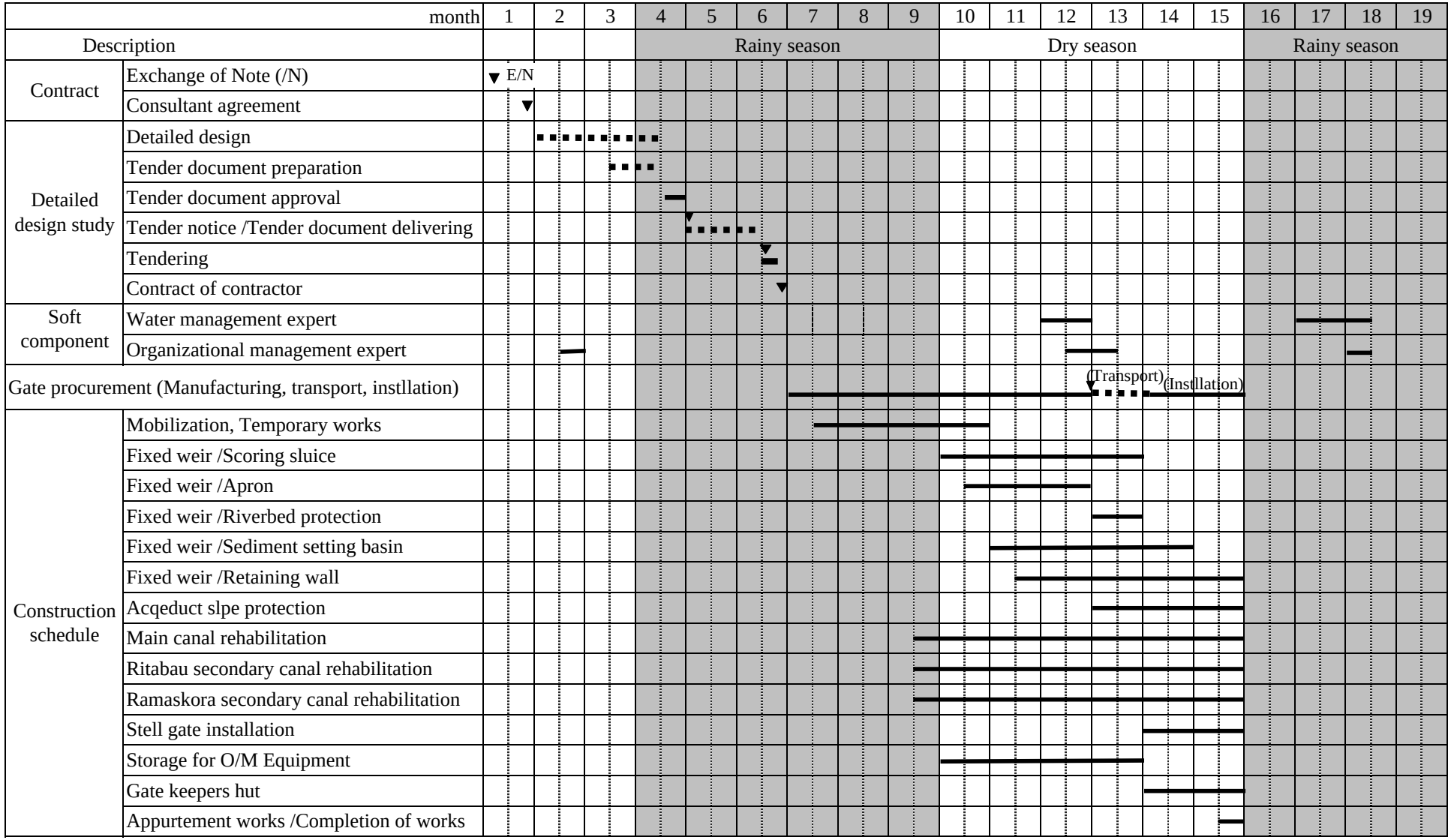

Figure 2-15 Project implementation schedule

2-3 Obligations of the Government of Timor-Leste

(1) Land acquisition and compensation for the Project

As the land acquisition should be promoted with the prior decision on the clearance of the procedure by Timor-Leste before the implementation of this project, the following procedure shall be asked through MAFF for land acquisition to be taken by implementing agency.

1) To establish a coordinated organization consisting of the representatives from beneficiary farmers in the area concerned, MAFF, agencies related to the land acquisition / expropriation and regional agencies concerned (district and sub-district).
2) To confirm the pursuance of the basic agreement between the implementating agency and the representatives of residents obtained during the Basic Design Study, then to secure the land acquisition with the final confirmation by individual agreement to be valid between the implementation agency and the individual land users/owners during the Detailed Design Study.
3) As for the expense for land acquisition (by compensation), it will be planned to clearly design and define the borders of acquired areas and sizes and to clarify the incidence of compensation on land acquisition maps (location, area, etc) on the completion of Detailed design study in order to facilitate compensation measures for the losses / damages of lands and crops.

Moreover, it will be requested that Timor-Leste should pay attention to the following in acquiring land for the works of the Project;

1) In case of felling trees and deforestation, compensation should be done for losses incurred, including the cost for planting /tending incurred so far and expected future profits.
2) As for the road expantion, the design like alternative sectional shape of road should be considered in order not to affect the residential areas. In case of construction of the work yards such as temporary road facilities, etc. on the land other than public property, a necessary rent must be appropriated.

For costs borne by the Government of Timor-Leste on land acquisition for project implementation, the following forms of expenses for compensation are anticipated.

1) Compensation for the land acquisition and the felling of existing trees for widening of irrigation canals,
2) Fees for land rental for temporary work yard of temporary canal works for intake weir and temporary roads,
3) Fees for land rental for temporary work yard of protection wall works for aqueduct and temporary roads,
4) Costs of land compensation concerning the lands for constructing architectural facilities including storage depot for accommodating equipment, gatekeeper's hut and access roads and
5) Construction costs for newly introduced tertiary canals (actual expense does not occur because real works are covered by contributed labor by the beneficiary volunteers) etc.

(2) Considerations for land acquisition

According to the information from local authorities and communities around the site as well as the examples from other implemented projects, the following issues should be considered for land acquisition:

1) Though the basic agreements of the land use have been obtained at the workshops held during the field survey for Basic design study, it is essential that the Government of Timor-Leste should confirm the details of land use and compensation, and complete the procedures to be cleared before the project implementation, according to the designed plan on compensation for possible losses of agricultural crops and deforestation,
2) Offices responsible for the Project hsould enlighten the beneficiaries in the site by telling them that the Project would bring the direct benefits to them, and to smoothly discuss so that they can enter into the agreements, transfer of the land acquired/expropriated and compensating the losses of beneficiary residents, representatives, land-users /owners in the sites in cooperation with the central government agencies and rural authorities.
3) They should make efforts to increase the employment opportunities within the beneficiaries and in realizing land acquisition in a smoother way.

(3) Permission for the collection of river stone materials

In order to obtain the permission of collecting river stone materials and royalty exemption, the implementating agency should clear the following procedures, referring to the procedures of the past and on-going irrigation projects.

1) To obtain the permission from concerning agencies for collection of river stone materials,
2) To obtain the permission from the Ministry of Traffic and Common Public Works (MTCPW) on the aspect of river training/protection,
3) To obtain the permission from the Department in charge of Environmental Assessment of Public Development (SSECTOPD) with regard to environment,
4) To obtain the right of quarry works from of Forestry and Water Resources Department of MAFF, and
5) To explain the project details to the municipalities and communities in and around the site, and to obtain their consents.

2-4 Project Operation Plan

2-4-1 Operation and Maintenance System and Staffing

In the Project, MAFF plans to provide subsidies to the operation and maintenance as per the "Policy for WUA and O/M of irrigation facilities (draft)". However, actual operation and maintenance of irrigation facilities will be handed over to WUA to be organized. In this transfer, MAFF provides training and monitoring on fortification of managing WUA and O/M of the transferred facilities through MAFF

Agricultural Regional Office III. The assumed O/M system and staffing is presented in Figure 2-16.

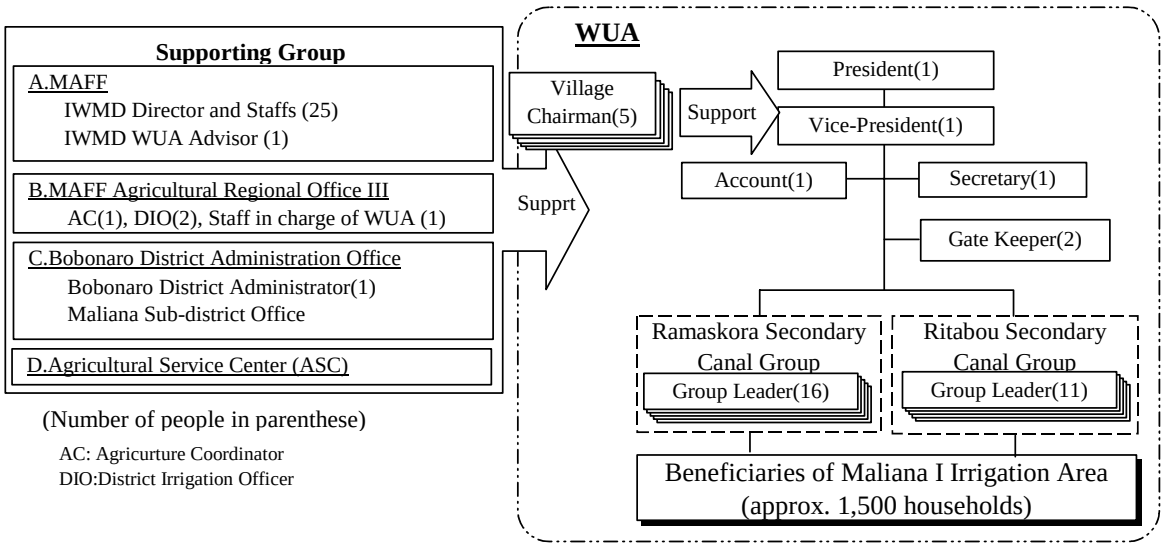

Figure 2-16 Operation and maintenance system and staff arrangement

2-4-2 Contents of Operation and Maintenance Works

The operation and maintenance consists of operation of WUA, instruction and monitoring of cadres on the use of intake facilities, water management and gate operation for WUA and gatekeepers by MAFF, diversion works, O/M of gates, repairing of facilities, dredging of canals etc. by beneficiary farmers and group leaders, as tabulated in Table 2-51.

Table 2-51 Contents of O/M works

Item	Content of practices	Demarcation
A. Operation of WUA	4 managerial cadres are responsible for the operation of WUA	Beneficiary
B. Instructions / monitoring of water management and gate operation	DIO and O/M coordinators under MAFF will give training and monitoring on the use of facilities for the initial 10 years.	MAFF
C. Diversion practices at intake facilities, main canal and secondary ones	2 gatekeepers and 22 group leaders practice the operation of gates at intake facilities and canal diversion gates	Beneficiary
D. O/M of gates (Intake facilities: 8 leafs of gates) (diversion works: 65 leafs of gates)	1) Lubricant injection: lubrication with grease is made once a year at gate spindles (axis of rolling up the gates)	Beneficiary
	2) Recoating painting: gates are repainted for recoating once in 7 years but gates are grouped into 3 years term	Beneficiary
	3) Water-sealing rubber: water sealing rubber is exchanged once in 15 years but gates are grouped into 3-year-term groups	Beneficiary
E. Facility Compensation cost (riprap works, bank protection and slope surface of banks)	Intake facilities, riprap floor at aqueduct, masonry bank protection retaining wall and masonry coated slope of main / secondary canals are checked once a year and repairings are made whenever necessary parts are found	Beneficiary
F. Routine works for O/M	Sediment evacuation works in sediment settling basin, canal dredging works, sediment removal from intake, weeding in canals are done in routine works	Beneficiary (labor portion)

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

The overall construction cost is estimated as 738.1 million yen which consists of 737.8 million yen of the cost is to be born by Japan and 0.34 million yen by Timor-Leste under the "(3) Conditions of estimation". However, it should be noted that this cost estimate is provisional and not the amound of this grant on E/N.

(1) Project cost to be undertaken by Japan: approximately 737.8 million J.Yen

Table 2-52 Project cost to be undertaken by Japan

Estimated project cost 737.8 million J. Yen

Items			Estimated project cost (million J. Yen)	
Facilities	Intake Facility	Reinforced concrete weir: 1,740m^3, Wet marsonry protection: 190m^3, Scoring sluice gate: 2, Inteke gate: 2 Scoring gate at sedeiment setting basin: 1	192.2	665.3
	Main canal	Wer marsonry lining Canal intake gate: 1, Scoring sluice gate: 1 Wet marsonry protection at aquaduct bridge: 240m^3	164.0	
	Ramaskora secondary canal	Wer marsonry lining, Diversion: 13 Drop structure: 2 etc.	124.2	
	Ritabau secondary canal	Wer marsonry lining, Diversion: 15 Drop structure: 17 etc.	155.1	
	Building Facilites	Gate keeper's hut: 14.7m^2 Storage for O&M equipment: 68m^2 Access road	29.8	
Detail Design/Construction supervison/Soft compornent				72.5

※ This estimated project cost is not the amound of this grant on E/N

(2) Project cost to be undertaken by Timor-Leste：US$ 2,841 (0.34 million J.Yen)

1)	Land acquisition cost for widening canal section	720 US$	(0.086 million J. Yen)
2)	Compensation cost for tree	150 US$	(0.018 million J. Yen)
3)	Land rent for Works of temporary canal at intake weir	202 US$	(0.024 million J. Yen)
4)	Land rent cost for works of bank protection at aqueduct	41 US$	(0.005 million J. Yen)
5)	Land rent cost related to the construction of building facilities	1,728 US$	(0.207 million J. Yen)
6)	Cost of newly constructed tertiary canals by beneficiary	Beneficiaries' contribution	

(3) Conditions of estimation

1) Time of estimation: The estimation was done as of March 2007, at the completion of imprementaion review field study.
2) Exchange rate employed for conversion: 1 US$ = 119.59 J.Yen (US$ is employed as local currency)
3) Construction period: Construction period is specified in the implementation work schedule (9 months).
4) Others：This costestimate is provisional and would be further examinated by the Government of Japan

for the approval Grant.

2-5-2 Operation and Maintenace Cost

(1) Annual operation and maintenance (O/M) cost and water user's fee to be collected

Required operation and maintenance cost (O/M) of this project is estimated at about 16~21 US$ / ha / year in line with the method of calculating O/M costs employed by MAFF. O/M costs consist of 1) allowances to be paid to four board members of WUA after the establishment thereof, 2) personnel cost required for trainings and monitoring after transferring irrigation facilities, 3) operative return for gate operation by gate keeper or by group leaders, 4) costs for maintaining gates such as purchase of rubricating oil, recoating, exchanging water-seal rubber etc., 5) repairing costs for facilities and 6) labor hiring costs for such routine works as manual scouring in scouring sluice and sediment settling basin, regular dredging and weeding etc.(not actually incurred, or shadow cost). In these costs, 1) allowance to be paid to cadres of WUA has not been included in the following estimation since the rates will be decided in the mutual consultation among beneficiaries.

Table 2-53 Required annual O/M cost in each 5-year period for 25 years (unit: US$/year)

Item of cost		Required annual O/M cost in each 5-years (unit: US$/year)					
		1-5th year	6-10th year	11-15th year	16-20th year	21-25th year	Remarks
A. Allowance of WUA board (not estimated)							salary of 4 board members of WUA
B. Personnel cost for instruction	1) DIO advisor	240	240	-	-	-	estimated up to 10th year
	2) OM coordinator	1,800	1,800	-	-	-	estimated up to 10th year
	3) Manipulation (M) of intake gates	900	900	900	900	900	estimated up to 11th year as gate keeper
C. Water distribution works	1) (M) offtake gates	2,640	2,640	2,640	2,640	2,640	22 persons of Group Leaders
	2) (M) intake gate	180	180	180	180	180	1 intake gate keeper
D. Maintenance cost of gates (intake F.) for 8 leaves of gate	1) Lubricant injection	502	628	628	628	628	Taking place once a year
	2) Recoating painting	0	673	673	224	449	Once in 7 years div by 3 terms
	3) WT Rubber exchange	0	0	623	1,246	0	Once in 15 years div by 3 terms
(offtake Facility) for 65 leaves of gate	1)Lubricant injection	632	790	790	790	790	Taking place once a year
	2)Recoating painting	0	1,093	1,093	364	729	Once in 7 years div by 3 terms
	3) WS Rubber exchange	0	0	810	1,620	0	Once in 15 years div by 3 terms
E. Compensatory cost for Facility	1) Riverbed protection works	695	869	869	869	869	3% of direct construction cost for riverbed protection works
	2) Riprap bank protection	2,190	2,737	2,737	2,737	2,737	2% of ditto for bank protection
	3) Main canal	1,099	1,373	1,373	1,373	1,373	1% of ditto for bank lining
	4) Ramaskora 2ndary	2,116	2,645	2,645	2,645	2,645	1% of ditto for bank lining
	5) Ritabau 2ndary canal	2,135	2,668	2,668	2,668	2,668	1% of ditto for bank lining
F.OMRoutine works (labor-cost component)	1) Dredging works	801	801	801	801	801	Scouring works：267 m^3/year
	2) Weeding in canals	1,610	1,610	1,610	1,610	1,610	total length weeding 10.7 km/year
Total operation/maintenance (O/M) (US$/year)		17,539	21,647	21,040	21,296	19,018	
Annual mean O/M cost /ha(US$/ha/year)		16.7	20.6	20.0	20.3	18.1	Target area：1,050ha

Note: 1) In the table, items A, B and C are decided through conferring among members. O/M cost for B, C is provisional by MAFF.
2) F is labor contribution among beneficiary farmers where no real expense takes place.

(2) Balance between annual operation and maintenance (O/M) cost and amount of water fee collected

The following amounts of O/M cost as shown in the below table are resulted from the phased estimation in compliance with "the policy for WUA and O/M of irrigation facilities (draft)", and subsidies by MAFF is counted on the other, where the project period is divided into three phases; namely, 1) the 1st period of initial 5 years with the subsidy equivalent to 70% of the O/M cost, 2) the 2nd period from 6th to 10th year with the subsidy equivalent to 30% of the O/M cost and 3) the 3rd period after 11th year or later without any subsidy or after transferring irrigation facilities to WUA until 25th year during which re-coating of gates (every 7 years) and exchange of rubber seal (every 15 years) will take place.

Table 2-54 Required annual water fee for 25 years to be collected from WUA

Items	Period	1st period	2nd period	3rd period			
		1-5th year	6-10th year	11-15th year	16-20th year	21-25th year	average
Annual A.V. O/M Cost	(US$/year)	17,539	21,647	21,040	21,296	19,018	20,451
Subsidy from MAFF: (1-5th year: 70%, 6-10th year: 30%)	(US$/year)	12,277 (70%)	6,494 (30%)	0	0	0	0
Necessary Annual Water Fee collected from WUA	(US$/year)	5,262	15,153	21,040	21,296	19,018	20,451
Required Annual Water Fee collected from WUA / ha	(US$/ha)	5.0	14.4	20.0	20.3	18.1	19.5

Plan of water fee collection from beneficiary users can be examined based on the necessary annual O/M cost shown in Table 2-56. Provided necessary O/M cost is borne by water fee collection under the condition below, "Balance of the water fee collected" for 25 years after rehabilitation is shown in "reference 6-12 Balance sheet for O/M cost and water fee collecting by year".

Conditions for calculation on balance of O/M cost and collected amount of water fee

1) The water fee collected shall be set enough to meet necessary annual O/M cost. Moreover, the remainder shall be reserved for re-coating of gate (every 7 years) and exchange of rubber seal (every 15 years), and the amount of water fee shall be determined in a way no deficit in deposit shall occur.
2) The interest 1.5% is taken into account.
3) Out of the above-cited water fee, fixed rate of water fee is applied to the planted area in rainy season (75%) and piece rates of water (user's) fee are applied to the planted area in dry season (25%).
4) Water fee collected at piece rates is 80% of usual once in 5 years, taking account of the low-flow reliability.

Table 2-55 Consideration of required annual O/M cost in each 5-year preiod

Period	Required annual O/M Cost	Water Fee Collected
1. 1st period: 1-5th year (5 years)	5.0 US$/ha	5.5 US$/ha shall be collected because the amount in the left column cannot offset the shortfall for the drought year occurring once in 5 years. The remainder is reserved for the cost of gate re-paint in 2nd phase.
2. 2nd period: 6-10th year (5 years)	14.4 US$/ha	15.5 US$/ha shall be collected because the amount in the left column cannot bear the re-coating cost for 3 years from 6th to 8th year, and the remainder is reserved for the cost of gate re-paint (every 7 years) and rubber seal exchange (every 15 years) in 3rd phase.
3. 3rd period (a): 11-15th year (5 years)	20.0 US$/ha	20.5 US$/ha shall be collected because the amount in the lowest left column is not enough to bear the cost of gate re-coating and rubber seal exchange occur continuously for 6 years from 12th to 17th year.
4. 3rd period (b): 16-20th year (5 years)	20.3 US$/ha	
5. 3rd period (b): 21-25th year (5 years)	18.1 US$/ha	
Average of 3rd period	19.5 US$/ha	
6. 4th phaseafter 26th year	Repeating the same in 3rd period	

The result of the above tabulated cost balance estimation is compiled in Table 2-57. In preparation for the concentrated cost incurring during the 3rd period from 12th to 17th year, the fixed amount, 20.5 US$/ha will annually be collected throughout the whole cycle. In this estimation, the total collected amount comes to 428,610 US$.

Table 2-56 Examination on the balance of the annual water fee in each 5-years period for 25 years

Cycle period		1st period	2nd period	3rd period (a)	3rd period (b)		Remarks
MAFF subsidy		70%	30%	No MAFF subsidy applied			
year		1st~5th year	6st~10th year	11th-15th year	16th-20th year	21th-25th year	
Annual mean water fee (US$/ha)		5.0	14.4	20.0	20.3	18.1	Counting MAFF subsidy
Water fee to be collected (US$/ha)	Fixed fee	4.0	12.0	15.0			equiv. to cropped area r.s.75%
	Piece rate fee	1.5	3.5	5.5			equiv. to cropped area r.s.25%
	Total	5.5	15.5	20.5			Total for 25 years
Every 5 years cumulative depo. amount		2,422	7,635	9,810	10,350	22,948	428,610 US$

Note: equiv. : equivalent, r.s.: rainy season. d.s : dry season, depo: deposit reserve

(3) Relevance of the amount of collected water fee

① Compatibility with other projects

This proposal assumes the application of the subsidy from MAFF and the rate of water fee is planned at gradual escalation from initial 5 US$/ha to maximum 22 US$/ha (option-2). In the WB F/S report the O/M cost after implementation of the Project is estimated at 26 US$/ha and the same amount is applied to water fee. In addition, MAFF has imposed an obligation of setting water fee to be collected to the irrigation systems under rehabilitation or planned assisted by the WB and/or other international consultants in the light of " Policy for WUA and O/M of irrigation facilities (draft)", where the level of water fee is estimated at 20

～25 US$/ha. This amount, to be collected from the users, is considered almost equivalent to that suggested in the Project.

② The amount of voluntarily payable fee by the beneficiaries

MAFF held a workshop held in January 14, 2006 at the site of Maliana I at the occasion of explaining outline of basic design, inviting 5 village chiefs, group leaders etc. It presented the principles in this workshop of "1) to assist establishment of WUA and to monitor after the establishment, 2) to assist WUA by providing subsidy on the O/M cost at the rate of 70% for the initial 5 years after the rehabilitation of existing facilities followed by the rate of 30% during 6^{th} - 10^{th} year". Then it made the attendants recognize that the subsidy rate is reduced from 70% to 30% from the 6^{th} year and completely lifted from the 11^{th} year. Later, 5 village chiefs were asked their intention to pay for water fee at the initial stage of rehabilitated irrigation. There was a wide range among their reply from 1 to 10 US$/ha, but after a long consultation they gave the final reply of the level "around 5 US$/ha at the initial stage".

And at workshop held in February 28, 2007, board members of WUA and group leaders expressed that 5.5 US$/ha for first 5 years and 15.5 US$/ha for second 5 years were affordable amout. While taking the fee of puddling tractor for lease 60 US$/ha/day, 20.5 US$/ha of the proposed future rate of water fee, is considered reasonable rate imposed from 11^{th} year or later provided that irrigation is securely performed allowing paddy yield to increase.

③ Post-Project gross earnings and collectable amount of water fee

The gross earnings of the beneficiaries of Maliana I irrigation system after rehabilitation is estimated in Table 2-58. With regards to planted area, it's assumed to plant paddy over the irrigated command of 1,050 ha as water intake is stabilized in rainy season. In dry season, it's planned to cultivate paddy on 150 ha irrigated area and maize on 200 ha. Assuming that the beneficiaries sell their crop at the purchasing price set by ASC, the annual gross earnings is estimated at 545 US$/ha.

Table 2-57 Estimation of gross earnings after the Project implementation

		Planted area (ha)	Unit yield (ton/ha)*1)	Production (ton)	Purchasing Price set by ASC (US$/ton)*2)	Gross earnings (US$)	Gross earnings (US$/ha)
1.Rainy season	1) Irrigated Paddy	1,050	2.8	2,940	130	382,200	364 US$/ha
2.Dry season	1) Irrigated Paddy	150	2.8	420	130	54,600	
	2) Maize	200	2.7	540	250	135,000	
	Sub-total	350				189,600	542 US$/ha
Annual (a Rainy season plus a Dry season) gross earnings		1,050				571,800	**545 US$/ha**

Remarks: *1) The current maximum unit yield in the result of baseline survey is applied.
*2) The result of hearing from ASC office of Bobonaro district.

Among the Asian countries where O/M of irrigation system is transferred to WUA, water fee equivalent to about 3-4% of gross earnings of the irrigation beneficiaries is collected in the Philippines. In Mexico, the national economy has been facing hardship since 1980's and the program to transfer O/M to WUA is on the

way. Under the assistance of the WB, IIMI (International Irrigation Management Institute) has been studying the relevance of the amount of water fee for a long time, yielding a result that the amount beneficiaries can pay continuously is about 3-5% of gross earnings.

Table 2-58 Ratio of the water fee to gross earnings

Cycle	1st Period	2nd Period	3rd Period(a)	3rd Period(b)		Remarks
	1-5th year	6-10th year	11-15th year	16-20th year	21-25th year	
Amount of water fee (US$/ha)	5.5	15.5	20.5			Annual gross earnings : 545 US$/ha
Ratio to gross earnings (%)	1.0%	2.8%	3.8%			

Judging from what is mentioned above, the amount of water fee collection from 11th year or later, of 20.5 US$/ha, is considered relevant since the amount is equivalent to around 4.0% of the gross annual gain.

④ Proposal of reserve management

Micro Finance Institute is currently leasing micro credit at an annual interest rate of 18% in Maliana I area and some of the beneficiary farmers utilize it. According to the estimated balance of the reserve of water fee shown in Appendix 6-12 "Balance Sheet for O/M Cost by and Water Fee Collecting by Year", the amount of reserve is 15,000 US$ for 15 years after 11th year. It's expected that the instruction of financial management to make use of this reserve in the soft component plan would contribute to the enlightenment for improving rate of water fee collection.

2-6 Other Relevant Issues

(1) Environmental and social consideration

As regards to environmental and social consideration, MAFF submitted the application for development to SSECTOPD in April 2005. SSECTOPD conducted a site study for screening environmental impacts and judged that the applied project is classified as category B, and informed MAFF to formulate an EMP in compliance with the environmental guideline (January 2006).

From now, MAFF will provide an EMP in line with the environmental guideline to ask for the approval of SSECTOPD prior to the Project implementation, and this is a precondition to implement the Project.

(2) Strengthening of sustainable operation system of WUA

According to "Policy for WUA and O/M of irrigation facilities (draft)", MAFF assists establishment of WUA and strengthening of its management, and from 11th year after rehabilitating irrigation facilities and later it will completely transfer their operation and maintenance to WUA. During the transitional period, MAFF is requested to share the cost and to monitor towards WUA including what is contained in the framed article shown below; The board members of WUA has already been elected in March 2006, thus its activities are expected to develop. In this respect, it is indispensable that MAFF provides sustainable support for strengthening management of WUA towards the realization of proper management and O/M after the rehabilitation of irrigation facilities.

"**Outline of the Policy for WUA and O/M of Irrigation Facilities (draft)**"
(Abstract of JICA short-term Expert Report)

(1) A WUA shall be established in every rehabilitated/newly constructed irrigation scheme, and all the farmers under each irrigation scheme shall be organized into the WUA established.
(2) All the WUAs established shall be registered as the juridical organizations.
(3) Irrigation water fee shall be collected from all the farmers belonging to the designated WUA, and WUA will keep the fee in the bank account established, and the water fee collected shall be used for O/M of the irrigation facilities as required.
(4) WUA shall implement, at its own expense, such construction works as additional construction of irrigation canal systems including construction of attached structures, which exceed the responsibility of the Government.
(5) All the rehabilitated/newly constructed irrigation schemes shall be taken over by the designated WUAs, and WUAS shall be responsible for O/M of the irrigation facilities. The Government shall provide the Seed Fund with WUA for the period of 5 years after taking over the irrigation scheme by the WUA. The Seed Fund will help farmers buy seeds and accelerate O/M activities of the irrigation facilities by the farmers. The draft O/M also suggests that 30% of the Seed Fund shall be borne by the farmers.

(6) The cost sharing in O/M of the irrigation facilities between the Government and the farmers is suggested as follows;
Cost Sharing in Major Repairs
(First year to Fifth year)
1) 70% of the total cost shall be borne by the Government, including cash, materials, fuel and technical assistance etc.
2) 30% of the total cost shall be borne by the farmers, including the cost for materials and labors.
(Sixth year to 10th year)
1) 30% of the total cost shall be borne by the Government.
2) 70% of the total cost shall be borne by the farmers.
(Beyond the 11th year)
No cost for O/M of the irrigation facilities shall be borne by the Government budget; instead, WUA shall bear all the cost required for O/M of the irrigation facilities.
Cost Sharing in Minor Repairs
All the minor repairs of the irrigation facilities shall be made by the WUAs at their own cost, and no subsidies shall be made by the Government.

(7) The draft O/M suggests that Irrigation Systems Management Committee (ISMC) should be established in every district of the country. ISMC shall consist of government officials, members of the WUA, and NGOs. In the committee, problems with respect to agricultural production, such as yield, pests, and irrigation water distribution etc. will be discussed based on their experiences. And the outcomes from the discussions will be utilized for improvement in agricultural production as well as improvement in the technique for o/M of the irrigation facilities. According to the draft O/M manual, ISMC should be held at least 3 times during farming period, i.e., the first meeting before commencement of irrigation, the second during irrigation, and the third meeting after finishing irrigation. In the case, members of the WUA request to hold another meeting to discuss important issues with respect to farming activities and WUA, the irrigation officers in charge shall call another meeting to settle the problems.

(3) Budgetary provision for the expense items to be borne by Timor-Leste

In implementing Grant aid scheme, Timor-Leste is required to bear the cost of land acquisition cost accompanying with widening the width of canals, cost of land rent for temporary canals for rehabilitation

works of the intake weir and for works of protection wall for aqueduct etc. The amount to be undetaken by Timor-Leste is estimated at 2,841 US$ (or about 340 thousand J.Yen), and this amount is considered small as compared to annual budgetary account of MAFF, 14,009 thousand US$ (fiscal year 2006/2007), thus it is considered within bearable extent. On the other hand, MAFF is requested to explain the construction of tertiary canals (about 12 km in length), the component to be borne by the beneficiary, to the beneficiary people, where the relevant assistance and instruction thereof is required (refer to Table 2-53 "Cost to be undertaken by Timor-Leste").

Chapter 3 Project Evaluation and Recommendations

Chapter 3 Project Evaluation and Recommendations

3-1 Project Effect

3-1-1 Direct Effect

(1) Effect by the rehabilitation of the fixed weir at the raised but lost portion by 0.70 m damaged by flood

By rehabilitating the washed out portion (0.7 m) of Maliana I fixed weir by flood, direct effect is brought about by the improved state as compared to currently insufficient intake from the water source Bulobo River. As indicated in Table 3-1, the peak intake discharge during rainy season will be increased from 0.88 m^3/sec to 1.37 m^3/sec, or by 0.49 m^3/sec.

Table 3-1 Increase in water intake discharge

	2007(at present)	2009 (with Project)
Peak intake discharge	0.88 m^3/sec	1.37 m^3/sec

(2) Effect by the implementation of the Soft component plan

Necessity of adequately managing, operating and maintaining irrigation facilities by WUA are recognized through the implementation of the soft component plan, thus acceptable amount and method of collecting water fee from the users in the first year are determined. Furthermore, gates installed at sediment scouring sluice, water intake, sediment settling basin and gates installed at turnouts are properly operated in a linkage and irrigation water is distributed to tertiary canals. In addition, it is expected that WUA members can avail the practical manual on water management. The direct achievement and what should be identified as the degree of achievement and means of identification are tabulated in Table 3-2. In this context, questionnaire surveys will be made towards the same WUA members (beneficiary households) with the same contents of inquiry sheets before and after the implementation of soft component plan, in order to identify the degree of the achieved performances through questionnaire survey.

Table 3-2 Purpose and effects of the Soft component plan

Purpose of the soft component(3 years after the expiry of the Project)	Performances of the soft component (at the completion of soft component activities)	Factor of identifying degree of performances	Measures to identify them (period and frequency)
(1) Disciplinary in terms of organizational management			
a) WUA is active and soundly functioning	① Necessity of proper management and O/M of irrigation facilities is recognized and accepted	• Degree of understanding of WUA members	Questionnaire: (twice, before and after soft component plan)
b) Water fee is regularly collected	② Affordable amount and method of water fee collection are established	• Degree of acceptance of WUA members	Questionnaire: (once, after soft component plan)
(2) Disciplinary in terms of water management			
c) Efficient water intake and water management are practiced	① Gates installed at sediment scouring sluice, water intake, sediment settling basin, canal intake turnouts are properly operated in a linkage	• Maturity of skill in operating gates by gate keepers / members	Operational identification: (before and after soft component plan)
	② Irrigation water is distributed up to the tertiary canals	• About 12km of the conveyance distance of new tertiary canals	Site confirmation (twice, just after constructing tertiary and after on-the-site training)
	③ Practical water management manual available to WUA members is provided	• Extent of satisfaction of WUA members	Questionnaire: (once, after soft component plan)

(3) Mitigation of labor burden on construction of masonry guide wall and removal of sediment

It is expected that the construction of scouring sluice by the Project enables to dispense construction of masonry guide wall that have been practiced by the beneficiary people three times a year, dredging works (the volume of flown-in boulder and gravel: 150 m^3/year) and also occasional repairing works. Besides, labor of sediment evacuation will be eased by the rehabilitation replacement of sediment settling basin and the scouring sluice gate installed in the main canal, leading to expected alleviation of labor burden thereon.

3-1-2 Indirect Effect

Expansion of irrigation area for paddy by the increase of intake discharge

Table 3-3 Expansion of irrigation area for paddy by the increase of intake discharge

Irrigated paddy	2007 (at present)		2009 (post-project)	
	Peak intake	Irrigable area	Peak intake	Irrigable area
Rainy season	0.88 m^3/s*1)	600 ha	1.35 m^3/s*2)	1,050 ha
Dry season	0.23 m^3/s*3)	100 ha	0.34 m^3/s*2)	150 ha

Note: *1) actual measurement in main canals,
*2) planned design intake (not including intake for domestic water),
*3) estimated from unit water quantity at post-project stage.

3-1-3 Other Anticipated Effect

Assumed damage of collapse of the existing Aqueduct（Effect of renewal）

Provided that the current status continues without implementation of the Project, the scouring around bank protecting wall at the aqueduct will be progressed, increasing risk of eventual fall and collapse. If it fell down, irrigation water supply to the beneficiary command would completely be interrupted and the command cannot help relying on rainfed only. The proposed Project can obviate before it happens.

The annual amount of assumed damage is estimated at 218.3 thousand US$ as shown in Table 3-4 by multiplying unit sale price to the actual production of irrigated paddy and irrigated upland crops.

Table 3-4 Amount of assumed annual damage caused by collapse of the existing Aqueduct

		2007 (present state)				Amount of annual damage
		Cropped area	Unit yield	Production	Sale price[*1)]	
Rainy season crop	Irrigated paddy	600 ha	2.1 t/ha	1,260 ton	130 US$/ton	163.8 thousand US$/year
Dry season crop	Irrigated paddy	100 ha	1.5 t/ha	150 ton	130 US$/ton	19.5 thousand US$/year
	Irrigated upland	100 ha	1.4 t/ha	140 ton	250 US$/ton	35.0 thousand US$/year
					Total	**218.3** thousand US$/year

Remarks：*1) Sale price referred to is purchasing price by ASC (February 2007)

3-2 Recommendations

3-2-1 Issues to be Undertaken by Timor-Leste Side

According to "Policy for WUA and O/M of irrigation facilities (draft)" by MAFF, operation and management of newly constructed or rehabilitated irrigation facilities are basically transferred to the beneficiaries thereof. Also, this Policy stipulates obligated establishment of WUA, to which the rehabilitated irrigation facilities are completely handed over from MAFF after the 11th year of post-rehabilitation. To ensure the transfer, MAFF is requested, also in this project, not only to provide support and monitor for the beneficiaries during the stage of establishing WUA and the transitional period, but also to urge members of WUA to determine the annual water fee necessary for proper O/M and management of the rehabilitated irrigation facilities, that is affordable for the members to continue payment.

The average amount of water user's fee to be collected for the initial 5 years is estimated at 5 US$/ha/year, from the calculation of O/M cost for the period 1) during the initial 5 years just after the rehabilitation with a subsidy at the rate of 70%, 2) during the next 5 years with a subsidy at 30% and 3) during the period after 11th year without subsidy, according to this policy (draft). In January 2006, MAFF held a workshop at Maliana I irrigation area inviting 5 village chiefs and some group leaders to explain to 1) support the establishment of WUA and to monitor the activities of WUA, 2) to help them by granting subsidy of MAFF for the O/M cost after rehabilitating the facilities. After the explanation, MAFF asked the participants their willingness to pay water user's fee at the initial stage. After the consultation with them, MAFF obtained their reply that "they can afford to pay about 5 US$ in the initial stage". From this result, it was judged that the collection of imposed water user's fee is concluded feasible.

Also, MAFF explained to the participants that even after the granting of subsidy is expired during the period after the 11th year when O/M of the facilities are handed over to WUA, MAFF will be responsible for the support for coping with heavier damages of intake facilities. It means that MAFF will collaborate with WUA in O/M by giving necessary support even after the rehabilitation. However, in the case where subsidy is not applied by MAFF, the amount of water user's fee to be collected will become around 17 US$/ha/year during the initial 5 years, then the amount is far from acceptable by the beneficiary users who do not have any experience of paying water cost.

Therefore, in so far as Timor-Leste observes the above-mentioned Policy (draft), and entrusts WUA to properly manage, operate and maintain irrigation facilities, the realization of strengthening of managerial capacity of WUA and sustainable collection of water user's fee are indispensable. This is why MAFF is requested to pledge support and monitoring for WUA, the granting of subsidy after the rehabilitating facilities, also to explain the methods of these aids to the beneficiaries of the facilities.

3-2-2 Collaboration with Technical Cooperation and Other Donors

In spite that training for scouring sluice gates to be newly installed is needed, most of other facilities are just rehabilitated and replaced. Therefore, when scouring system is to be well functioned through the new scouring sluice gates at fixed weir and replacing gate at sediment settling basin, 1) labor burden by beneficiaries will be reduced, and 2) dredging by heavy machineries which may be make handling water fee opaque due to much consumption of fuel, is not required, it is acceptable for the WUA. Taking into the above situations, implementation of the soft component under the Japan’s grant aid scheme is sufficient for strengthening WUA, not necessary assisted by any other technical cooperation.

Irrigation advisor (Kenyan) and advisor of water users’ association (Dutch) engaged under the ARP 3 financed by WB have been assisting IWMD. Further collaboration with WB assistance is essential to assure to maintain the Project.